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2009 | Expedition Report

CCGS *Amundsen*

LEG 1B
ArcticNet/Malina
Beaufort Sea

LEG 2A
ArcticNet/IORVL
Beaufort Sea

LEG 2B
Malina/ArcticNet
Beaufort Sea

LEG 3A
Geotraces/ArcticNet
Beaufort Sea

LEG 3B
ArcticNet/IORVL
Beaufort Sea

LEG 4A
ArcticNet
Beaufort Sea, Canadian Arctic
Archipelago and Baffin Bay

Leg 4B
ArcticNet
Labrador fjords

CCGS *Pierre Radisson*

BaySys/ArcticNet
Hudson Bay

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AMUNDSEN
BRISE-GLACE DE RECHERCHE CANADIEN
CANADIAN RESEARCH ICEBREAKER

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Part II – Project reports

2009 Expedition Report

The 2009 Expedition Report is a collection of all cruise reports produced by the participating research teams and assembled by the Chief Scientists at the end of their leg. The 2009 Expedition Report is divided into two parts:

Part I provides an overview of the *Amundsen* expedition, the ship track and the stations visited, and a synopsis of operations conducted during each leg. Also included is an overview of the operations conducted during the BaySys expedition on board the CCGS *Pierre Radisson*.

Part II contains the reports submitted by the participating science teams or researchers, with details on the specific objectives of their project, the field operations conducted and methodology used, and in some cases, preliminary results. When results are presented, they show the data as they were submitted at the end of the legs in 2009. The data presented in this expedition report are illustrative only and have not been quality checked, thus parties interested in the results should contact the project leader or the researchers who collected the data.

Project reports in Part II are organized according to research topics. The first project presents the core data and information collected onboard the *Amundsen* (pages 63 to 67). Projects 2 to 6 (pages 68 to 129) cover topics of atmosphere, atmosphere-ocean processes and sea ice. Projects 7 to 13 (pages 130 to 210) cover topics of water column structure, ocean circulation and the physical and optical properties of seawater. Geochemical cycling, biogeochemical processes, and biological productivity, including projects from the GEOTRACES program, are treated in projects 14 to 30 (pages 211 to 271). Projects 31 and 32 presents the marine wildlife surveys and bioacoustics projects (pages 272 to 284). The contaminants sampling program is presented in project 33 (pages 285 to 300). Seabed mapping, geology, sediments and benthos, including ROV operations, are covered in projects 34 to 38 (pages 301 to 390).

The 2009 Expedition Report also includes four appendices: 1) the list of stations sampled, 2) the scientific log of activities conducted, 3) a copy of the CTD logbook and 4) the list of participants on board during each leg.

The core navigation data (NAV) and meteorological information (AVOS) as well as oceanographic data collected using the CTD-Rosette, the Moving Vessel Profiler (MVP), the ship-mounted current profiler (SM-ADCP) and the thermosalinograph (TSG) are available in the Polar Data Catalogue (PDC) at www.polardata.ca.

Following ArcticNet's data policy, research teams must submit their metadata to the PDC and insure that their data are archived on the long-term, but it is not mandatory to use the PDC as a long-term archive as long as a link to the data is provided in the metadata (see www.arcticnet.ulaval.ca/Docs/data-policy for more details on data policy).

Part I – Overview and synopsis of operations

1 Overview of the 2009 ArcticNet Expedition

1.1 Introduction

Understanding the transformation of the Arctic environment is one of the great challenges faced by Canadians and the national and international scientific communities. ArcticNet is a Network of Centres of Excellence of Canada that brings together scientists and managers in the natural, human health and social sciences with their partners from Inuit organizations, northern communities, federal and provincial agencies and the private sector to study the impacts of climate change and modernization in the coastal Canadian Arctic.

Since 2004, ArcticNet researchers have been conducting extensive multidisciplinary sampling programs in the Canadian Arctic using the Canadian research icebreaker CCGS *Amundsen*. The overarching goal of the ArcticNet marine-based research program is to study on a long-term basis how climate induced changes are impacting the marine ecosystem, contaminant transport, biogeochemical fluxes, and exchange processes across the ocean-sea ice-atmosphere interface in the Canadian Arctic Ocean. The knowledge generated from this multi-year program is being integrated into regional impact assessments to help decision makers and stakeholders develop effective adaptation strategies for the changing coastal Canadian Arctic.

The geographic scope of the ArcticNet marine-based research program includes the Beaufort Sea in the western Canadian Arctic, the Canadian Arctic Archipelago and Baffin Bay in the eastern Arctic, and extends into Hudson Bay, Ungava Bay and along the northern Labrador coast.

Following its historic 2007-2008 overwintering Expedition to the Arctic in support of the International Polar Year, the CCGS *Amundsen* circumnavigated the North American continent in 2009 as part of a five-month research voyage to the Canadian Arctic. Sailing through the Panama Canal and entering the Arctic Ocean through Bering Strait allowed the vessel to reach its study area in the Beaufort Sea on 13 July, almost one month sooner than by sailing via its usual eastern route through the Northwest Passage. Supporting three major research programs in the Beaufort Sea in 2009, the *Amundsen* took full advantage of the short Western Arctic ice-free summer season.

In the Beaufort Sea, the CCGS *Amundsen* supported ArcticNet researchers that are continuing their sampling efforts (see Phase 2 projects at ArcticNet/Research/Phase2), to help understand and predict the impacts of climate change on the Canadian Arctic marine environment. In addition to their usual annual research expedition, ArcticNet researchers and their collaborators from Imperial Oil also collected environmental, bathymetric and geophysical data in areas of the Beaufort Sea recently awarded offshore exploration licenses by the Government of Canada.

Funded by the Centre national de la recherche scientifique (CNRS) and by the French and European Space Agencies, the French-led Malina project (www.obs-vlfr.fr/Malina) conducted an intensive 28-day mission using the sophisticated equipment of the CCGS *Amundsen* to study the impact of increasing penetration of solar radiation on the marine ecosystem and carbon fluxes of the Arctic Ocean. Led by Dr. M. Babin of the Laboratoire Océanologique de Villefranche, the Malina program involved numerous French and American research institutions (including NASA) and a close collaboration with ArcticNet researchers.

Taking the CCGS *Amundsen* in the deep Arctic pack ice of the Beaufort Sea and Canada Basin, researchers from the Canadian-led GEOTRACES program joined ArcticNet scientists to sample the multi-year ice environment and to identify, characterize and quantify processes that control the distribution and environmental sensitivity of key trace elements and isotopes in the Canadian Arctic Ocean. Led by University of British Columbia Professor R. François, the GEOTRACES expedition was funded by the Canadian International Polar Year (IPY) program (www.apiipy.gc.ca).

Once the sampling operations in the Beaufort Sea were completed by mid-October, the vessel headed back to the Atlantic through the Northwest Passage and supported ArcticNet operations in the Canadian Arctic Archipelago, Baffin Bay and the northern coast of Labrador. The CCGS *Amundsen* concluded its 168-day circumnavigation of North America in Quebec City on 18 November 2009.

Scientific operations were also conducted under the BaySys project in Hudson Bay aboard the CCGS *Pierre Radisson* to study ocean properties near the mouth of rivers, to collect seafloor sediment cores for paleoceanographic analyses and to maintain ArcticNet's network of long-term ocean observatories. These observatories are the oceanic equivalent of atmospheric meteorological stations and their objective is to track changes in the physical, biological and geochemical properties of Hudson Bay waters. These data constitute fundamental information to better understand how global warming is affecting the Bay.

1.2 Regional settings

1.2.1 Beaufort Sea

The Beaufort Sea/Mackenzie Shelf region in the western Canadian Arctic has undergone major changes in recent years, with decreasing sea ice cover and major shifts in sea-ice dynamics. The Beaufort Sea is characterized by a broad shelf onto which the Mackenzie River, the largest river in North America, carries large amounts of freshwater. The mixing of freshwater from the Mackenzie River and Arctic marine waters of the Beaufort Sea establishes an estuarine system over the shelf, with associated inputs of land-derived nutrients and freshwater biota. Along the Mackenzie Shelf stretches the Cape Bathurst polynya, an expanse of open water that exists year-round and is highly productive. This ecosystem is also exceptional since it provides habitat for some of the highest densities of birds and marine mammals in the Arctic Ocean.

Since 2002, ArcticNet has been conducting extensive multidisciplinary research programs in the Beaufort Sea area, including major oceanographic research activities conducted as part of two international overwintering research programs onboard the CCGS *Amundsen* in 2003-2004 (CASES program) and in 2007-2008 (CFL program).

Furthermore, recent interest in the Beaufort Sea has resulted in major bids from industry on offshore exploration licenses (EL) located in the 50-1500 m depth range of the shelf and shelf break. A partnership between ArcticNet and the Oil & Gas industry led to the development of an ambitious environmental and oceanographic research program in the offshore region of the Mackenzie Shelf, shelf slope and Beaufort Sea, starting in 2009. Of particular relevance to the 2009 Expedition is EL446 (called Ajurak) awarded to Imperial Oil (IORVL).

1.2.2 Canadian Arctic Archipelago

The Canadian Arctic Archipelago (CAA) is a vast array of islands and channels that lies between Banks Island in the west and Baffin and Ellesmere Islands in the east. While transiting through the Northwest Passage, the science teams aboard the *Amundsen* sampled the atmosphere, sea ice and ocean to extend existing time series. This work is aimed at better understanding how the ice conditions, oceanography and biogeochemistry are changing under the effects of climate change and industrialization. With dimishing sea ice extent and volume, the Northwest Passage may be ice-free and open to navigation during summer in the near future. Bathymetric data and sub-bottom information were collected while transiting through the Northwest Passage to map the seafloor and identify potential geohazards and obstacles to the safe navigation of this new seaway.

1.2.3 Baffin Bay

Baffin Bay is located between Baffin Island and Greenland and connects the Arctic Ocean and the Northwest Atlantic, providing an important pathway for exchange of heat, salt and other properties between these two oceans. In the south, Davis Strait, which is over 300 km wide and 1000 m deep, connects it with the Atlantic but Baffin Bay’s direct connection to the Arctic Ocean consists of three relatively narrow passages through the islands of the Canadian Arctic Archipelago (CAA). Arctic water also enters Baffin Bay/Davis Strait via the West Greenland Current, which flows northward along the western coast of Greenland. Melting ice sheets, changing sea ice conditions and changing weather also influence oceanographic conditions in Baffin Bay and Davis Strait.

Located in northern Baffin Bay, between Ellesmere Island and Greenland, the North Water (NOW) Polynya is a large, year-round expanse of open water. North Water is the largest (~80,000km^2) and most productive polynya in the Canadian Arctic and, in addition to the tremendous marine bird resources in this area, it is of significance to many species of marine mammals. The polynya has been the subject of a few ecosystem studies, including the Canadian-led study of the NOW Polynya in 1998. In 2009, the *Amundsen* served as a research platform to extend the time series of oceanographic data collected during the NOW Polynya program.

1.2.4 Hudson Bay

Hudson Bay is a virtually landlocked, immense inland sea that possesses unique characteristics among the world's oceans: a limited connection with the Arctic and Atlantic Oceans, a low salinity resulting from a high volume of freshwater inputs from numerous rivers that drain central North America, and it is completely ice covered in winter while summer is characterized by ice-free conditions. In Hudson Bay, research activities focused on the influence of riverine inputs into the Bay as part of the BaySys project and on the servicing of ArcticNet's oceanographic moorings deployed annually in the Bay since 2005.

1.3 2009 *Amundsen* Expedition Plan

1.3.1 General schedule

The 2009 Expedition started from Quebec City on 4 June and ended on 18 November, traveling a total of 28 380 nautical miles in 168 days (Figure 1.1). Onboard the CCGS *Amundsen,* the expedition was divided in 4 separate 42-day legs, with over two of them spent in the Beaufort Sea region. Based on the scientific objectives, each leg was further sub-divided into two segments.

1.3.2 Leg 1a – 4 June to 30 June 2009 – Quebec City to Victoria, BC (via Panama Canal) Leg 1b – ArcticNet/Malina – 30 June to 16 July 2009 – Bering Sea, Chukchi Sea and Beaufort Sea

Leaving Quebec City on 4 June, the vessel sailed to the western Arctic through the Panama Canal route (Figure 1.1). Following a mobilization and refuelling stop in Victoria, BC, the ship reached Point Barrow, Alaska (USA), on 12 July and entered the Mackenzie Shelf study area on 13 July. Once on site, the *Amundsen* completed bathymetric surveys in the Imperial Oil exploration acreage (Ajurak) until the 16 July crew change in Sachs Harbour (Figure 1.2).

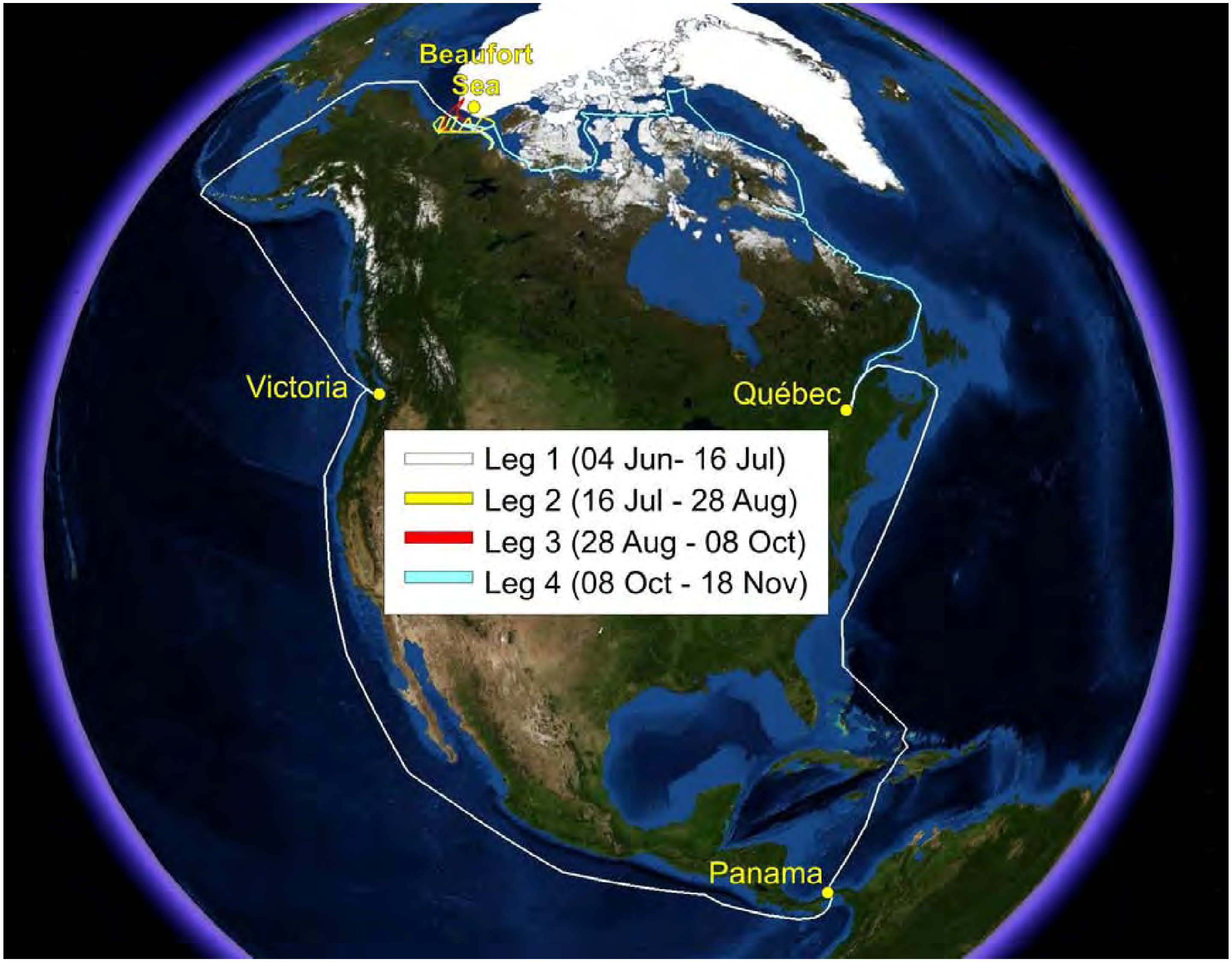

Figure 1.1. Overview of the CCGS *Amundsen* ship track during the 2009 ArcticNet Expedition: Leg 1a from Quebec City to Victoria (BC) via the Panama Canal; Leg 1b from Victoria to the Beaufort Sea; Legs 2a, 2b, 3a, 3b & 4a in the Beaufort Sea region, Leg 4a in the Canadian Arctic Archipelago and Baffin Bay; Leg 4b in the Labrador fjords. Not shown on this map are the locations of ArcticNet/BaySys oceanographic and mooring operations in Hudson Bay conducted aboard the CCGS *Pierre Radisson*.

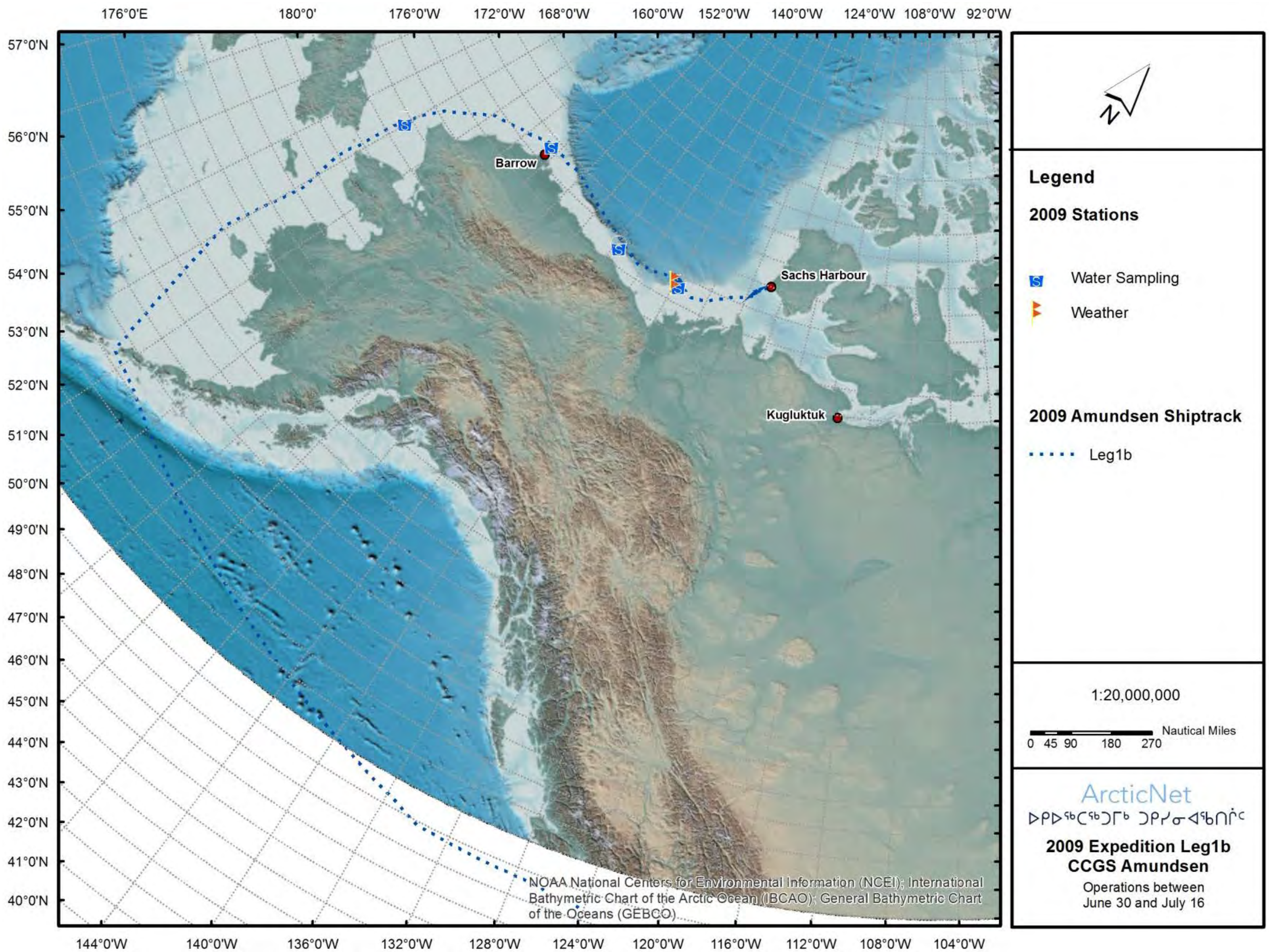

Figure 1.2. Map of the North Pacific, Bering Sea & Strait and Beaufort Sea showing the CCGS *Amundsen* ship track and the location of stations for Leg 1b of the 2009 ArcticNet Expedition.

1.3.3 Leg 2a – ArcticNet/IORVL – 16 July to 30 July 2009 – Beaufort Sea

Leg 2a started from Sachs Harbour on 16 July and was dedicated to mooring and oceanographic sampling operations in the Beaufort Sea, in and around the Ajurak offshore exploration acreage, in partnership with Imperial Oil (IORVL). The ship sailed back towards Sachs Harbour on 30 July (Figure 1.3).

1.3.4 Leg 2b – Malina/ArcticNet – 30 July to 28 August 2009 – Beaufort Sea

Operations and sampling were led and performed by the French Malina project in collaboration with ArcticNet. During this 28-day leg, sampling operations took place along 7 inshore-offshore transects in the Beaufort Sea/Mackenzie Shelf area, similar to the ones sampled by ArcticNet since 2004. Operations included seafloor mapping, measurements of meteorological variables and the physico-chemical properties of the water column, as well as the sampling of seawater, sediment, benthic organisms, plankton and larval fish (Figure 1.4).

1.3.5 Leg 3a – GEOTRACES/ArcticNet – 28 August to 12 September 2009 – Beaufort Sea

Starting in Paulatuk on 27 August, Leg 3a focused on the objectives of the Canadian International Polar Year GEOTRACES program as well as ArcticNet/Imperial Oil sea-ice research. Operations consisted of seawater, Met/Ocean and sea-ice sampling along an inshore-offshore transect entering the multi-year ice pack and Canada Basin. The ship's helicopter was also used to conduct sea-ice and Met/Ocean sampling on targeted multi-year ice floes (Figure 1.5).

1.3.6 Leg 3b – ArcticNet/IORVL – 12 September to 8 October 2009 – Beaufort Sea

As part of the ArcticNet/Imperial Oil collaboration, a total of 28 days were spent in the Ajurak exploration acreage in the Beaufort Sea to conduct geotechnical work (piston and box coring) and bathymetric surveys (Figure 1.6). A Met/Ocean moored surface buoy was deployed in open water for the duration of Leg 3b. Mooring operations also included servicing and redeploying subsurface moorings first deployed during Leg 2a in Ajurak. The Vessel sailed back towards Paulatuk on 8 October.

1.3.7 Leg 4a – ArcticNet/CHONe – 8 October to 6 November 2009 – Beaufort Sea, Canadian Arctic Archipelago and Baffin Bay

This final leg of the 2009 Expedition was led by ArcticNet. Following retrieval and redeployment of ArcticNet subsurface moorings (deployed annually since 2004) in Amundsen Gulf, the ship headed east to conduct sampling operations in Queen Maud Gulf, Peel Sound, Barrow Strait, Lancaster Sound and finally in Baffin Bay (Figure 1.7 and 1.8).

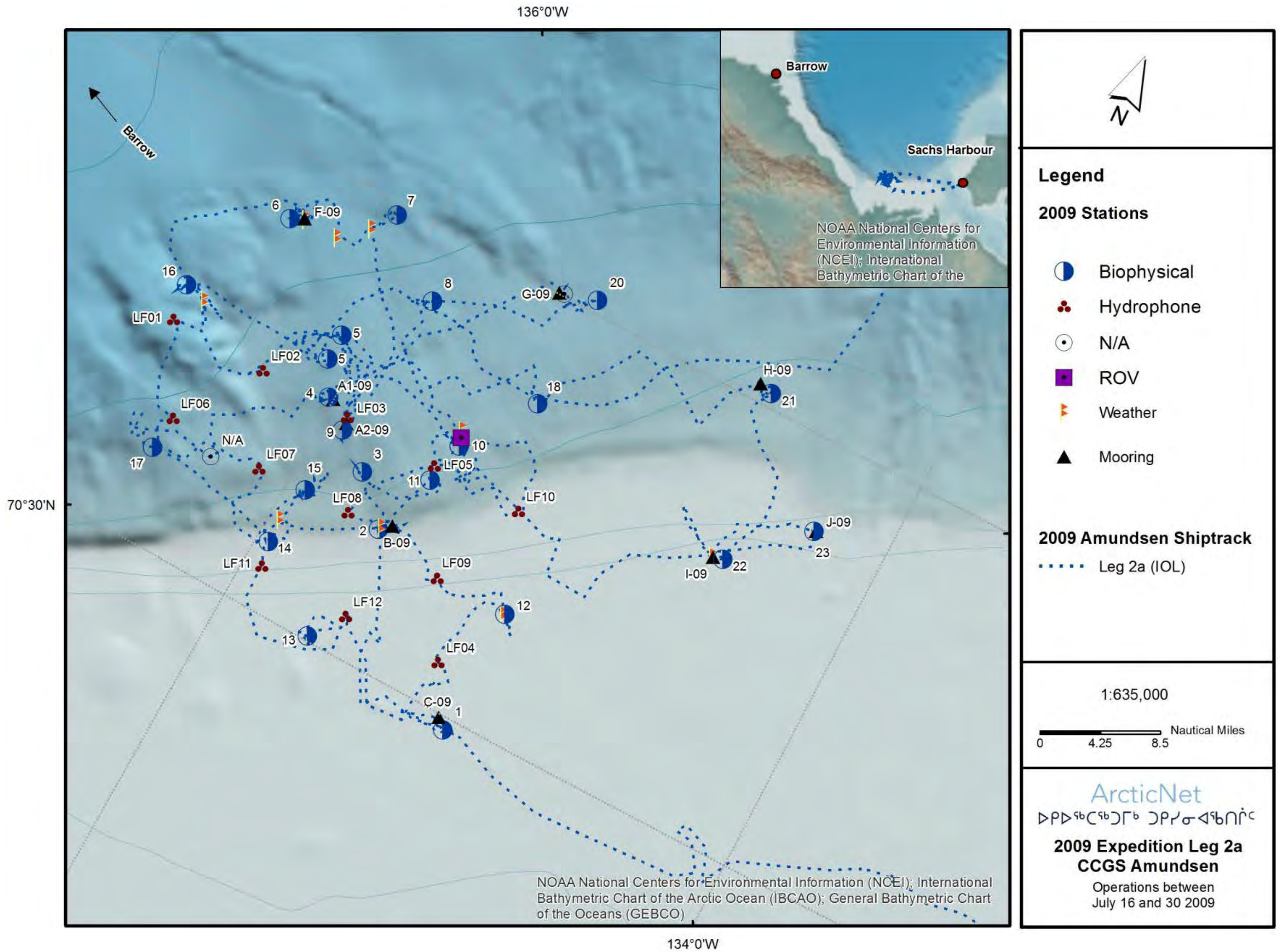

Figure 1.3. Map of the Beaufort Sea and IOL's Ajurak exploration acreage showing the ship track and the location of stations and mooring sites visited by the CCGS *Amundsen* during Leg 2a of the 2009 ArcticNet Expedition.

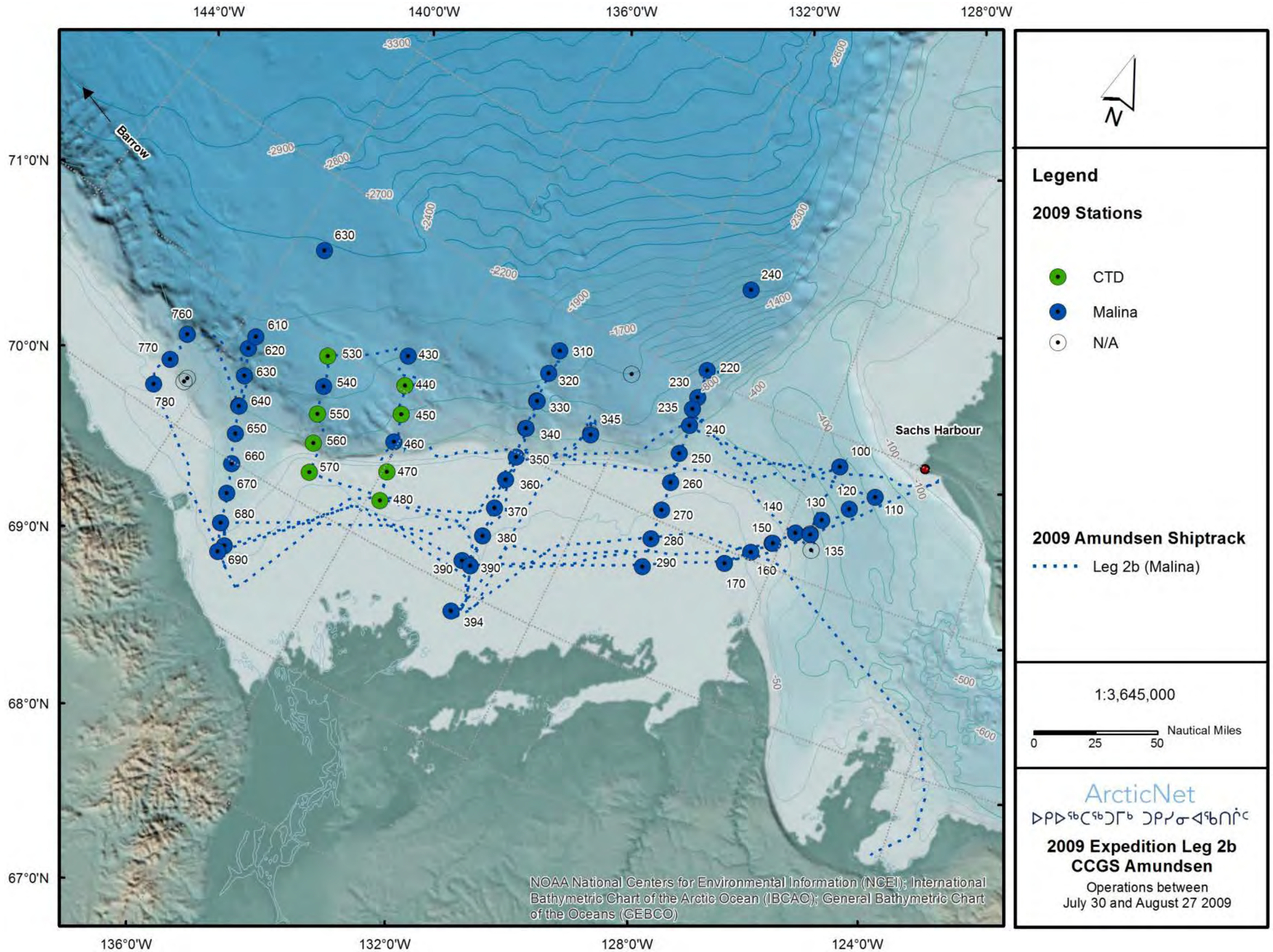

Figure 1.4. Map of the Beaufort Sea showing the ship track and the location of stations sampled by the CCGS *Amundsen* in support of the French-led Malina research program during Leg 2b of the 2009 Expedition.

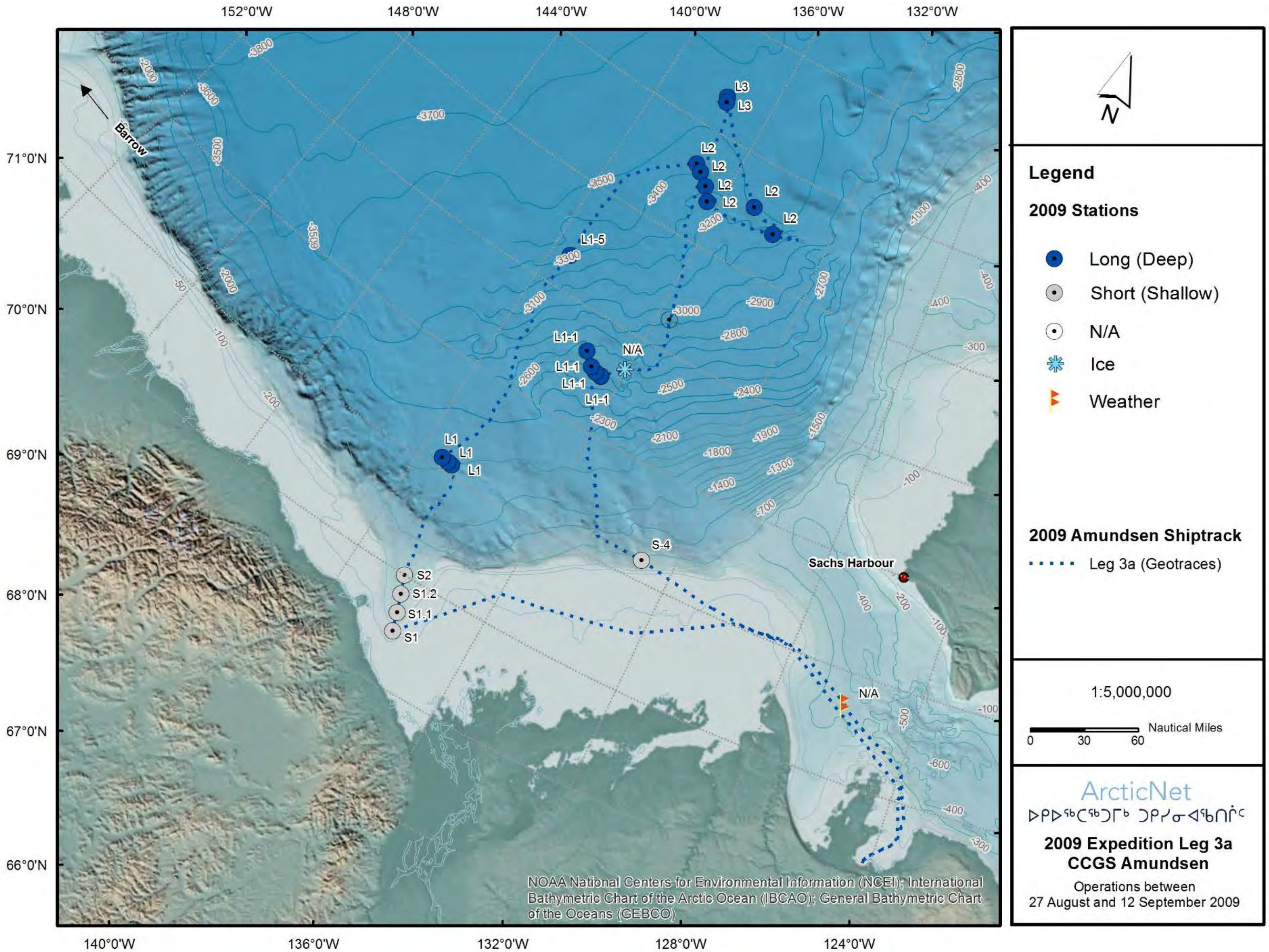

Figure 1.5. Map of the Beaufort Sea showing the ship track and the location of stations sampled by the CCGS *Amundsen* in support of the IPY-GEOTRACES research program during Leg 3a of the 2009 ArcticNet Expedition.

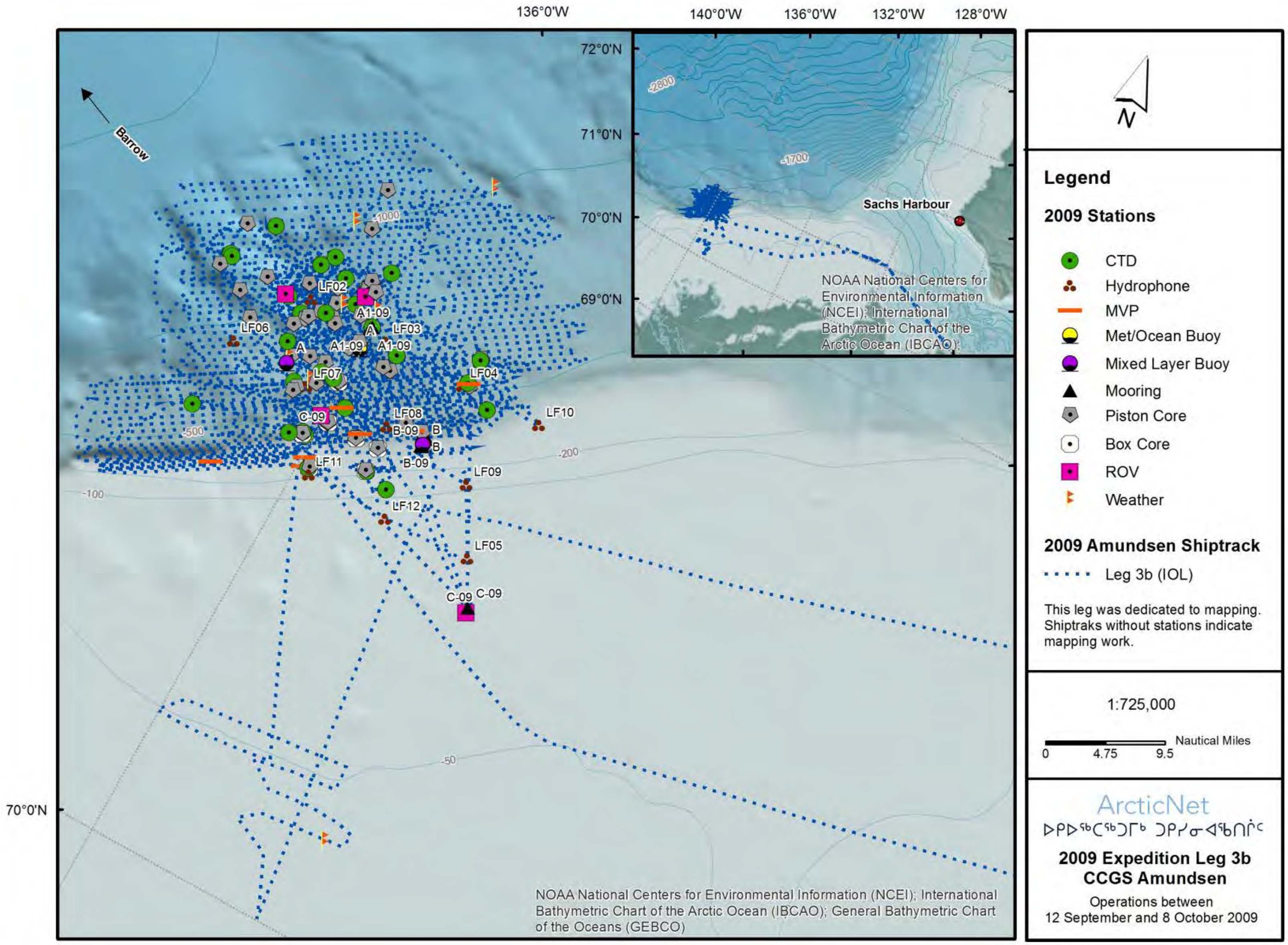

Figure 1.6. Map of the Beaufort Sea and IOL's Ajurak exploration acreage showing the ship track and the location of stations and mooring sites visited by the CCGS *Amundsen* during Leg 3b of the 2009 ArcticNet Expedition. Ship track with no stations represents seabed mapping activities.

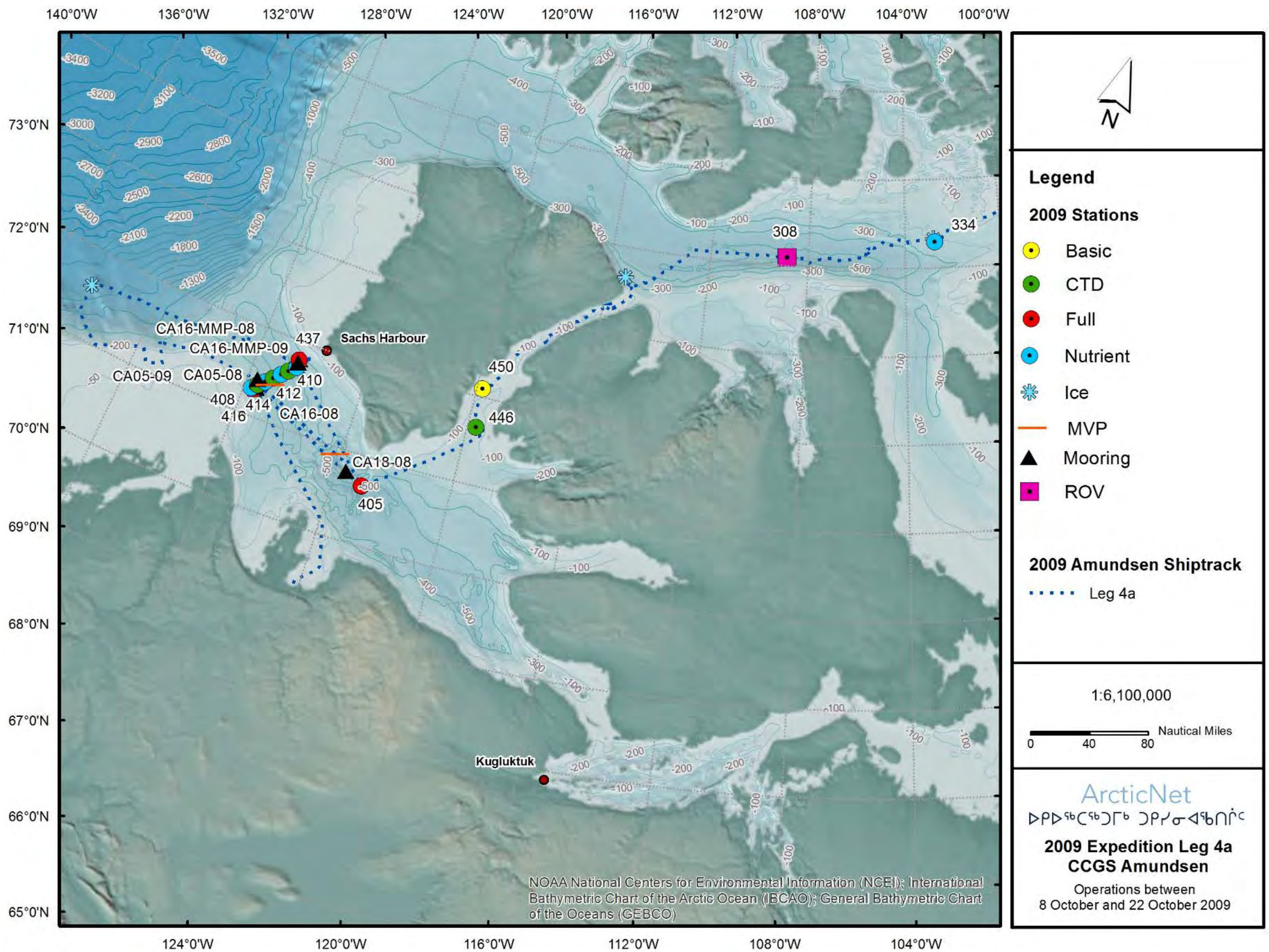

Figure 1.7. Ship track and the location of stations and mooring sites where operations were conducted aboard the CCGS *Amundsen* for ArcticNet's marine-based research program in the Beaufort Sea, Amundsen Gulf, Prince of Wales Strait and Viscount Melville Sound during the first part of Leg 4a of the 2009 ArcticNet Expedition.

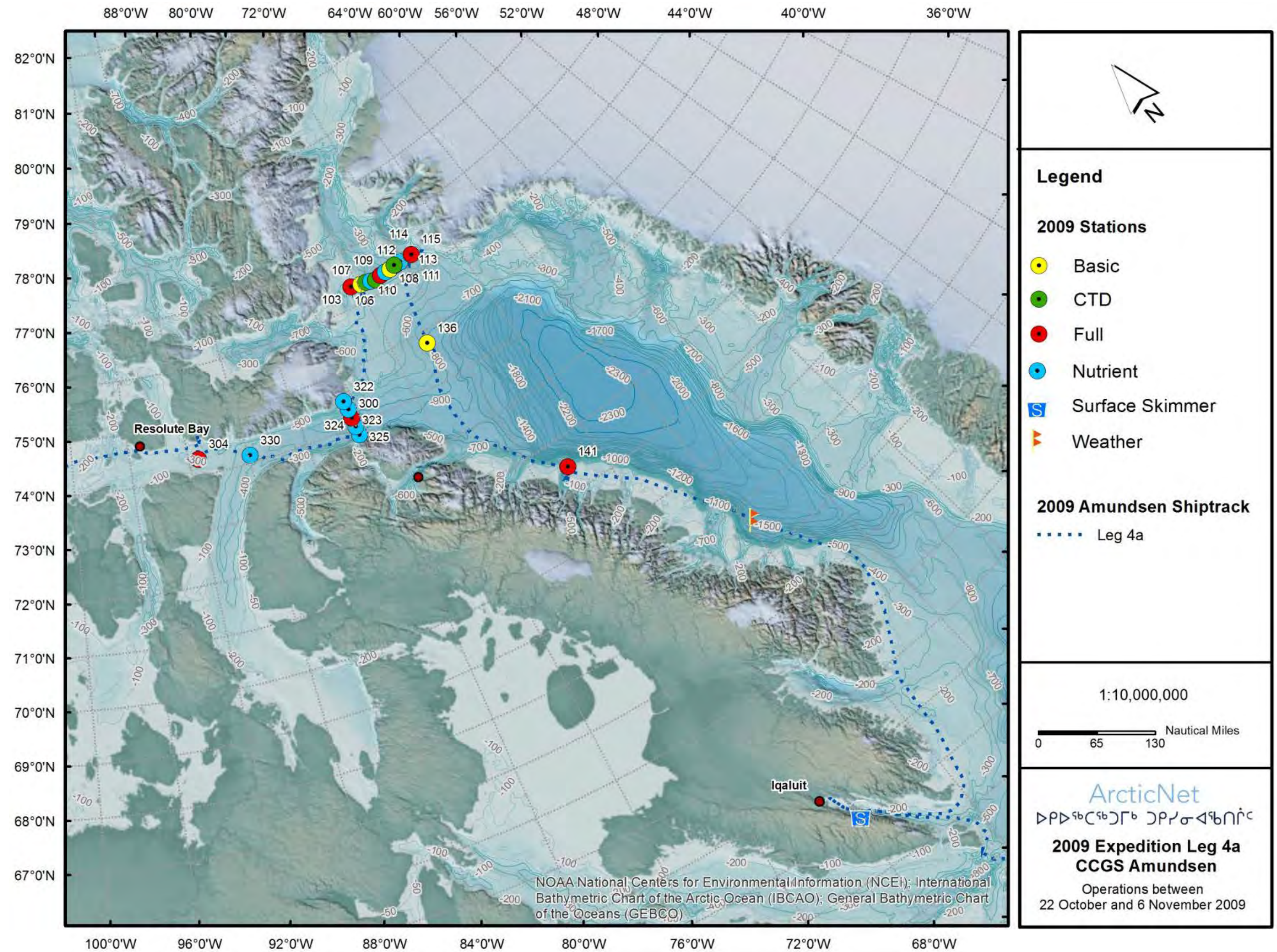

Figure 1.8. Ship track and the location of stations sampled by the CCGS *Amundsen* for ArcticNet's marine-based research program in Lancaster Sound and northern Baffin Bay during the second part of Leg 4a of the 2009 ArcticNet Expedition.

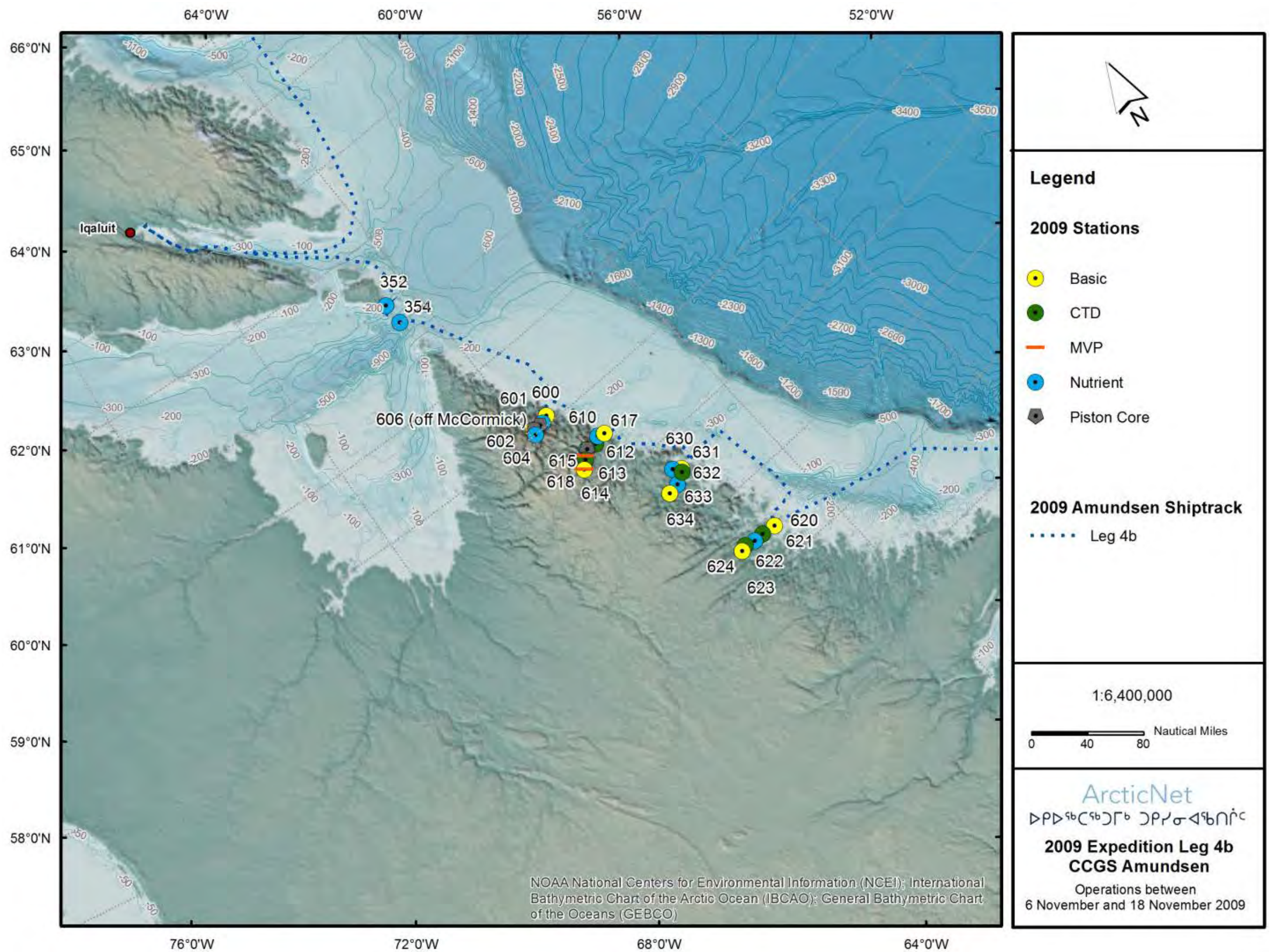

Figure 1.9. Ship track and the location of stations sampled by the CCGS *Amundsen* during the ArcticNet Nunatsiavut Nuluak project in the Labrador fjords during Leg 4b of the 2009 Expedition.

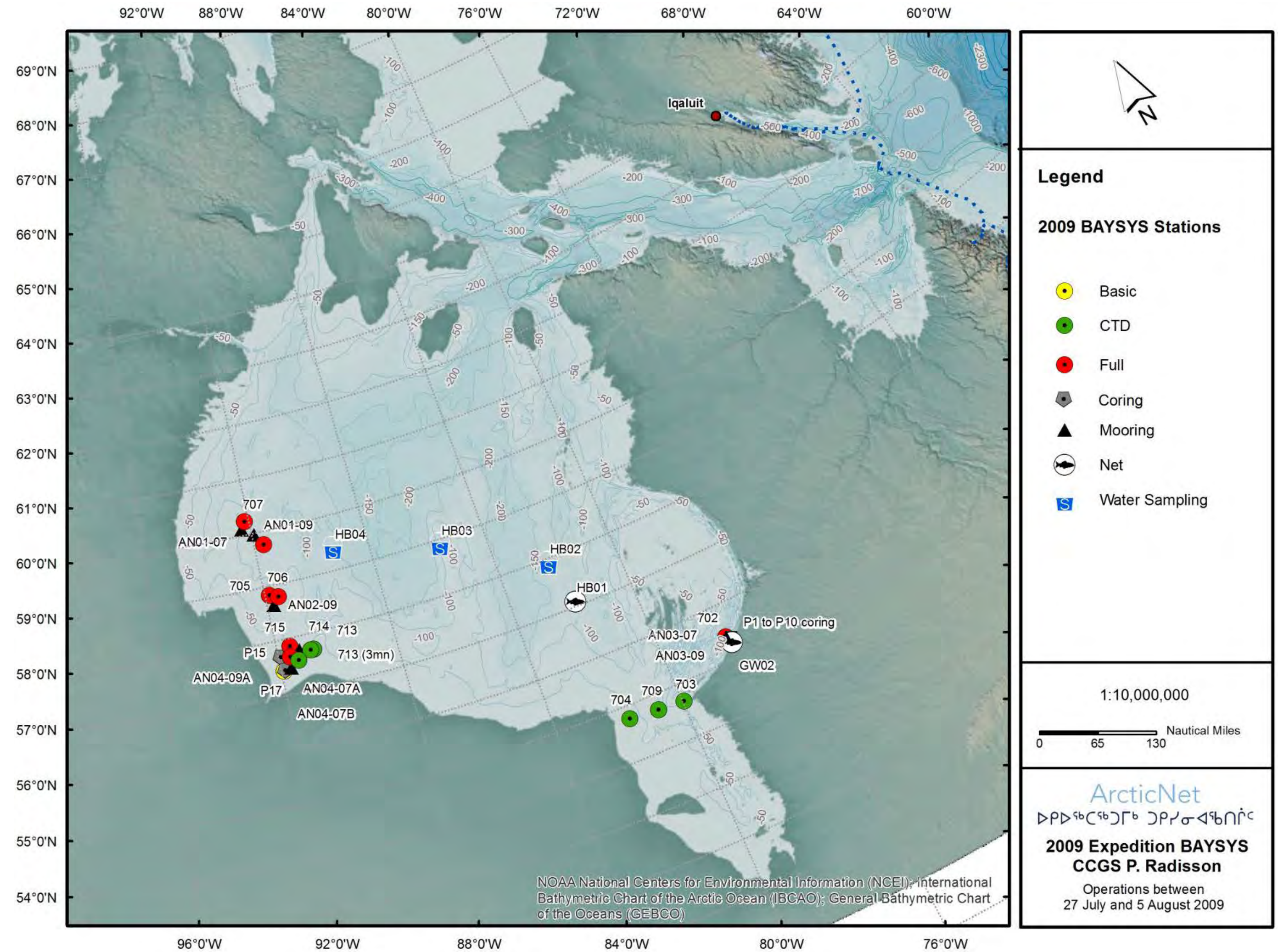

Figure 1.10. Location of stations and mooring sites where operations were carried out onboard the CCGS *Pierre Radisson* during the ArcticNet / Manitoba Hydro BaySys project in Hudson Bay.

1.3.8 Leg 4b – ArcticNet – 6 November to 18 November 2009 – Labrador fjords

The last segment of Leg 4 was dedicated to ArcticNet operations in the eastern Canadian High Arctic and the Nunatsiavut Nuluak project in the Labrador fjords (Figure 1.9), with the ship returning to Quebec City on 18 November.

1.4 2009 CCGS *Pierre Radisson* Expedition Plan

1.4.1 BaySys / ArcticNet / Manitoba Hydro – 27 July to 5 August 2009 – Hudson Bay

The BaySys cruise took place in Hudson Bay aboard the CCGS *Pierre Radisson* as part of a collaboration between ArcticNet and Manitoba Hydro. The focus of the expedition was to turn over the moorings deployed the previous year, conduct oceanographic sampling and collect sediment cores for geotechnical analyses at multiple sites around the Bay (Figure 1.10).

2 Leg 1 – 4 June to 16 July 2009 – Quebec City to Sachs Harbour

Leg 1a – 4 June to 30 June 2009 – Quebec City to Victoria, BC (via Panama Canal)
Leg 1b – 30 June to 16 July 2009 – North Pacific, Bering Sea, Chukchi Sea and Beaufort Sea

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2.1 Objectives

The aim of the Malina project teams for Leg 1b was to examine light absorption properties of particles and dissolved organic matter along the transect line from lower to higher latitudes as the ship traveled from Victoria, BC, to the Beaufort Sea.

The specific objectives for Leg 1b were to:

- Test the systems and methods in Arctic environments before the start of the Malina campaign in Leg 2b.
- Obtain a first assessment of the spatial variations (in amplitude and spectral dependence) of POM and DOM absorption properties in surface waters along the south-to-north transect from Victoria BC to the Beaufort Sea.
- Compare the results obtained with different methods of CDOM determination.
- Measure suspended particulate matter (SPM) and particulate organic carbon (POC) in surface waters. Intercomparisons will be made between results obtained using the method developed at R. Reynolds' Ocean Optics Lab at Scripps Institution of Oceanography, with other POC/SPM results obtained by the Malina project teams.
- Determine the particle size distribution (PSD) of SPM/POC, a measurement which is critical to calculate volume scattering function (VSF) of bulk seawater using Mie theory.
- Set up the Polarized Volume Scattering Meter (POLVSM) prototype and test the sampling and analysis protocols in preparation for the Malina cruise in the Beaufort Sea during Leg 2b.
- Sample phytoplankton for biomass, species composition, pigment analyses, physiological condition and light acclimatation/adaptation.

2.2 Synopsis of operations

Only one project carried out sampling activities in Leg 1a during transit from Quebec City City to Victoria via the Panama Canal. Details on this project are provided in Section 32.3.1 of Part II.

This section provides a general synopsis and timeline of operations during Leg 1b. Detailed cruise reports provided by onboard participants and including specific objectives, methodology and preliminary results for projects conducted during this leg are available in Section 11 of Part II of this report.

During Leg 1b, the *Amundsen* traveled from Victoria, BC (4 July) to Sachs Harbour (16 July) and measurements were made underway along the ship track in the North Pacific, Bering Sea & Strait, Chukchi Sea and Beaufort Sea (Figure 2.1):

- 28 surface seawater samples were taken from the ship's clean intake three times a day, at 09:00, 13:00, and 18:00.
- Continuous radiometer measurements were conducted from the top bridge tower starting on 11 July.
- Continuous measurements from the Met tower on the foredeck were recorded starting on 13 July.
- Sampling for air contaminants from the top bridge was carried out starting on 10 July.

The scientific log for Leg 1b begins on 11 July with the positions and depths of the visited stations available in Appendices 1 and 2 at the end of this report.

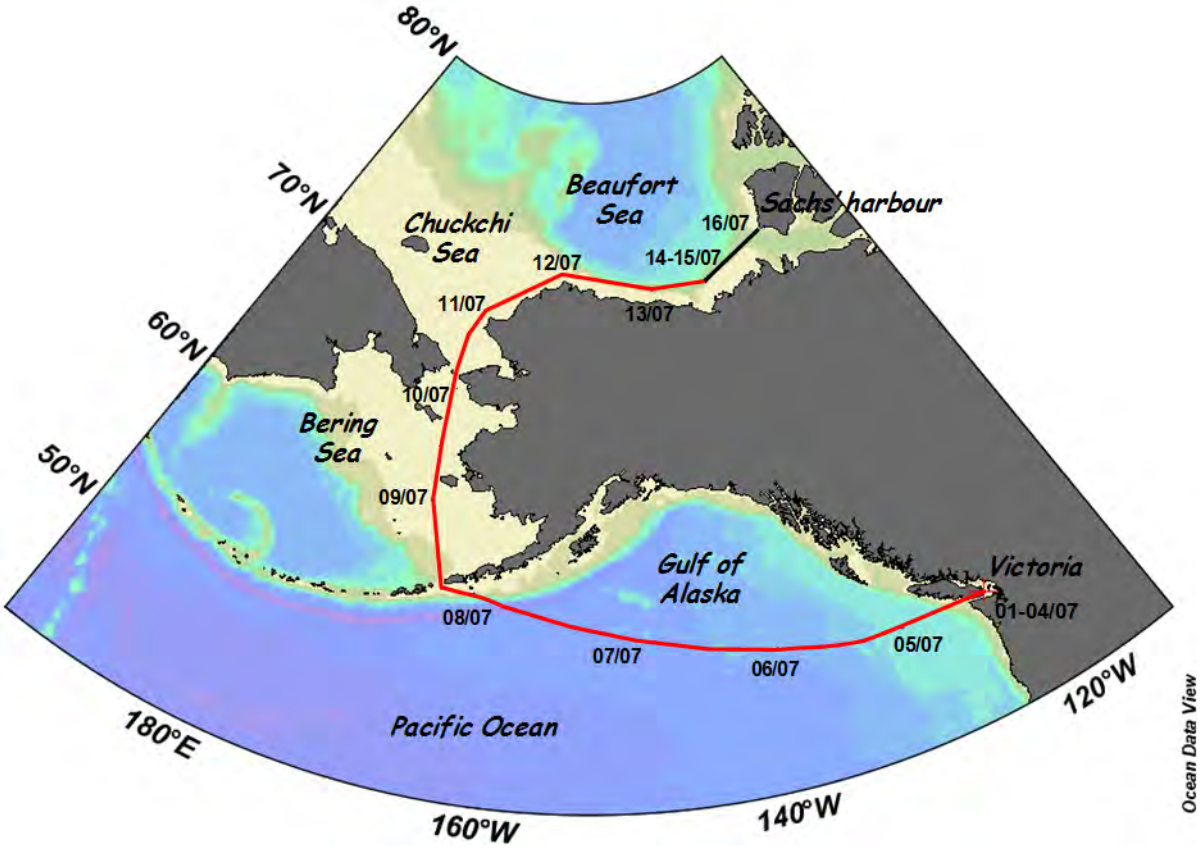

Figure 2.1. Ship track of the CCGS *Amundsen* from Victoria (BC) to Sachs Harbour, with the dates in July 2009 indicated along the transit through the North Pacific, Bering Sea & Strait, the Chukchi Sea and the Beaufort Sea, during Leg 1b.

2.2.1 Timeline of operations

<u>Mobilization in Victoria, BC (1 to 4 July)</u>

The CCGS *Amundsen* arrived in Victoria early in the morning of Wednesday 1 July. During the loading of equipment early on Friday morning, it became apparent that only one of the two Met/Ocean buoys could be safely transported and handled by the ship. The box for the new piston/box corer was too large to fit into the cargo hatch, and the corer had to be dismantled so the components could be stored there. The ship's departure was postponed until noon the next day to complete the preparations. With storage space constrained, it was decided to leave cables, a few buoys and the skippy boat in Victoria.

Transit to the Beaufort Sea (4 to 13 July)

As soon as the *Amundsen* exited Juan de Fuca Strait, the swell increased significantly and water sprayed the foredeck continuously. The ship nevertheless made 16 knots to compensate for the longer mobilization in Victoria and the delay caused by hurricane Andrès in the Pacific. The *Amundsen* was dispatched for SAR in the evening of the 4 July in response to an emergency buoy was that 24 hours away, almost on the ship's course to the Arctic, but the *Amundsen* was released from this duty after contact was established with the other ship and the emergency buoy stopped transmitting.

The thermosalinograph (TSG) was brought online early on, but the fluorescence sensor could not be hooked up to the new data logger. Attempts to start the N_2 plant showed that there was a Helium leak in the system. As the He cylinder was empty and there was no more high-purity He available on board, the plant could not be fixed until Leg 2a when a new cylinder would be brought onboard.

During transit, several requests were made to the ship to install, fix or modify scientific equipment: a bracket to hold the Met tower on the foredeck, a rail to slide the EM scanner off the port bow, and brackets to secure gas cylinders and various equipment on containers. Several of these reparations covered installations that existed in previous years, but were no longer on the ship, presumably due to their removal for dry dock operations. The pump for the on-track pCO_2 system was repaired and started, and the piping of the system was modified to include a temperature sensor. The Rosette was prepared for sampling starting in Leg 2a.

In the morning of 13 July, very large numbers of walruses were encountered, densely aggregated on ice floes. The population was roughly estimated at a thousand individuals.

Bottom mapping and sampling in the Ajurak block (14 and 15 July)

Two ice patrols were flown on 13 and 14 July to determine whether bottom mapping could be done in the Ajurak exploration lease area. The reconnaissance of the 14 July indicated that some mapping appeared possible although large ice floes of second year-ice were an obstacle to navigation over several of the priority lines (Figure 2.2).

Bottom mapping began early in the night of 14 July. The priority transects were located in a field of large ice floes and it was difficult to remain along straight lines. The bottom mapping group then opted to do sections perpendicular to the shelf.

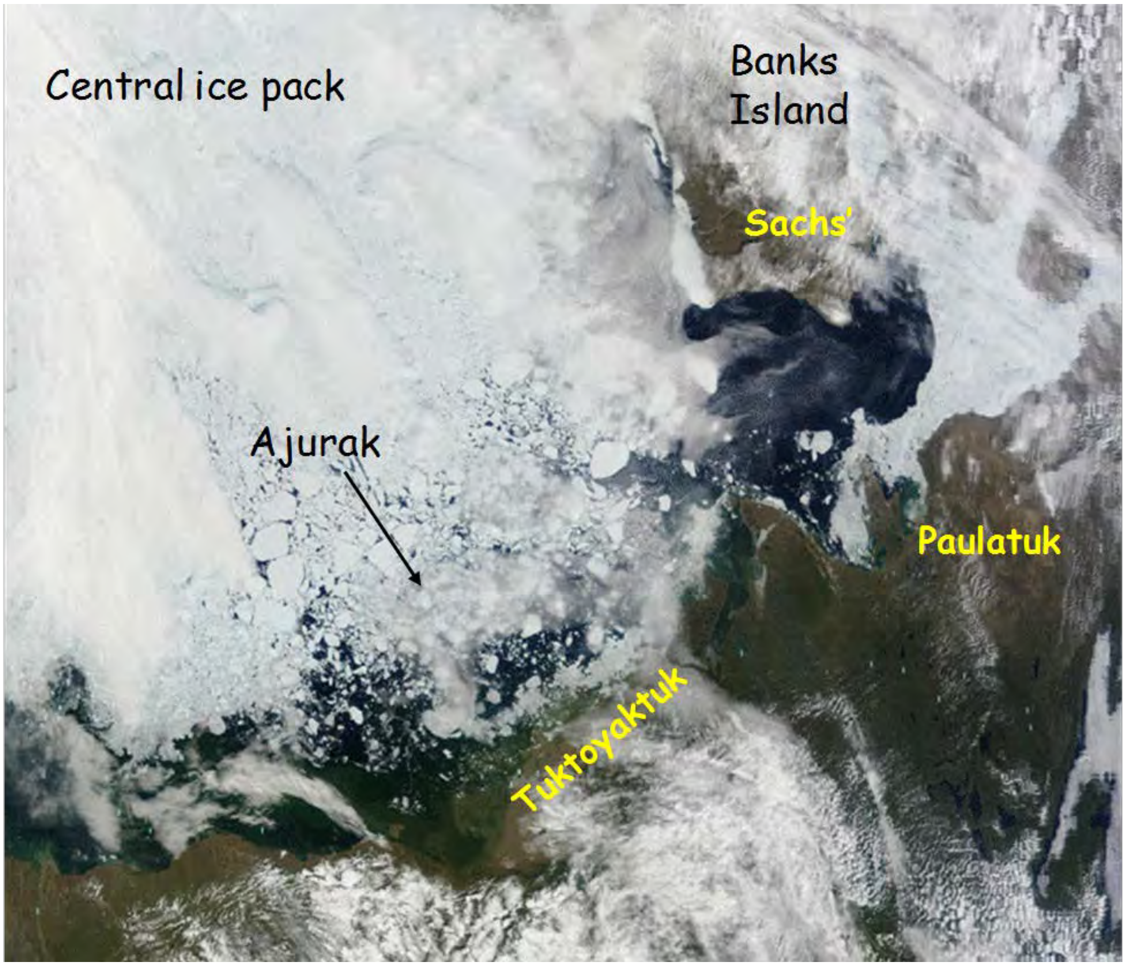

Figure 2.2. AQUA-MODIS image of ice/cloud conditions in the southeast Beaufort Sea on 12 July 2009 during Leg 1b.

In the morning of 14 July, the helicopter was deployed for ice sampling while mapping continued. One helicopter test flight with the camera pod used to measure ice granulometry was also conducted in the morning of 15 July. Operations ended around midnight on 15 July and the ship left for Sachs Harbour for the crew change.

2.3 Chief Scientist's comments

Overall Leg 1b has been successful and the atmosphere was very good aboard. Most sampling operations and preparations for the Malina Program in Leg 2b were successfully conducted. On behalf of all science personnel, our thanks and gratitude to the Commanding Officer, the officers and the crew, who accompanied us superbly during the leg.

3 Leg 2a – 16 July to 30 July 2009 – Beaufort Sea

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3.1 Introduction and objectives

The Beaufort Sea/Mackenzie Shelf region of the Arctic Ocean has witnessed major changes in recent years, with decreasing sea ice cover and major shifts in sea-ice dynamics. Although major inshore research activities were conducted in the 70's and 80's in large part due to the Oil & Gas interest in the region, much less is known about the offshore region of the Mackenzie Shelf, shelf slope and Beaufort Sea.

Since 2002, ArcticNet has been conducting extensive multidisciplinary research programs in the area. In addition to an annual fall sampling program, ArcticNet researchers have led two major international overwintering research programs conducted onboard the CGGS *Amundsen* in 2003-2004 (CASES program) and in 2007-2008 (CFL program). A marine observatory of a minimum of 5 oceanographic annual moorings (from 5 to 17 moorings) has been deployed and retrieved annually in the area by ArcticNet researchers since 2002.

Recent interest in the Beaufort Sea has resulted in major bids from industry on offshore exploration licenses (EL) located in the 50-1500m depth range of the Mackenzie Shelf and shelf break (Figure 3.1). Of particular relevance to the 2009 Expedition is EL446 (called Ajurak) awarded to Imperial Oil in 2007.

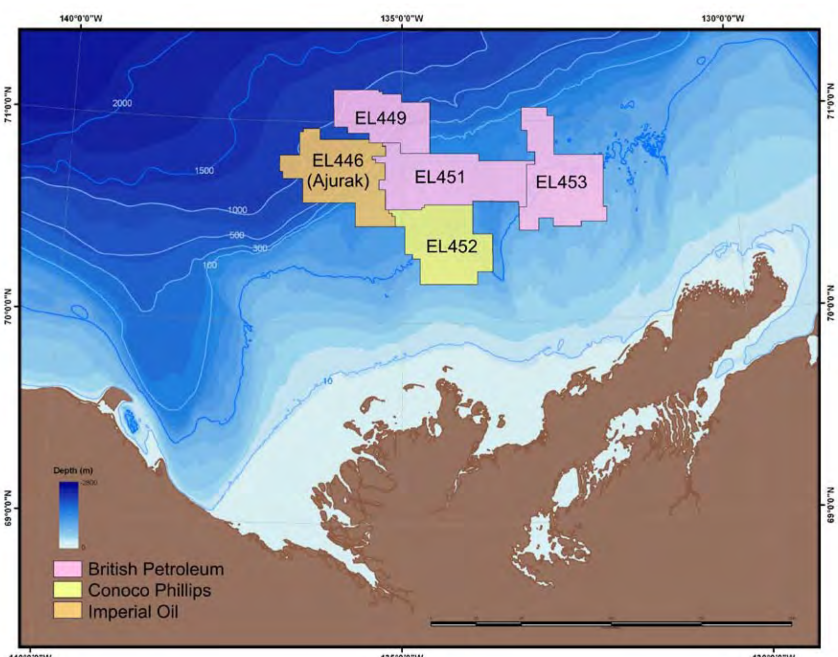

Figure 3.1. Map of exploration licenses (EL) awarded to the Oil & Gas industry by the Canadian Government in the Beaufort Sea. In 2009, activities focused on the Ajurak lease area (EL446) awarded to Imperial Oil Resources Ventures Limited (IORVL).

As part of a collaborative agreement between ArcticNet and Imperial Oil, one of the major goals of the 2009 ArcticNet Expedition to the western Arctic was to increase the level and spatial coverage of sea-ice, geological and environmental data collected in the Beaufort Sea/Mackenzie Shelf/Amundsen Gulf region (regional context) with a special focus placed in and around Ajurak (Figure 3.1). As designed jointly by ArcticNet and Imperial Oil, the research elements of the collaborative work were divided into 3 major research components:

- **Met/Ocean & Sea Ice:** The overarching goal of this component is to provide data describing the variability of met/ocean and sea ice variables within the Ajurak exploration block relative to the larger area of the southern Beaufort Sea continental shelf. The objective is to provide data on the ocean-sea ice-atmosphere (OSA) interface over a range of time and space scales, focusing on spatial and temporal variability over diurnal, seasonal and interannual time scales.
- **Environment & Marine Resources:** The general goal of this component is to quantify and map the summer-fall distribution and contamination of the main compartments of the pelagic and benthic food webs along the slope of the Mackenzie Shelf, from the inner shelf (50 m) to the margin of the deep basin (approx. 1200 m), and from the Mackenzie Trough to the west to Cape Bathurst to the east with special focus on specific areas in Ajurak.
- **Geology & Bathymetry:** This component will conduct an investigation of seabed stability conditions to meet engineering design and regulatory requirements for exploration drilling. Seabed mapping and bottom sediment characterization research is required to investigate seafloor stability conditions at the outer shelf/upper slope area of the central Beaufort Sea with special focus on specific areas in Ajurak. Foundation conditions, slope stability, seabed features and ice scouring are also key issues to be addressed.

All 3 research components, objectives and deliverables are highly integrated and were conducted as part of the 2009 ArcticNet Expedition in the Beaufort Sea during Legs 2 and 3.

While the main focus of Leg 2a was to complete the Environment & Marine Resources component of the program, important aspects of the two other research components were addressed. The major objectives of Leg 2a were to:

- Deploy 5 subsurface oceanographic moorings in Ajurak (EL 446) and 4 subsurface oceanographic moorings in EL 449.
- Sample at 17 biophysical stations in Ajurak and 4 biophysical stations in EL 449.
- Deploy 12 bottom anchored hydrophones in Ajurak.
- Deploy the Remotely Operated Vehicle for a visual survey of the ocean floor at a specific expulsion feature in Ajurak.
- Depending on ice conditions, deploy a moored Met/Ocean surface buoy for the duration of the leg.
- Conduct ice thickness and roughness surveys using the helicopter mounted EM Induction system and deploy ice drift satellite beacons on large ice floes around Ajurak.

3.2 Synopsis of operations

Detailed cruise reports provided by onboard participants and detailing specific objectives, methodology and preliminary results for 14 projects conducted during Leg 2a are available in Part II of this report. Here, a general synopsis and timeline of operations during Leg 2a is provided.

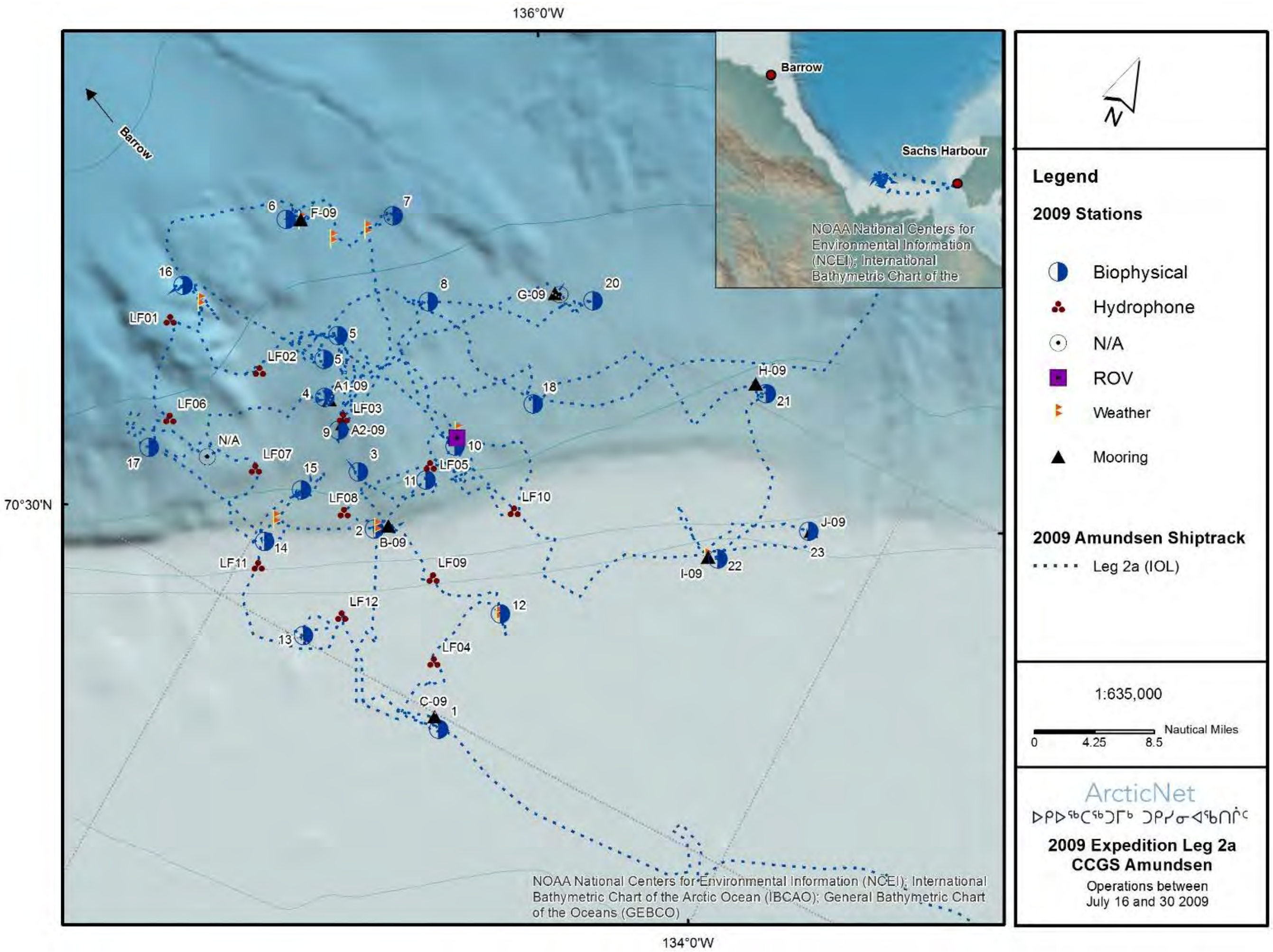

Figure 3.2. Ship track and the location of stations and mooring sites visited by the CCGS *Amundsen* in IOL's Ajurak exploration acreage in the Beaufort Sea during Leg 2a of the 2009 ArcticNet Expedition.

During this leg, 21 stations were visited with an overall tally of operations and activities as follows:

- 24 CTD-Rosette casts
- 41 zooplankton tows, including horizontal and vertical net tows
- 20 Agassiz trawls to sample benthic organisms
- 30 box cores sampling of the sediments
- One dedicated bathymetry / sub-bottom mapping survey
- 9 mooring deployments
- 12 MARU hydrophones deployments
- One ROV dive to study an expulsion feature on the seafloor

- 14 radiosonde (weather balloon) launches
- Over 300 helicopter transects to determine ice thickness and roughness
- 3 ice motion beacon deployments

In addition, a multitude of oceanic and atmospheric parameters were measured continuously during the entire leg using the *Amundsen*'s extensive array of continuous samplers (SM-ADCP, EK60 scientific echosounder, water surface pCO_2 and CTD on-track system, foredeck and top bridge met tower, ceilometer, radiometer, all-sky camera, etc.). On the bridge, Marine Wildlife Observers spotted and identified marine mammals and seabirds 14 to 24 hours a day. The EM302 multibeam sonar and the Knudsen sub-bottom profiler collected high resolution bathymetry and sub-bottom data as field conditions permitted during the entire leg.

A detailed scientific log for all sampling operations conducted during Leg 2a with the positions and depths of the visited stations is available in Appendices 1 and 2.

3.2.1 Ice conditions

Sea-ice was a dominant factor during Leg 2a with large, thick, first-year and multi-year ice floes of varying concentrations encountered at and between virtually all stations visited. Ice floe sizes ranged from a few hundred meters, to several kilometres in diameter (Figure 3.3).

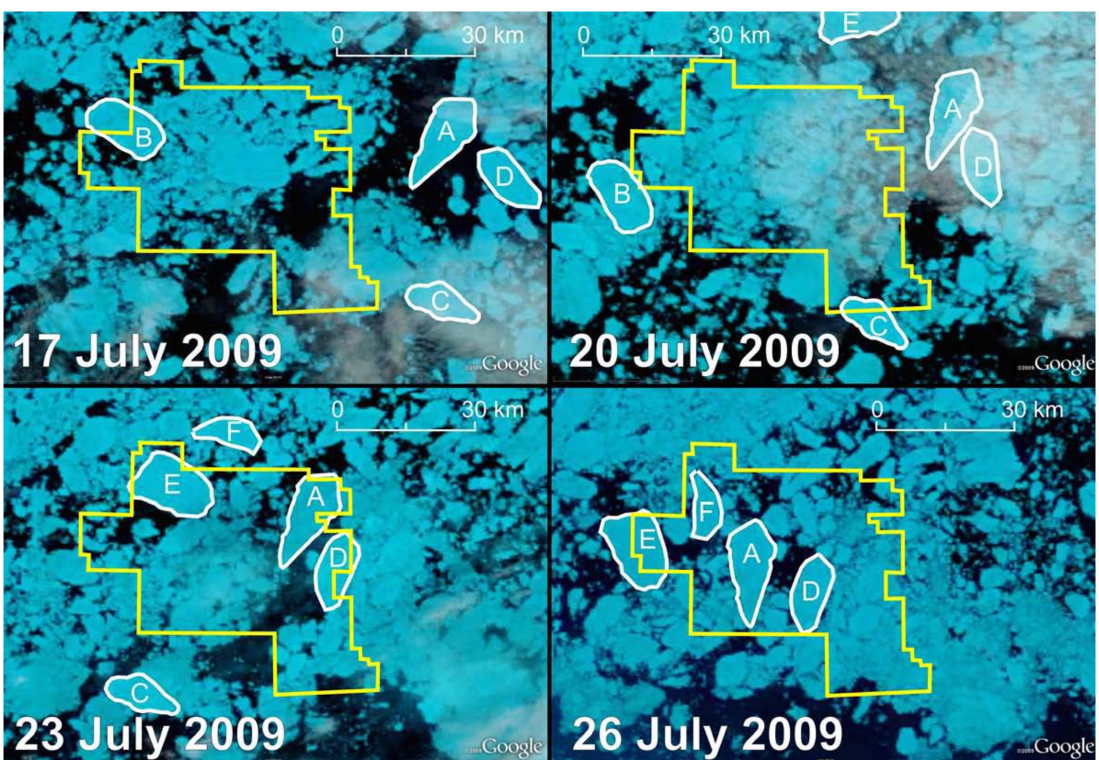

Figure 3.3. Ice conditions relative to Ajurak boundary area in the Beaufort Sea during Leg 2a. Large distinctive ice floes are identified to help follow ice movement. Floe A (23 km long; 140 km^2) drifted 65km to the southeast from 17 to 27 July. (Terra 250m Bands 7-2-1 images: NASA/GSFC, MODIS Rapid Response).

The presence of high ice concentrations can be attributed to atmospheric and oceanic conditions prior and during Leg 2a. A strong Beaufort High, centered west of the entrance to McClure Strait, produced weak (sometimes moderate) northerly winds throughout much of the month of July, and promoted normal anticyclonic rotation of the Beaufort Gyre. This resulted in slow, steady southward and southwestward advection of sea ice, and yielded ice concentrations ranging from 5/10 to 9+/10 over much of the Ajurak area for the duration of Leg 2a (Figure 3.3). Many of these ice floes showed evidence of a progressing melt season, with many melt ponds, some of which had melted straight through the ice floe. Access to Radarsat II imagery and ice analysis provided through the Canadian Ice Service was of great help in improving vessel navigation and research program planning.

3.2.2 Timeline of operations

Leg 2a started on 16 July in Sachs Harbour with a full Coast Guard and scientific contingent crew change. Leaving Sachs Harbour around midnight on 17 July, the first sampling station (Station 1) was reached at 02:00am on 18 July following a 26-hour, 230 nautical miles transit in heavy fog and often heavy ice conditions.

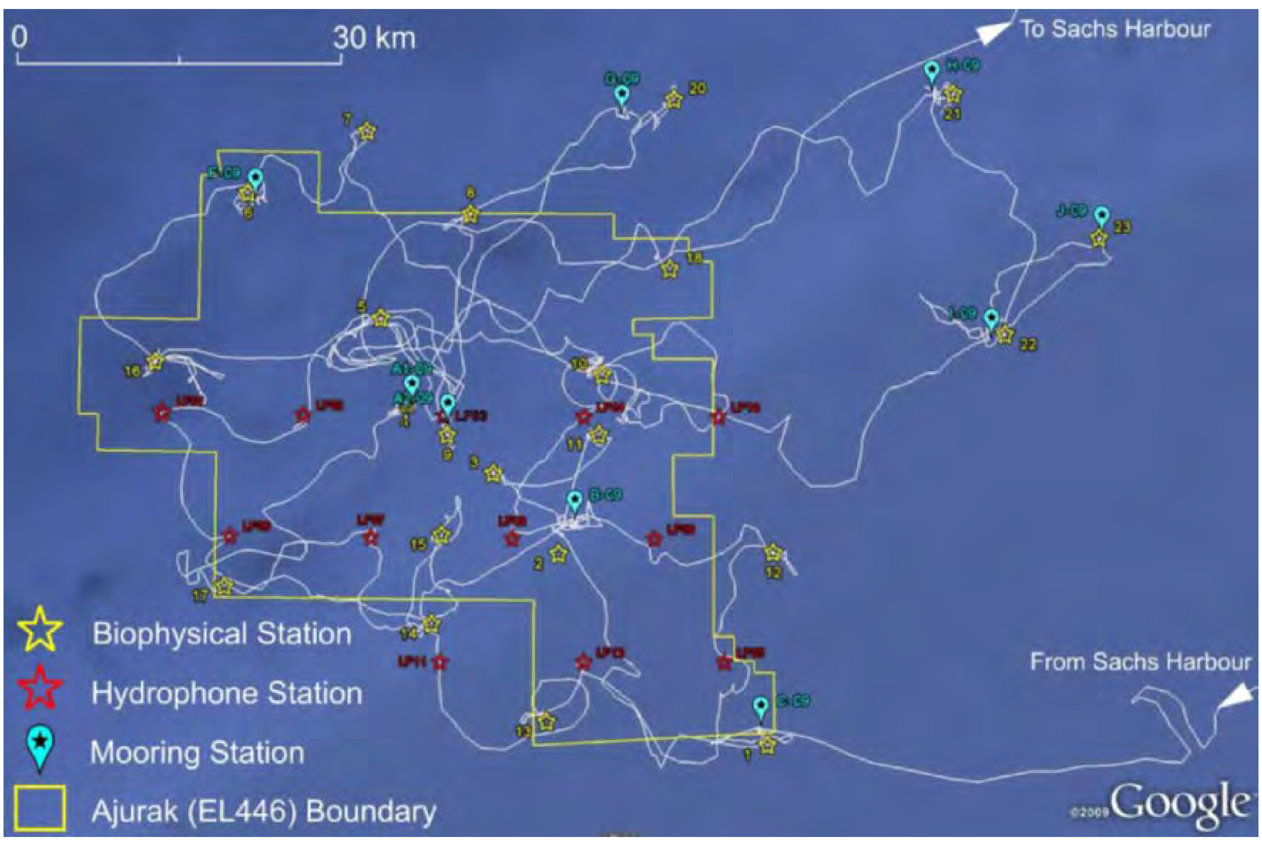

Figure 3.4. Ship track and sampling stations visited during Leg 2a in and around IOL's Ajurak exploration lease in the Beaufort Sea.

On 18 July, Biophysical Stations 1 and 2 were visited and the full suite of oceanographic operations were conducted. These operations included CTD-Rosette casts to sample the water column, horizontal and vertical zooplankton net tows, Agassiz trawl to collect benthic organisms and multiple box cores to sample seafloor sediments. Station 1 was also a mooring site (C-09), which was deployed successfully.

On 19 July, 3 biophysical stations were sampled (11, 3 and14), with additional mooring work conducted at Station 3 (B-09) and a seafloor mapping survey at Station 14. Over the next two days, 5 more stations were visited and sampled (15, 17, 4, 10 and 23) with moorings deployed near Station 4 (A1-09), Station 10 (I-09) and Station 23 (J-09). Helicopter flights were also conducted over selected ice features to measure various ice properties.

Between 22 and 25 July, nine additional biophysical stations of the grid were sampled (Stations 22, 21, 18, 8, 20, 16, 6, 7 and 9, in this order) with moorings H-09, G-09, F-09, A2-09 deployed at Stations 21, 20, 6 and 9, respectively. The helicopter was launched once while at Station 20 to conduct ice profiling operations and deploy ice motion beacons.

The deployment of 12 hydrophones on MARU buoys in a grid within the Ajurak lease block took place on 26 and 27 July. Biophysical Stations 5, 13 and 12 were also visited during that period. Finally, a 4-hour ROV dive was performed on 28 July to inspect an expulsion feature on the seafloor located near Station 10.

Sampling for Leg 2a ended on the evening of 28 July when the ship started the transit back to Sachs Harbour for a scientific crew change scheduled for the morning of 30 July.

3.3 Chief Scientist's comments

On behalf of the science personnel onboard during Leg 2a, I would like thank and congratulate everyone on board for their work and efforts in making Leg 2a such a success. Thanks to Commanding Officer Thibault and the officers and crew of the *Amundsen* for their dedication, professionalism and camaraderie that make the *Amundsen* such a special research vessel.

Special thanks are extended to the onboard Québec-Océan technicians: L. Michaud, P. Massot and F. St-Germain. From setting-up and deploying moorings and the ROV to the maintenance of winches and scientific equipment onboard, their contribution to Leg 2a and the overall expedition is invaluable. Thanks also to C. Marec for her valuable experience and help with the maintenance of the CTD-Rosette.

The planning and delivery of Leg 2a was done in close collaboration with Imperial Oil and thanks and gratitude are extended to the Imperial Oil Ajurak team for their essential contribution in putting together the program and for the numerous meetings, phone calls and countless hours of preparation leading to the field work. The Imperial Oil lead scientist onboard the ship played a major role in the success of this leg. Thanks to him for his co-leadership and support.

Finally, I would like to thank K. Levesque, ArcticNet's Ship-based Research Coordinator, for his tireless efforts, dedication and investment in the preparation of this very challenging 2009 Expedition. From community consultations, to research licensing, to planning workshops, to ship mobilisation, crew changes, security clearances and the numerous needs of dozens of demanding research groups rotating onboard the ship, a colossal amount of work is involved in the preparation of such an expedition. Thanks to K. Levesque and all who helped him with the preparation of this 2009 Expedition.

4 Leg 2b – 30 July to 27 August 2009 – Beaufort Sea

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4.1 Introduction and objectives

In the last decades, the Arctic has seen important changes that will affect its climate and ocean processes:

- A decrease in summer ice cover that exposes sea surface to solar radiation and physical forcings.
- Permafrost thawing and increased river runoff, both leading to an increase in the export to the ocean of organic carbon previously sequestered in the tundra.
- An increase in ultraviolet (UV) radiation.

The physical environment of the Arctic Ocean will continue to change in two fundamental ways as a consequence of climate change. First, the perennial sea ice will recede which will result in major modification of the planetary heat budget and, second, the increase in precipitation over the Arctic Ocean watershed, combined with deeply modified atmospheric forcing on the ocean surface, will impact the formation of deep-water. This in turn may affect regional climates outside the Arctic.

The goal of the Malina project is to address the biological and photochemical impact of another major physical consequence of climate change in Arctic: the drastic switch in the light regime encountered by the ocean surface layers. Simply put, because of ice cover currently present even in summer, the surface waters of much of the Arctic are essentially dark, but with the ice receding, these waters will be illuminated 24 hours a day. Beyond warming the water when penetrating the water column, light interacts with the plankton and the colored organic matter in solution thus influencing the most fundamental source of energy in the ecosystem: photosynthesis. Beyond photosynthesis, photo-oxidation and, indirectly, bacterial activity will also be impacted. The predicted increased export of organic matter by rivers draining the permafrost amplifies the potential consequences of this change in the light climate of the Arctic Ocean surface waters. Indeed, just like fossil fuels, the carbon contained in the permafrost is “sequestered” carbon. A potential positive feedback of climate change is that it may trigger the oxidation of that sequestered carbon, adding a natural process to human activity in releasing even more CO_2.

Some data exist on those processes, and a number of ongoing international projects include, among others, the study of some of those processes. But Malina proposes to deploy at once the effort required to build a self-consistent data set and to obtain a body of knowledge sufficiently large (beyond a critical size) to significantly improve the present understanding of the fluxes in this remote ecosystem, and to further the capacity to predict future changes.

An extensive study was conducted in the Mackenzie River / Beaufort Sea system in July, August and September 2009 onboard the Canadian research icebreaker CCGS *Amundsen*. The spatial distribution of organic carbon stocks (living and detrital) in the water column and sediments were determined on the shelf and beyond. The magnitude and variability of organic carbon mineralization through photo-oxidation and bacterial activity, and production through photosynthesis were also determined. These targeted studies will allow the monitoring of these processes using remote sensing in the coming years and decades.

A detailed study of microbial biodiversity was conducted to describe the different biocenoses and biotopes and to anticipate their response to climate change. Diagnostic models of the studied processes (primary production, bacterial activity and light-driven mineralization of organic matter) will be combined with a coupled physical-biological ecosystem model, and applied using outputs from global climate models to assess the fate of the associated carbon fluxes in the Arctic Ocean during the next decades under different climate change scenarios. Additionally, a retrospective approach will be followed to partly answer the Malina questions, based on the analysis of geochemical proxies in the past 1000-y sediments.

The general objective of Malina is to determine the impact of climate change on the fate of terrestrial carbon exported to the Arctic Ocean, on the photosynthetic production of organic carbon, and on microbial diversity. More specifically, the Malina field campaign in the Beaufort Sea attempts to answer the following 10 questions:

- What is the importance and form (particulate vs. dissolved) of the terrestrial organic material transported to the Arctic Ocean by rivers?
- What are the transport pathways of this material in the coastal zone and offshore?
- What is the chemical composition of the terrestrial organic material exported and what transformations occur during transport from rivers ⇒ coast ⇒ open ocean?
- What is the importance of photo-oxidation of organic material in the pelagic environment (production of CO and CO_2)?
- What is the impact of photodegradation on the chemical composition and bioavailability of terrestrial organic material?
- What is the importance of bacterial activity in the pelagic environment and its impact on the fate of terrestrial organic material?
- What is the impact of coloured dissolved organic material on primary productivity (e.g. release of nutrients, shading)?
- What is the importance of primary productivity and how is it affected by nutrients and light?
- How will these processes evolve in response to climate change (principally ice cover and UV)?
- What will be the impact of these changes on the biodiversity of bacteria and marine phytoplankton and, in turn, on carbon fluxes?

4.2 Synopsis of operations

Detailed cruise reports detailing specific objectives, methodology and preliminary results for the Malina sub-projects are unavailable. More information can be found on the Malina website (malina.obs-vlfr.fr) or by contacting the researchers and teams who collected the data. Here, a general synopsis and timeline of operations during Leg 2b is provided. During this leg, a total of 67 stations were visited with an overall tally of operations and activities as follows:

- 27 CTD casts
- 139 CTD-Rosette casts
- 115 optical and phytoplankton measurements, including IOPs, UVP casts and above water radiometry, conducted both from the *Amundsen* and from the auxiliary vessel (barge)
- 17 zooplankton tows, including horizontal and vertical net tows
- 11 box cores and 2 CASQ gravity cores to sample the sediments
- 8 coastal transects
- 5 primary production line deployments
- 3 drifting sediment traps deployments
- 9 Thorium samplings
- 10 turbulence (SCAMP) profiles

A detailed scientific log for all sampling operations conducted during Leg 2b with the positions and depths of the visited stations is available in Appendices 1 and 2.

4.2.1 Timeline of operations

The Malina oceanographic expedition documented the stocks, processes and boundary fluxes as extensively as possible, with operations conducted 24 hours a day. Sampling was conducted over a network of sampling stations extending from the Mackenzie Shelf, over the shelf break and into the Beaufort Sea deep basin (Figure 4.1). Additional coastal transects parallel to the coast were also sampled using the barge.

From 31 July to 3 August, operations focused on the four stations closest to the shore (390, 394, 680 and 690), and on coastal transects carried out between these end points. Activities included multiple CTD-Rosette casts and optical (IOP) measurements, as well as box coring (Stations 390, 690 and 680) and CASQ coring (Stations 680 and 690) operations. The barge (or Zodiac) was also deployed on 7 occasions during this period to conduct the coastal transects or to perform optical and turbulence profiles in shallow waters away from the *Amundsen*.

Starting on 4 August, the 200 transect was sampled from both the Amundsen and the barge using the CTD-Rosette and various optical instruments. Box cores, plankton net tows and thorium pumping operations were also carried out at some of the stations. The transect ended at the deeper Station 240 on 5 August and the ship headed for the 100 line located between Banks Island and Cape Bathurst.

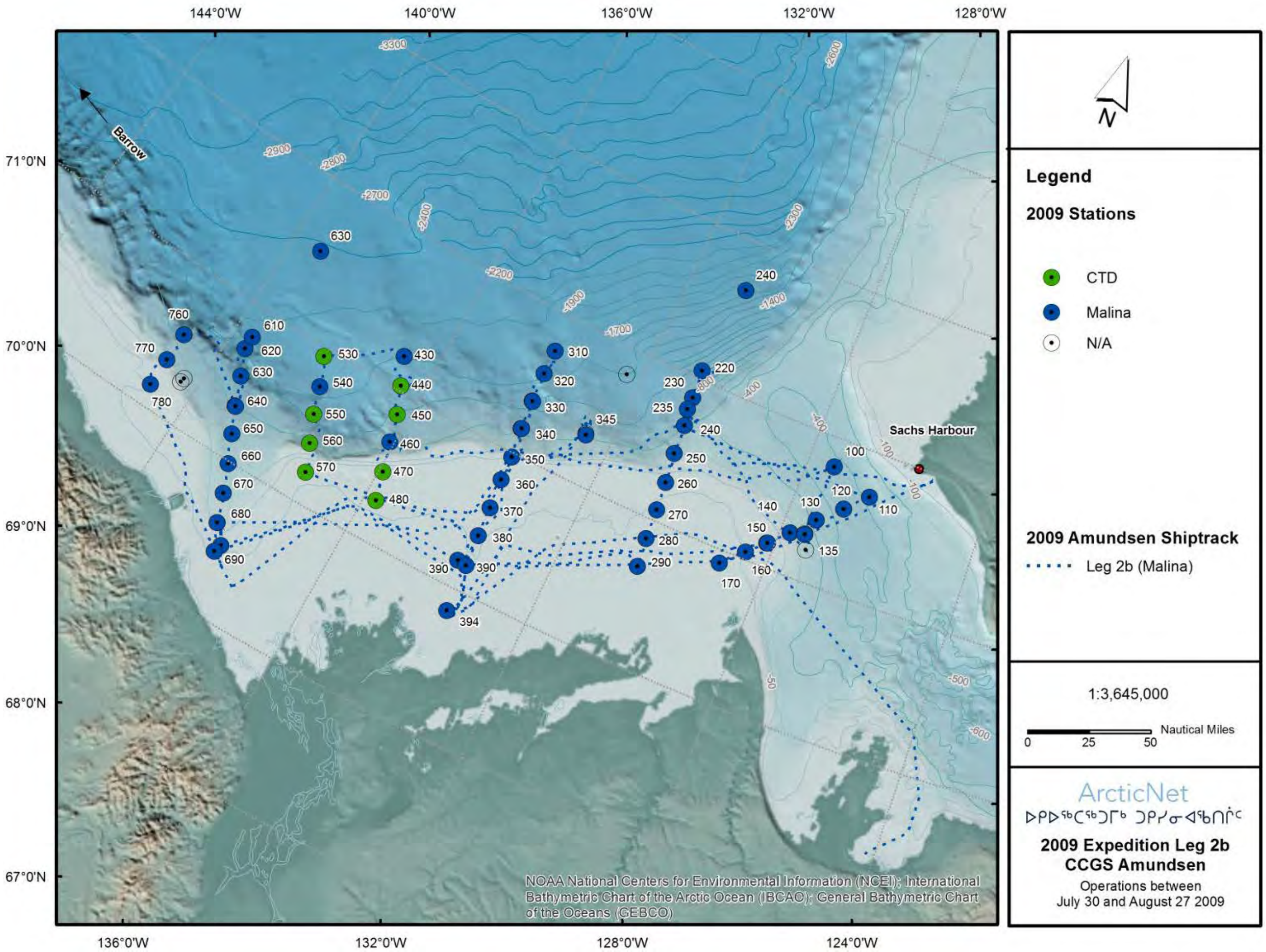

Figure 4.1. Ship track and the location of stations sampled by the CCGS *Amundsen* during the French-led Malina research program in the Beaufort Sea during Leg 2b of the 2009 ArcticNet Expedition.

The usual water sampling and optical measurements were conducted at 7 stations on the 100 transect over the course of 6 and 7 August, in addition to zooplankton net tows, thorium pumping and the deployment of an Argo ProvBIO float at Station 130 and box cores at Station 140.

The stations on Transect 300 were visited on 9 and 10 August, followed by Transect 600 on 11 August and Transect 700 on 12 August. In addition to the usual CTD-Rosette casts and optical measurements at the Malina stations, zooplankton net tows and thorium pumping were carried out at Station 640 and box cores at Station 680.

Both auxiliary vessels (barge and Zodiac) were used to conduct coastal transects between lines 600 and 700 on 13 August, then the ship headed for Station 345 where 24-hour primary production and sedimentation flux studies were planned. Short term drifting sediment traps were succesffully deployed in the morning of 14 August and were recovered on 16 August. Primary production lines were also deployed, from 12:00 to 21:40 on 14 August, from 01:35 to 23:45 on 15 August. Coastal transects were carried out with the barge and Zodiac in this area then the ship left for Transect 500. Stations 530-570 and 430-480 were successfully sampled on 17 August and 18-19 August respectively, including plankton net tows and thorium pumping at Stations 540 and 460.

The Argo ProvBIO float deployed on 7 August was retrieved at a station labeled 100 then the ship headed for Station 135 where a series of process studies (sediment traps and primary production line deployments) were carried out over the next two days.

Starting on 22 August, the last station of the Malina cruise was sampled, including the deployments of sediment traps and two primary production lines, net tows and thorium pumping. Science operations for the Malina campaign and Leg 2b ended in the morning of 24 August and the *Amundsen* headed for Paulatuk for the crew change.

4.3 Chief Scientist's comments

The Chief Scientist on behalf of the science personnel would like to thank the Commanding Officer, officers and crew of the CCGS *Amundsen* for their professionalism and hard work during the Malina campaign. Thanks to our colleagues at ArcticNet for organizing so efficiently the complex planning and logistics before and during this cruise.

5 Leg 3a – 27 August to 12 September 2009 – Beaufort Sea

Chief Scientist: Roger François[1] (rfrancois@eos.ubc.ca)
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5.1 Introduction and objectives

The Canadian IPY-GEOTRACES sampling program took place from 27 August through 12 September and was part of Leg 3a of the 2009 CCGS *Amundsen* Expedition in the western Canadian Arctic. Sampling started in the Mackenzie River delta and continued into the Beaufort Sea (Shelf, slope and deep Canada Basin). Various measurements (temperature, salinity, nutrients, alkalinity, pH, primary production, bacterial production) and sampling (seawater, marine particles) were conducted at 10 stations (Figure 5.1).

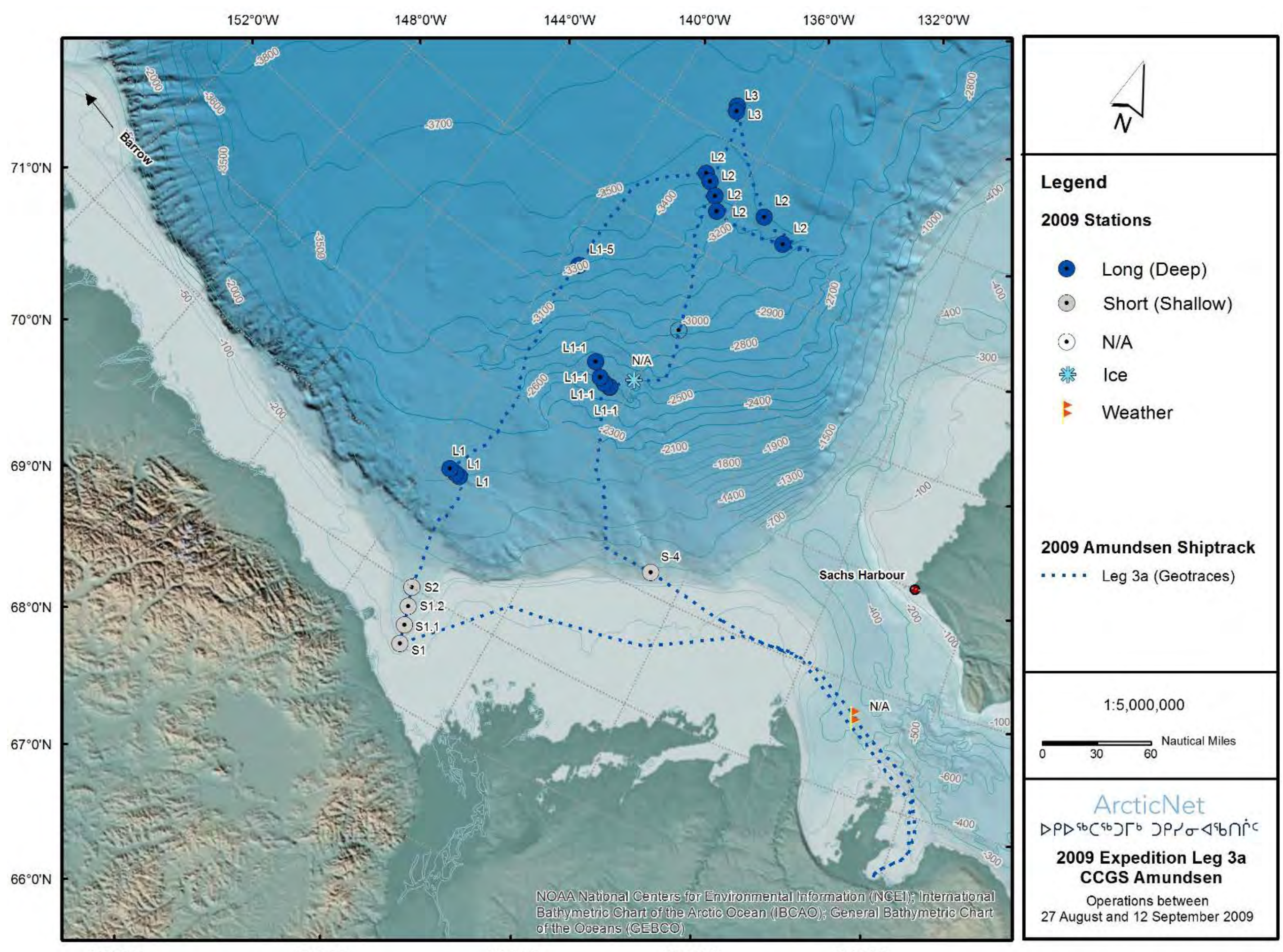

Figure 5.1. Ship track and the location of stations sampled by the CCGS *Amundsen* in support of the IPY-Geotraces research program in the Beaufort Sea during Leg 3a of the 2009 ArcticNet Expedition.

Underway measurements (temperature, salinity, trace gases) and sampling (marine particles) were also conducted along the cruise track. Sampling tools used on stations were the ship's CTD-Rosette (ArcticNet), a Trace-Metal CTD-Rosette system (UVic / UBC) and large volume in-situ pumps (UBC).

Measurements were conducted and samples collected to document a suite of key physical (temperature, salinity, ice cover, light penetration), chemical (nutrients, trace metals, trace gases, radioisotopes, stable isotopes) and biological (phytoplankton and microbial assemblages, primary and microbial productivity, trace metal phytoplankton quotas) parameters in relation to proximity to the Mackenzie River delta. Seafloor bathymetry and ice cover were investigated to elucidate the processes influencing phytoplankton growth and carbon cycling in the Arctic Ocean. In particular, samples were collected to elucidate the processes which supply and remove trace metals, nutrients and carbon to and from the upper ocean, and ship-board experiments were conducted to study how biological productivity is affected by various chemical and physical conditions. Through a combination of on-board measurements, experiments and subsequent laboratory analyses, the research program aimed at:

- Documenting the pathways of addition, removal and cycling of key trace elements which act as biological micronutrients or tracers of carbon and nutrient cycles in the Arctic Ocean.
- Elucidating the potential effects of changing ice cover and river discharge on productivity, carbon sequestration and trace gas emission in the Arctic Ocean.
- Developing chemical tracers to establish a historical sedimentary record of Arctic Ocean productivity in relation to long-term natural climate change.

This research program was a Canadian contribution to the international GEOTRACES program (www.geotraces.org) and the International Polar Year (www.api-ipy.gc.ca). The results will be integrated in the International GEOTRACES database (www.bodc.ac.uk/geotraces) and the Polar Data Catalogue (www.polardata.ca).

5.2 Synopsis of operations

Sampling was carried out at 10 stations (Figure 5.2) chosen to highlight the relative influence of the Mackenzie River and the Pacific Ocean/Chukchi shelf, and to contrast ice-free and ice covered areas. The station depths ranged from 58 m at S1 on the shelf to 3485 m in the deep ocean basin at L3.

Detailed cruise reports provided by onboard participants and detailing specific objectives, methodology and preliminary results for projects conducted during the GEOTRACES campaign and Leg 3a are available in Part II of this report. Here, a general synopsis and timeline of operations during Leg 2a is provided.

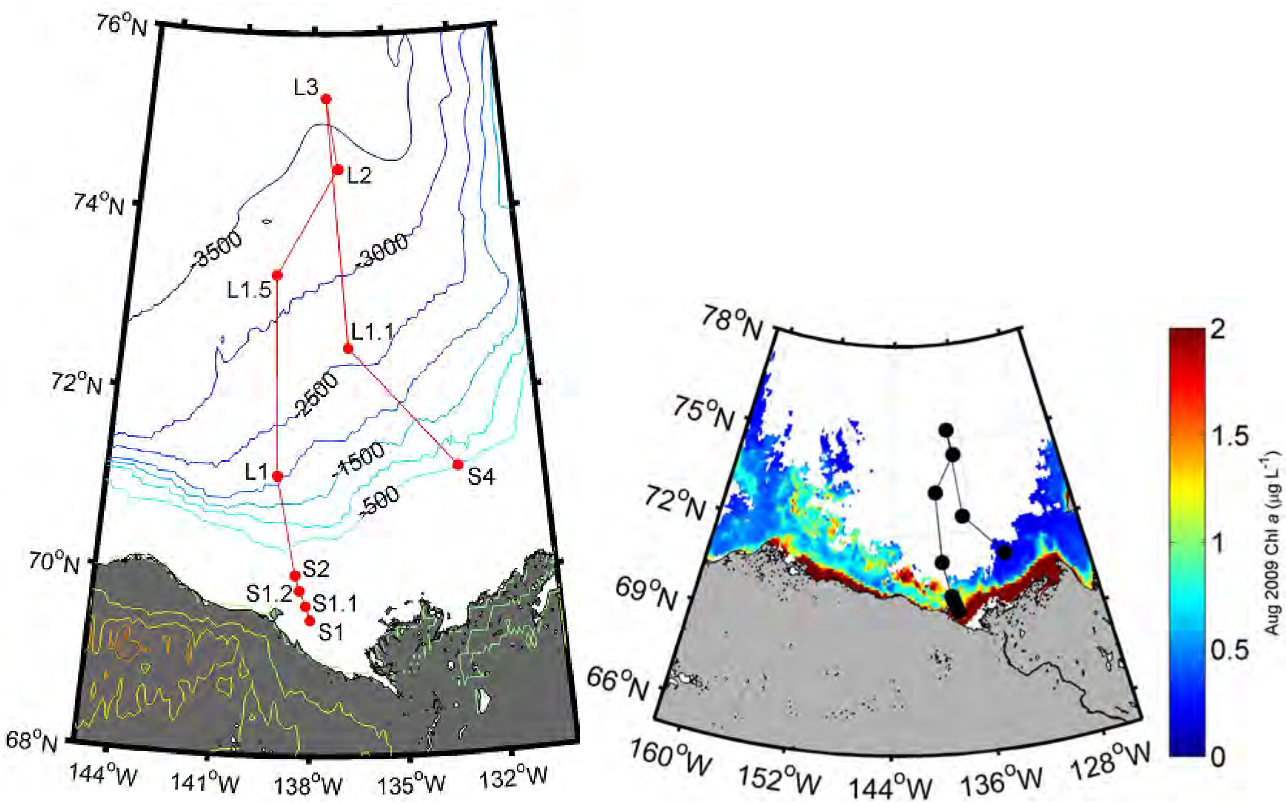

Figure 5.2. Maps showing the location of the GEOTRACES stations in the Beaufort Sea with the bathymetry (left) and surface Chl a for August 2009 (right).

During this leg, 21 stations were visited with an overall tally of operations and activities as follows:

- 46 CTD-Rosette casts
- 21 Trace Metal (TM) Rosette casts
- 15 water sampling using large volume in situ pump, with 6 deployments made through the moonpool
- 13 radiosonde (weather balloon) launches
- 4 deployments of MOB buoy
- 10 on-ice sampling operations and 2 ice sampling using the ice cage
- 2 ice motion beacon deployments
- 8 helicopter flights to determine ice thickness and roughness

A detailed scientific log for all sampling operations conducted during Leg 2a with the positions and depths of the visited stations is available in Appendices 1 and 2.

5.2.1 Timeline of operations

After the crew change in Paulatuk on 27 August, the *Amundsen* headed for the Mackenzie River delta and shelf. A first radiosonde was launched during transit to the first short station nearest the mouth of th river (S1) which was reached in the evening of 29 August. Operations at the GEOTRACES short stations consisted of multiple CTD-Rosette casts, both with the *Amundsen*'s Rosette and with the Trace-Metal Rosette, the deployment of the in situ pump (2-4 hours), to collect large volumes of water, and the short-term (4-12 hours) deployment of a Met/Ocean buoy (MOB). Station S1, as well as Stations S1.1 and S1.2 located on the way to S2, were completed in the morning of 30 August.

The standard operations, including the deployment of the large volume in situ pump from the deck or through the moonpool, were carried out at S2 over the course of 30 August and the ship headed for the first long station L1.

Operations at Station L1 consisted of repeated CTD-Rosette (8 casts), TM-Rosette (6 casts), and in situ large volume water pumping (4 deployments through the moopool) over the next 48 hours. Additionnally, the vicinity of the deeper stations (L1, L2 and L3) was characterized by 7/10th to 9/10th sea ice and intensive ice operations took place to sample ice features of interest. Near Station L1, sea ice was sampled using ship-based instruments (EM, scatterometer and photogrammetry), as well as during four helicopter flights over the ice and four on-ice sampling operations. Station L1 was successfully completed on 2 September.

A Trace-Metal Rosette cast was carried out at Station L1.5 before heading to Station L2 which was reached in the evening of 3 September. Over the next 3 days, this long station was extensively sampled for water column properties using the Rosettes and the in situ pump, and for various ice features, using the ice cage and the helicopter. A Met/Ocean buoy (MOB) was also deployed at this station.

The deepest long station L3 was reached in the morning of 7 September and was dedicated to water sampling with the two Rosette systems and the in situ large volume pump. While transiting to Station L1.1, ice sampling operations were conducted from the ship and with the helicopter. Station L1.1 began in the afternoon of 8 September and was sampled successfully over the next 48 hours.

The last station of the GEOTRACES campaign (S4) was visited on 11 September where a short Trace-Metal Rosette cast was conducted, then the ship headed for Paulatuk for the crew change on 12 September.

5.3 Chief Scientist's comments

Overall, the GEOTRACES field program and Leg 3a in general was very successful for all science participants onboard. Our thanks go to the Commanding officer, the officers and crew of the CCGS *Amundsen* for their indispensable contribution to this success. Their hard work and support during science operations was very appreciated. Thanks to K. Levesque for the preparation and planning of this cruise and to ArcticNet's technicians (U. Laval and INRS) for the day-to-day operation of the Rosettes and the *Amundsen*'s equipments.

6 Leg 3b – 12 September to 8 October 2009 – Beaufort Sea

Chief Scientist: Tim Papakyriakou[1] (papakyri@cc.umanitoba.ca)
[1] *University of Manitoba, Centre for Earth Observation Science (CEOS), Wallace Building, 125 Dysart Rd, Winnipeg, MB, R3T 2N2, Canada.*

6.1 Introduction and objectives

The Beaufort Sea/Mackenzie Shelf region of the Arctic Ocean has witnessed major changes in recent years, with decreasing sea ice cover and major shifts in sea-ice dynamics. Although major inshore research activities were conducted in the 70's and 80's in large part due to the Oil & Gas interest in the region, much less is known about the offshore region of the Mackenzie Shelf, shelf slope and Beaufort Sea.

Since 2002, ArcticNet has been conducting extensive multidisciplinary research programs in the area. In addition to an annual fall sampling program, ArcticNet researchers have led two major international overwintering research programs conducted onboard the CGGS *Amundsen* in 2003-2004 (CASES) and in 2007-2008 (CFL). A marine observatory of a minimum of 5 oceanographic annual moorings (from 5 to 17 moorings) has been deployed and retrieved annually in the area by ArcticNet researchers since 2002.

Recent interest in the Beaufort Sea has resulted in major bids from industry on offshore exploration licenses (EL) located in the 50-1500 m depth range of the shelf and shelf break. Of particular relevance to the 2009 expedition is EL446 (called Ajurak) awarded to Imperial Oil in 2007 (Figure 6.1).

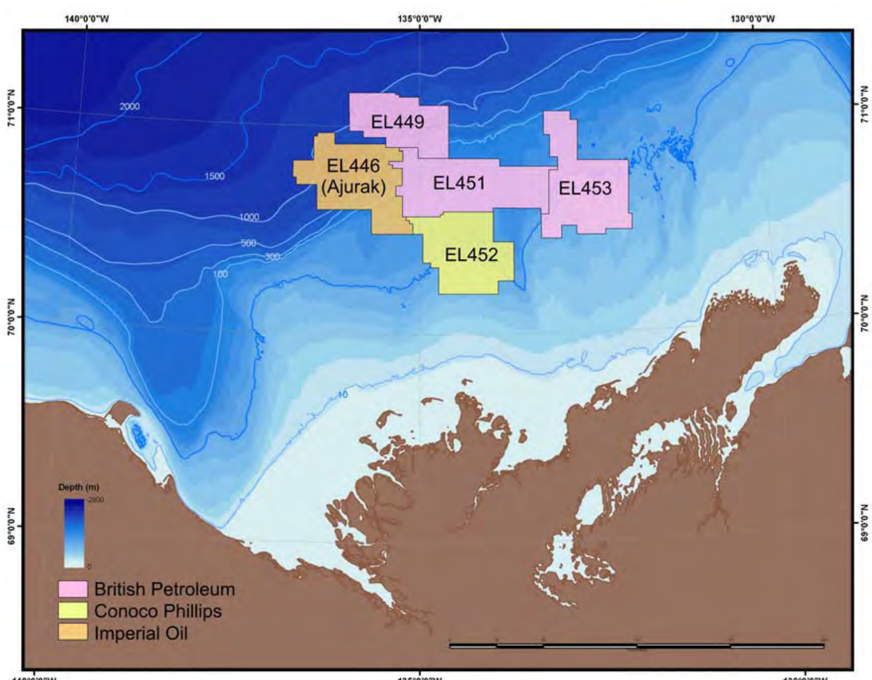

Figure 6.1. Map of offshore Exploration Licenses (EL) awarded by the Canadian government in the Beaufort Sea region (modified from image courtesy of GSC).

As part of a collaborative agreement between ArcticNet and Imperial Oil, one of the major goals of the 2009 ArcticNet expedition to the western Arctic was to increase the level and spatial coverage of sea-ice, geological and environmental data collected by the ArcticNet network in the Beaufort Sea/Mackenzie Shelf/Amundsen Gulf region (regional context) with a special focus placed in and around Ajurak.

As designed jointly by ArcticNet and Imperial Oil, the research elements of the collaborative work are divided into 3 major research components:

- **Met/Ocean & Sea Ice:** The overarching goal of this component is to provide data that describe the variability of met/ocean and sea ice variables within the Ajurak exploration block relative to the larger area of the southern Beaufort Sea continental shelf. The objective is to provide data on the ocean-sea ice-atmosphere (OSA) interface over a range of time and space scales, focusing on spatial and temporal variability over diurnal, seasonal and interannual time scales.
- **Environment & Marine Resources:** The general goal of this component is to quantify and map the summer-fall distribution and contamination of the main compartments of the pelagic and benthic food webs along the slope of the Mackenzie Shelf, from the inner shelf (50 m) to the margin of the deep basin (approx. 1200 m), and from the Mackenzie Trough to the west to Cape Bathurst to the east with special focus on specific areas in Ajurak.
- **Geology/ Bathymetry:** This component will conduct an investigation of seabed stability conditions to meet engineering design and regulatory requirements for exploration drilling. Seabed mapping and bottom sediment characterization research is required to investigate seafloor stability conditions at the outer shelf/upper slope area of the central Beaufort Sea with special focus on specific areas in Ajurak. Foundation conditions, slope stability, seabed features and ice scouring are also key issues to be addressed.

All 3 research components, objectives and deliverables are highly integrated and conducted as part of the 2009 ArcticNet expedition in the Beaufort Sea during Legs 2 and 3. The main focus of Leg 3b was to complete the Geology & Bathymetry Component of the program, and to continue facets of the both the Environment & Marine Resources and Met/Ocean & Sea Components that were initiated during Leg 2a. The major objectives for Leg 3b were to:

- Deploy a moored Met/Ocean surface buoy and two Mixed-Layer buoys for the duration of the leg.
- Turn-over 2 subsurface oceanographic moorings, and retrieve a third in Ajurak block. These moorings were deployed during Leg 2a.
- Complete the systematic seabed mapping coverage of the Ajurak block, and at strategic locations outside of the block in support of a regional geophysical survey.
- Undertake systematic piston and box core operations at 50 locations in the Ajurak block in support of a regional geotechnical survey.
- Retrieve 12 bottom anchored hydrophones in Ajurak block that were deployed in Leg 2a.
- Deploy the Remotely Operated Vehicle (ROV) for a visual survey of the ocean floor at strategic sites in support of the geophysical and geotechnical programs.

- Deploy a moored Met/Ocean surface buoy for the duration of the leg.
- Conduct ice thickness and roughness surveys using the helicopter mounted EM Induction system and deploy ice drift satellite beacons on large ice floes around Ajurak.

6.2 Synopsis of operations

Detailed cruise reports provided by onboard participants detailing the specific objectives, methodology and preliminary results for 8 projects conducted during Leg 3b are available in Part II of this report. Here, a general synopsis and timeline of operations are provided for Leg 3b.

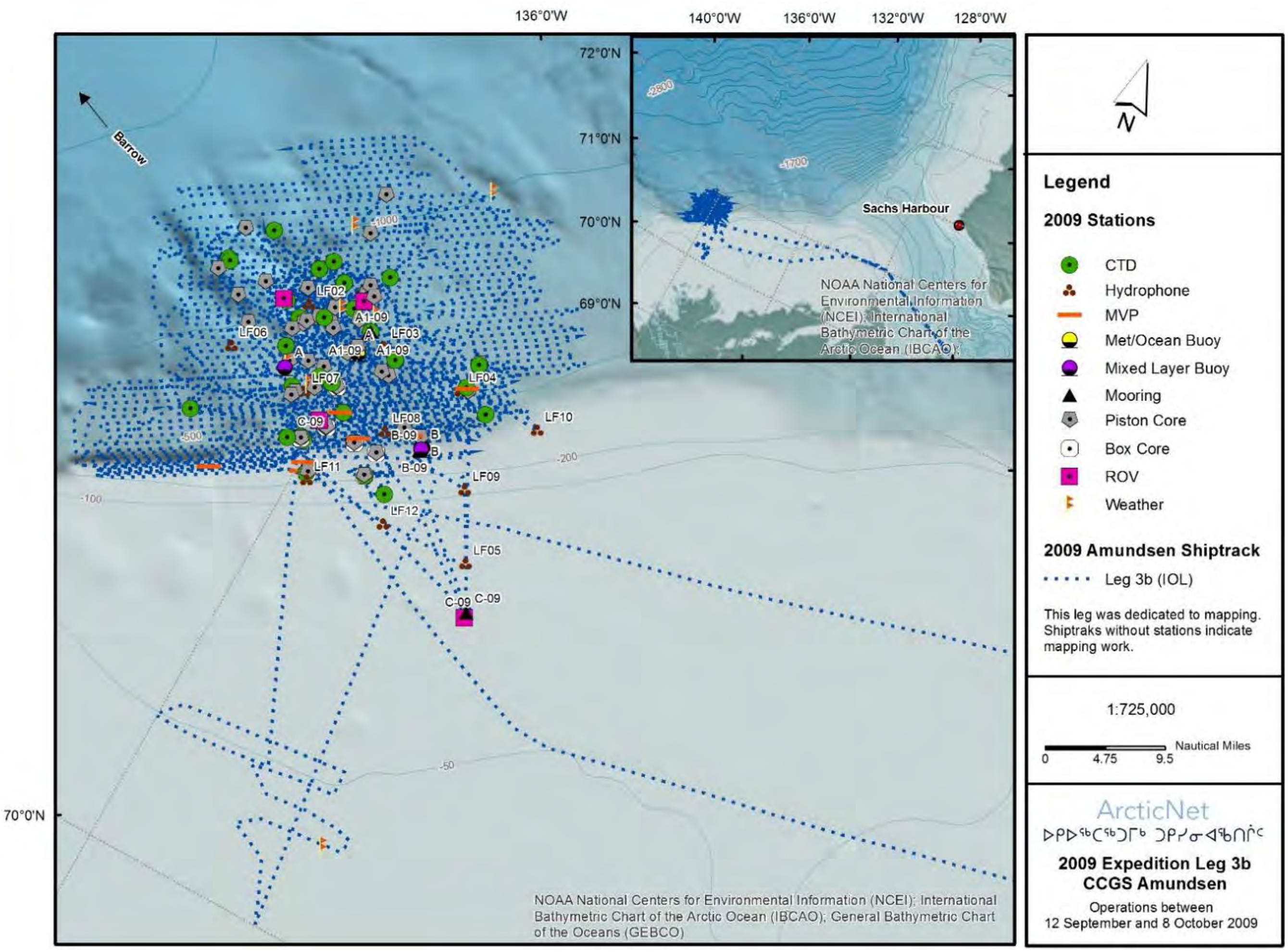

Figure 6.2. Ship track and the location of stations and mooring sites visited by the CCGS *Amundsen* in IOL's Ajurak exploration acreage in the Beaufort Sea during Leg 3b of the 2009 ArcticNet Expedition. Ship track with no stations represents seabed mapping activities.

During this leg, 17 stations were visited with an overall tally of operations and activities as follows:

- 30 CTD casts
- 1 CTD-Rosette cast
- 51 piston cores and 8 box cores to collect seabed sediments

- 3 surface moored met/ocean buoys deployed and retrieved
- 3 sub-surface oceanographic moorings recovered and 2 re-deployed
- 11 moored MARU hydrophones recoveries
- 4 ROV dives
- 5 MVP transects
- Over 6 600 km (27 areas) of dedicated multibeam and sub-bottom seafloor surveys
- 13 radiosonde (weather balloon) launches
- 5 helicopter transects to measure sea ice thickness and surface roughness

A detailed scientific log for all sampling operations conducted during Leg 3b with the positions and depths of the visited stations is available in Appendices 1 and 2.

6.2.1 Ice and weather conditions

The main sea ice pack remained between 20 nm to 60 nm north of the Ajurak block for much of the cruise. In early October a low concentration ice tongue from the main ice pack extended into the block, and during this same period atmospheric conditions (low wind and cool temperature) prompted the growth of nilas, frazil and pancake sea ice. In contrast to Leg 2a, the weather was quite variable, and often presented an obstacle around which science operations had to be scheduled. Wind speed (Figure 6.3) often exceeded the safe threshold (approximately 25 kts or 12.8 m/s) for piston core operations (the main deck operation of Leg 3b). Responding to wind speed, maximum wave height ranged from a few centimetres to over 6 m. The latter occurred during the leg's premier storm on 19 September. Air temperature (Figure 6.3) ranged between -8°C and 14°C. The spacing in peaks (troughs) in the plots provides a crude measure of the frequency in cyclonic activity.

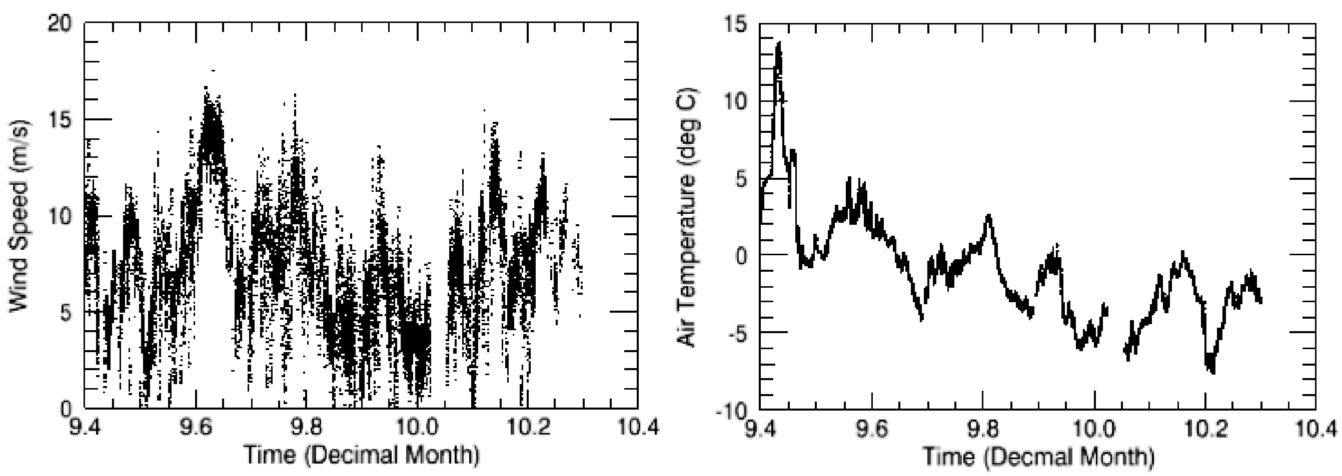

Figure 6.3. True wind speed (left) and temperature (right) measured from the foredeck tower on the ship during Leg 3b. X-axes range from 12 September to 12 October. Wind speed in knots is approximately m/s times 1.94.

6.2.2 Timeline of operations

Leg 3b started in Paulatuk with a full Coast Guard and scientific contingent crew change. Leaving Paulatuk during the evening of 12 September, the ship reached the Ajurak block around 03:00 (local time) on 14 September and commenced the science program with bottom-mapping operations in Areas 1 to 4. A CTD cast was carried out before the start of the bathymetric survey in each area.

The seafloor in Area-5 was surveyed on 15 September with an interruption in the afterrnoon to deploy a surface Met/Ocean buoy. On 16 and 17 September, areas 6 and 7 were mapped with the multibeam system, 2 mixed-layer buoys (A and B) were deployed and mooring B-09 was recovered and re-deployed.

Work in Area-8 was conducted from 17 to 19 September and included mapping ang coring operations. Deck operations (2 piston cores and 1 box core) were difficult during this time due to high winds and sea state associated with the passage of a storm.

On 20 and 21 September, the seafloor in Area-9 and Area-10 was mapped and sampled using the piston core (8 deployments) and box core (1 deployment). In the evening of 21 September, a MVP transect was conducted followed by a CTD cast and the recovery of a first MARU hydrophone (LF07) before mapping of Area-11 started for the night. Ten more MARU buoys (total of 11 out of the 12 deployed in Leg 2a) were retrieved on 22 and 23 September along with coring activities and bathymetric mapping in Areas 12 and 13.

A piston core in Area-14 was done before nightfall on 23 September then the area was mapped during the night. Mapping and coring operations in Areas 15 and 16 took place through the day and night of 24 September, including a short MVP section in the evening.

Weather conditions were good on 25 and 26 September and all mapping and coring operations planned for Areas 17 to 20 proceeded rapidly. Seabed apping of Area-21 started mid-morning on 27 September and operations for this day also included 2 piston cores and 1 box core followed by the mapping of Area-22.

Activities in Areas 23, 24 and 25 proceeded as planned under good weather conditions and calm seas consisting of the usual mapping and coring operations plus two MVP sections (one in Area-24 in the evening of 28 september and one in Area-25 on the morning of 30 September) and the recoveries of the Met/Ocean buoy and the Mixed Layer buoy B deployed on 15-16 September. A ROV dive also took place on 29 September to conduct a 2 km transect along the seafloor and inspect the ship's propeller.

Mooring A1-09 was recovered on 1 october and re-deployed the following day. Mixed layer buoy A was also recovered in the afternoon of 1 october. Two ROV dives were carried out on 2 October, the first consisting of a 1-km transect along the slope and the second dive succeeded in recovering a beacon on the seafloor. The mapping of Area-26 began in the evening of 1 October and continued over the next 3 nights to end in the morning of 4 October. Mooring C-09 was successfully recovered on 3 October but necessited the use of the ROV to disentangle a cable preventing the mooring to surface.

The mapping and coring in the last sector of the Ajurak block (Area-27) started in the afternoon of 4 October and was finalized in the morning of 6 october, and the ship set sail for Paulatuk.

Throughout the cruise, the *Amundsen*'s extensive array of oceanographic and atmospheric underway systems associated with the Met/Ocean program were operational. These include water surface pCO_2 and CTD on track system, foredeck and top bridge met towers, ceilometers, radiometer, all-sky camera, …). Details appear in the various sections in Part II of this report. On the bridge, Marine Wildlife Observers spotted and identified marine mammals and seabirds.

Sampling for Leg 3b ended on the evening of 6 October, when the transit back began to arrive in Paulatuk for the science rotation scheduled for the morning of 8 October.

6.3 Chief Scientist's comments

The Chief Scientist would like to thank and congratulate everyone on board for their work and efforts in making Leg 3b a success. In particular, thanks go to Commanding Officer Julien and the officers and crew of the *Amundsen* for their dedication, professionalism and camaraderie that make the *Amundsen* such a special research vessel. Special thanks are extended to the Québec-Océan technicians, S. Blondeau and J. Ouellet, for continued hard work and dedication to the projects' needs. When called upon, J. Ouellet, in conjunction with S. Blondeau, were outstanding in orchestrating ROV deployments, particularly in regard to their contribution toward the retrieval of a shallow mooring that did not surface. The planning and delivery of Leg 3b was done in close collaboration with Imperial Oil. On-board, the science steering committee did a tremendous job of scheduling events, working around obstacles, and working in the true spirit of collaboration. They deserve recognition for their professionalism and dedication to the project. I would like to thank the Imperial Oil Ajurak team for their essential contribution in putting together the program and for the numerous meetings, phone calls and countless hours of preparation leading to the field work. We are indebted to K. Levesque, ArcticNet's Ship-based Research Coordinator, for his tireless efforts, dedication and investment in the preparation of this very challenging 2009 expedition. Finally, I would like to thank M. Fortier for continued dedication to ArcticNet, and in particular for the support and energy that he extended toward the planning and implementation of Leg 3b.

7 Leg 4a – 8 October to 6 November – Beaufort Sea, NW Passage, Baffin Bay

Chief Scientist: Keith Lévesque[1]
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7.1 Introduction and objectives

Leg 4a was dedicated to the ArcticNet marine-based research program. The main objective of this long-term research program is to assess the changes occurring in the coastal Canadian Arctic marine ecosystem in response to climate warming. In addition to ArcticNet conducting its program (Phase 2 projects), the NSERC-funded Canadian Healthy Oceans Network (CHONe) carried out its first Arctic field campaign during Leg 4a (and 4b). Data collected during Leg 4a and the 2009 *Amundsen* expedition will contribute to a better understanding of the impacts of climate variability and change on the physical, biological and geochemical processes in the coastal Canadian Arctic.

7.1.1 ArcticNet

From 8 October to 6 November, the Amundsen carried out operations in the Beaufort Sea/Amundsen Gulf and the Canadian Arctic Archipelago (Viscount Melville Sound, M'Clure Strait and Lancaster Sound), as well as in Baffin Bay as part of the ArcticNet marine-based research program (Figure 7.1 and 7.2). The specific objectives and priorities for Leg 4a were to:

- Sample the atmosphere and quantify gas fluxes at the sea ice-seawater-atmosphere interface along the cruise track.
- Recover and re-deploy 6 oceanographic moorings (CA05-, CA05-MMP-, CA16-, CA16-MMP, CA04- and CA18-) in the Beaufort Sea and Amundsen Gulf.
- Conduct oceanographic sampling at designated stations in the Beaufort Sea, Amundsen Gulf, Northwest Passage, Lancaster Sound and northern Baffin Bay.
- Collect seawater from the surface microlayer, at the interface between the ocean and atmosphere.
- Conduct sea ice operations in the Beaufort Sea, the Canadian Archipelago and northern Baffin Bay, including helicopter transects, on-ice physical sampling and the deployment of ice beacons.
- Conduct a ROV dive in Viscount Melville Sound to investigate the seafloor and benthic community in an important marine mammal usage area.
- Conduct dedicated multibeam surveys and ROV dives in Scott Inlet (Scott trough) on the coast of Baffin Island (Station 141) to locate and delineate a potential oil seepage site.

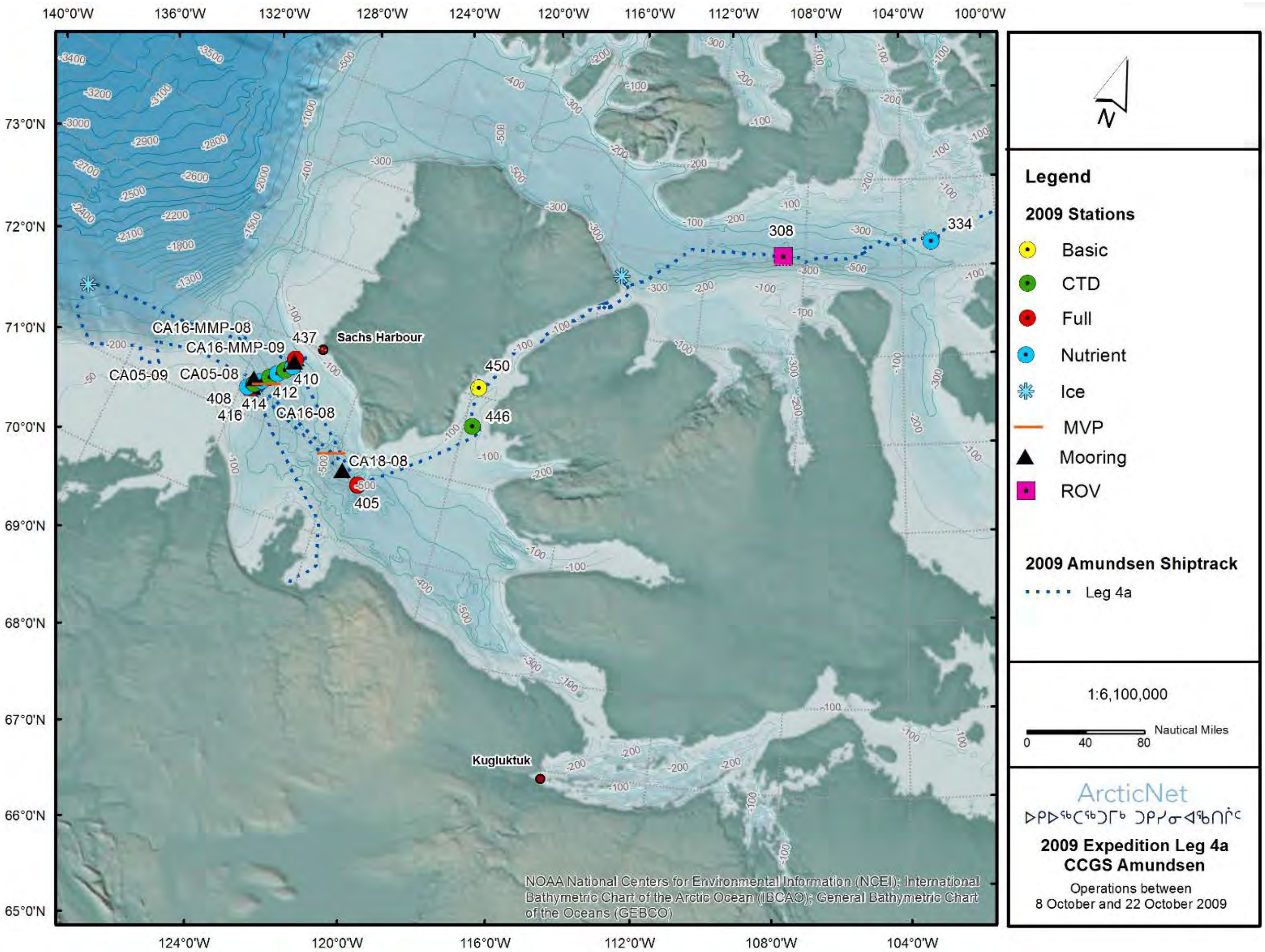

Figure 7.1. Map of the Beaufort Sea, Amundsen Gulf, Prince of Wales Strait and Viscount Melville Sound showing the ship track and the stations visited by the CCGS *Amundsen* during the first portion of Leg 4a.

7.1.2 Canadian Healthy Oceans Network (CHONe)

CHONe is a 5-year strategic partnership between Canadian university researchers, government agencies and ArcticNet. This network is about aligning Canadian marine science capacities to respond to research challenges and knowledge gaps on biodiversity in frontier oceanic environments, such as the Canadian Arctic. CHONe is a national marine science initiative that is uniting researchers to provide scientific guidelines for policy in conservation and sustainable use of marine biodiversity resources in Canada's three oceans.

Within CHONe, the *Marine Biodiversity* research theme addresses how patterns of biological biodiversity are related to habitat diversity, specifically testing hypotheses that link functional (ecological roles of different species) and species biodiversity to habitat complexity. The theme *Ecosystem Function* aims at determining how ecosystem function (processes such as nutrient cycling) and health (whether ecosystems are able to maintain these processes) are linked to biodiversity and natural and anthropogenic disturbances.

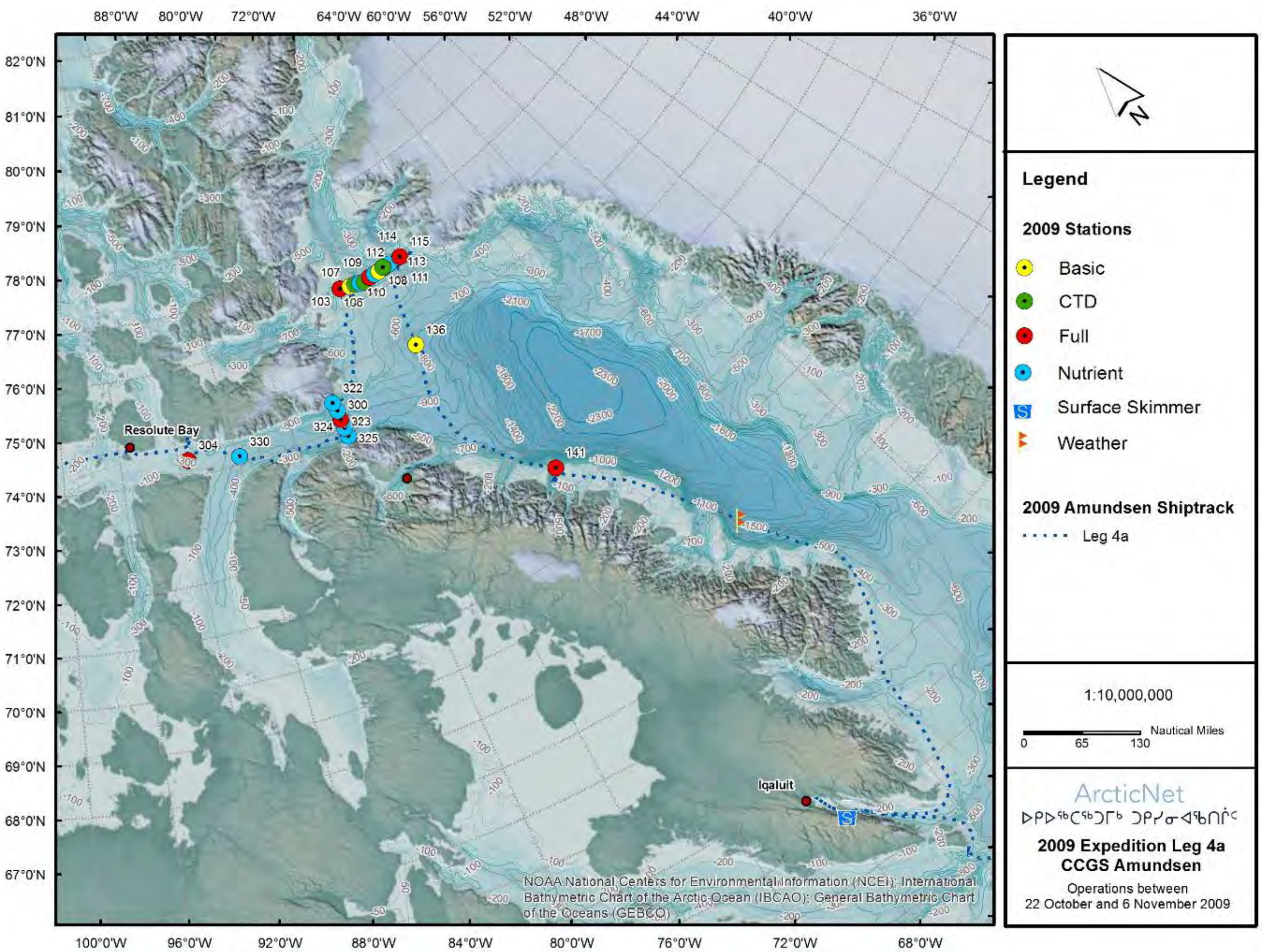

Figure 7.2. Map of the Eastern Canadian Arctic showing the cruise track and the stations visited in Lancaster Sound and Baffin Bay by the CCGS *Amundsen* during the second portion of Leg 4a.

Specifically, the aim is to understand the role of biodiversity in marine ecosystem services (the “goods” provided to humans by living organisms) by linking biodiversity and ecosystem function measures, and to provide predictive models and tools to minimize anthropogenic impacts. The outcomes of each of these themes will be synthesized to identify approaches to bridge science and policy.

Leg 4a constitutes a collaboration between CHONe and ArcticNet and allowed obtaining samples for 8 different CHONe projects related to benthic biodiversity. More details on these projects are provided in Section 36 in Part II of this report.

7.2 Synopsis of operations

Detailed cruise reports provided by onboard participants and detailing specific objectives, methodology and preliminary results for 17 projects conducted during Leg 4a are available in Part II of this report. A general synopsis and timeline of operations during Leg 4a is provided hereunder.

A total of 50 stations were visited with an overall tally of operations and activities as follows:

- 16 CTD casts
- 48 CTD-Rosette casts
- 4 sub-surface oceanographic moorings recovered (CA05-08, CA05-MMP-08, Ca16-08 and CA16-MMP-08) and 3 re-deployed (CA05-09, CA05-MMP-09 and CA16-MMP-09). Note that CA18-08 could not be located and CA04-08 recovery was not attempted due to ice conditions.
- 26 deployments of optical instruments, including UVP, IOPs and PNF
- 8 surface microlayer samplings to collect water at the interface between ocean and atmosphere
- 7 Agassiz trawl deployments to collect benthic organisms
- 37 zooplankton and icthyoplankton net deployments, including horizontal and vertical net tows, hydrobios and RMT.
- 29 box cores to collect seabed sediments and endofaunal organisms
- 3 ROV dives
- 4 dedicated multibeam bathymetry and sub-bottom seafloor surveys
- 1 MVP transect
- 13 radiosonde (weather balloon) launches
- 5 on-ice operations using the ice cage, barge or helicopter to access ice features of interest

A detailed scientific log for all sampling operations conducted during Leg 4a with the positions and depths of the stations is available in Appendices 1 and 2.

7.2.1 Timeline of operations

Following a full crew change in Paulatuk on 8 October, the ship headed for the Amundsen Gulf/southern Beaufort Sea for the first part of the leg to service the ArcticNet moorings, conduct sampling operations at designated stations and carry out sea ice operations. The first mooring station (CA05 and CA05-MMP) was reached in the morning of 9 October. Recovery operations involved locating and interrogating the moorings, followed by a CTD cast and then the release codes were sent. The recovery of CA05-08 and CA05-MMP-08 went smoothly under good weather conditions and operations were concluded at 12:50. The *Amundsen* then proceeded toward the Beaufort Sea for sea ice sampling operations planned the following day.

Physical sampling of snow and sea ice and the collection of ice cores were conducted at two sites on the ice pack on 10 October. The recovery of mooring CA04-08 was scheduled for the next day but due to the worsening weather conditions, the decision was taken to leave mooring CA04-08 in its position for another year. The acoustics releasers battery life was estimated to be good for at least three years, so there was no need to pursue a dangerous mooring recovery if the operation was feasible next season.

The ship reached mooring station CA16 in the evening of 11 October and was successfully recovered the following day in strong wind conditions (Beaufort scale 6). The sampling of Full Station 437 associated with this mooring was carried out during the night of 11 to 12 October.

Six hours of multibeam seafloor mapping was conducted during the night of 12 October while the ship steamed back to Full Station 408 / Mooring CA05. Science operations at station 408 started immediately upon arrival (at 4:00) with the full suite of water column sampling activities: CTD-Rosettes, zooplankton net tows (horizontal & vertical nets, hydrobios and RMT) and optical measurements. Mooring CA05-09 was successfully re-deployed on 13 October.

The CTD and Nutrient stations along the transect between Cape Bathurst and Banks Island (416, 415, 414, 413, 412, 411 and 410) were sampled on 14 October, and the recovery operation for mooring CA16-MMP-08 began early in that afternoon. The mooring was successfully retrieved in good weather and re-deployed for another year as CA16-MMP-09.

Mooring CA18 in Amundsen Gulf was interrogated on 15 October. Unfortunately, the mooring's two acoustic releases did not respond. Going over the mooring location with the ship's multibeam did not reveal any echoes from the mooring's instruments. It was then decided to head back to deploy mooring CA05-MMP-09 (paired to CA05-09 already deployed) which was successfully completed before nightfall that evening.

On 16 October, the *Amundsen* tried again to communicate with the acoustic releases of mooring CA18 at a range of 2 nm without success. It is likely that this mooring was released from its anchor due to corroded shackles or defective releases.

With operations already behind schedule and ice conditions rapidly worsening in the Northwest Passage and Lancaster Sound, it was decided to go through Prince of Wales Strait and Viscount Melville Sound rather than via Queen Maud Gulf and McClintock Channel.

CTD Station 446 and Basic Station 450 were sampled during the night and early morning of 17 October. The helicopter was launched on 17 October to install an ice beacon on a large multi-year ice floe located at the mouth of Prince of Wales Strait (73°34.323' N, 115°11.465' W). The passage through Viscount Melville Sound was difficult due to severe ice conditions. Full Station 308 in Viscount Melville Sound was finally reached 2.5 days later, in the evening of 19 October. Sampling operations proceeded in heavy ice (9/10th – 9+/10th) and sometimes strong winds and included the usual CTD-Rosettes, net tows (vertical tow only) and box cores. A ROV dive was also conducted near this station the following morning (20 October) to investigate the benthic community associated with this important beluga habitat.

The assistance of the CCGS *Louis S. St. Laurent* was requested to push through east in Viscount-Melville Sound. The sampling plan in Lancaster Sound had to be completely changed because most stations were located in heavy ice and could not be easily accessed or sampled even with the assistance of the *Louis Saint Laurent*. Hence, Full Station 304 was moved northwest of its 2008 position and all the Nutrient and Basic stations (except one: Nutrient Station 330) were canceled. Stations 325, 324 and 323 along the transect at the eastern end of Lancaster Channel were sampled under very difficult weather conditions and strong winds but all the planned operations along the transect, including Stations 300 and 322 located in heavy ice (9/10), were successfully completed by midnight on 25 October. The *Amundsen* finally sailed into Baffin Bay, relieved the CCGS *St. Laurent* from its escort duties and proceeded north to conduct oceanographic sampling along the transect between Ellesmere Island and Greenland.

Heavy ice conditions prevailed all along the coast of Ellesmere Island and the first station of the transect (Full Station 101) had to be canceled. Station 103 became the eastern end of the transect and was converted from Nutrient to Full station. Station 103 was reached in the evening of 26 October and was sampled over the next 12 hours despite the heavy ice and bad weather encountered. Two sea ice sampling operations also took place at Station 103. Stations 105 to 108 were visited and sampled as planned over the next 24 hours (27 October).

A high priority message was issued from the Coast Guard that a satellite launched by Russia and the ESA was scheduled for 2 November and that debris from the rocket may fall in northern Baffin Bay. It was decided to quickly proceed with the sampling of the transect and leave the area at the latest on 31 October. Stations 109 to 112 proceeded as planned throughout the day of 28 October although winds consistently above 25 knots and freezing temperatures (and 9/10th ice around Station 111) made deck operations difficult. On 29 October, the final westernmost stations of the transect (113 to 115) were completed under better weather and ice-free conditions, including a short ROV dive at Station 115.

Having completed the transect between Ellesmere Island and Greenland, the ship headed for Station 136 located approximately 12 hours sailing to the south. Basic oceanographic sampling operations at station 136 were concluded by 19:00 on 30 October despite the prevailing heavy ice and strong winds. The last station of the leg (141) at Scott Inlet on Baffin Island was reached in the evening of 31 October and included 48 hours of science operations, consisting of the usual sampling scheme for a Full station, plus 20 hours of multibeam seafloor mapping and 10 hours of ROV diving (2 dives, including test dive).

The *Amundsen* arrived in Iqaluit on 6 October for the scheduled science rotation and the end of Leg 4a.

7.3 Chief Scientist's comments

The amibitious cruise plan for this leg covered three broad regions in late fall, and was essentially carried out despite sometimes severe ice conditions, strong winds and bad weather (and the threat of falling debris from a Russian rocket). The Chief scientist would like to thank the scientific steering committee and all the science personnel for their hard work under difficult conditions and their positive attitude despite the constantly changing schedule. The Chief Scientist and the science participants of Leg 4a express their gratitude to the Commanding Officer and the officers and crew of the CCGS *Amundsen* (and of the CCGS *Louis Saint Laurent*) for their unrelenting support and comprehension throughout this cruise.

8 Leg 4b – 6 November to 18 November – Labrador fjords

Chief Scientist: Sam Bentley[1] (sbentley@mun.ca)
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8.1 Introduction and objectives

Leg 4b of the 2009 ArcticNet *Amundsen* Expedition spanned the time of 6-18 November, beginning in Iqaluit and ending in Quebec City (Figure 8.1). The overall goal of this leg was to conduct oceanographic sampling in the fjords of Nunatsiavut and Labrador, including Nachvak Fjord, Saglek Fjord, Okak Bay, and Anaktalak Fjord (north to south respectively) (Figure 8.1). This leg constitutes a major field component of the ArcticNet Nunatsiavut Nuluak project, focused on the impacts of climate change and modernization on waters and communities of the Labrador/Nunatsiavut coastal region.

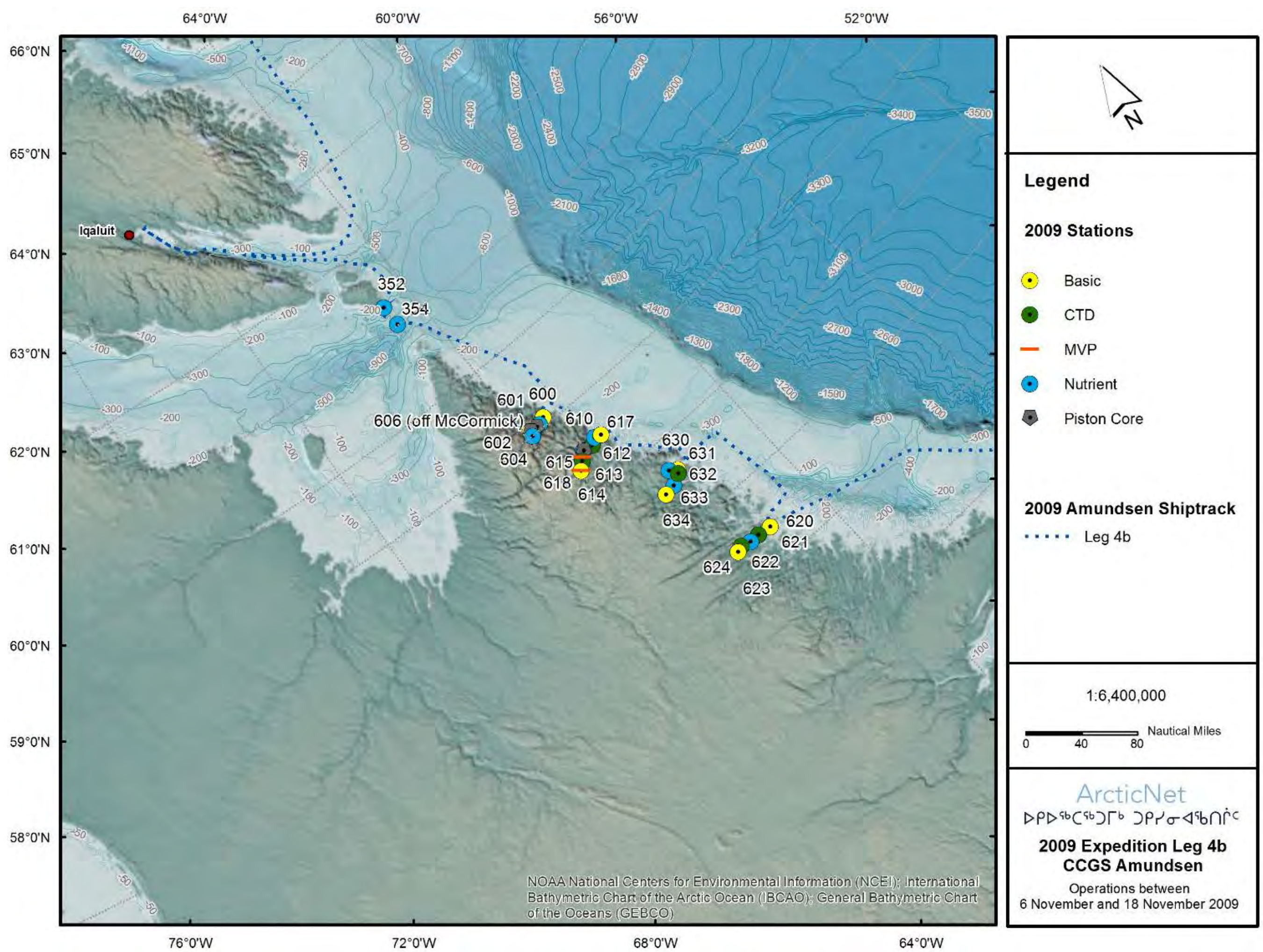

Figure 8.1. Map showing the cruise track and the stations visited by the CCGS *Amundsen* in Hudson Strait and the four northern Labrador fjords during Leg 4b of the 2009 ArcticNet Expedition.

The ship-based component of Nunatsiavut Nuluak is an integral component of the overall project and complements the shore-based work. The specific objectives for Leg 4b were to:

- Determine present and past rates of sediment/water transfer from rivers to fjords, as well as rates of sediment accumulation in fjord basins.
- Provide geochronological / historical context for other geochemical/biological measurements made in sediments.
- Determine the spatial variability of phytoplankton production and biomass in the coastal zone. Compare this variability across latitudinal gradients (i.e. between fjords) and across longitudinal gradients (i.e. mouth versus head) within each fjord.
- Determine the spatial variability of zooplankton production and biomass in the coastal zone. Compare this variability across latitudinal gradients (i.e. between fjords) and across longitudinal gradients (i.e. mouth versus head) within each fjord.
- Determine the spatial variability in nutrient production rates within and between each fjord.
- Determine the role of environmental conditions on the phytoplankton and zooplankton dynamics.
- Compare seasonal differences in the fjords using previous results obtained in Fall 2006 and July 2007.
- Determine oceanographic conditions using vertical profiles with a CTD.
- Determine the concentrations of inorganic nutrients (NO_3, NO_2, PO_4 and $Si(OH)_4$) with a nutrient autoanalyzer.
- Conduct seabed mapping in Okak Bay.
- Determine long-term and recent environmental change in northern Labrabor fjords using the mircofossil record preserved in sedimentary deposits.
- Reconstruct long-term paleoceanographic variability in Nachvak Fjord.

<u>Nunatsiavut Nuluak – Labrador fjords project</u>

The ArcticNet Nunatsiavut Nuluak project is a partnership with the Nunatsiavut Government, the Royal Military College (Environmental Sciences Group), Parks Canada, the Department of National Defense, Environment Canada, the Department of Fisheries and Oceans (DFO), and Voisey's Bay Nickel Company Ltd. The goal of the project is to conduct a baseline inventory and comparative assessment of the marine ecosystems in four northern Labrador fjords. The purpose of the project is to address Inuit concerns regarding the ecological integrity of the marine environment in northern Labrador by acquiring a better understanding of the effects of climate change, natural resource extraction and contaminants. An integrated regional approach has been implemented to ensure concerns from all stakeholders, including major industrial and governmental organizations are adequately addressed.

The four marine ecosystems that were studied were Anaktalak Bay (the shipping route to the Voisey's Bay nickel mine), Saglek Bay (affected by a historical source of PCB contamination), Okak fjord (an area used frequently by Inuit for harvesting and traveling), and Nachvak fjord (a pristine ecosystem adjacent to the Torngat Mountains National Park

Reserve). These studies complement each other and provide good comparative data for other systems currently being investigated by ArcticNet.

The study integrates Inuit and Inuit knowledge throughout the entire process including selection of indicators and areas of study, analyzing and interpreting data and conducting field research, and is helping to build capacity among Inuit in Labrador and strengthen partnerships through collaboration. The Kangidluasuk Student Program is an integral component of our ArcticNet Nunatsiavut Nuluak study. This year, three students from Nunantisiavut communities were able to join the Schools on Board Program and the Kangidlusuk Student Program Coordinator (M. Arnold) co-led the program with L. Barber.

This project also builds on previous work, and on well-established and successful relationships between the proponents and their partners. In particular, the cruise aboard the CCGS *Amundsen* this year built upon a successful eight-week field season that was completed via longliner and small boats (shore-based component) run from the jointly-operated Kangidluasuk Base Camp during August and September, prior to boarding the ship. The sampling approach taken aboard the *Amundsen* was to complement the shore-based research whenever possible and pursue activities that would otherwise be impossible without the ship and its equipment.

<u>Schools on Board and CHONe</u>

In addition to ArcticNet research programs, the cruise supported a Schools On Board expedition (led by L. Barber and M. Arnold), and provided biological and geological observations for the Canadian Healthy Oceans Network (CHONe), a new NSERC Strategic Research Network, in which ArcticNet NIs Bentley, Archambault, and Juniper are also principal investigators. A description of the rationale and objectives of the CHONe research program is available in the introduction to Leg 4a (Section 7.1.2) above.

8.2 Synopsis of operations

The sampling onboard the *Amundsen* consisted of CTD profiles, nutrient and phytoplankton samples using the Rosette, zooplankton sampling using an oblique Tucker trawl and Hydrobios as well as Monster vertical tows for species composition, trophodynamics and contaminants work, and Rectangular Mid-Water Trawl (RMT) for trophodynamics and contaminants work.

Box cores were employed for seabed habitat mapping, DNA barcoding, sediment flux, contaminants, and palaeoceanographic work, and piston cores for sediment flux, and paleoceanographic work. These were conducted in conjunction with multibeam seabed mapping and subbottom profiling.

During this leg, 24 stations were visited with an overall tally of operations and activities as follows:

- 5 CTD casts
- 21 CTD-Rosette casts
- 10 surface water samples
- 6 optical instrument deployments, including IOPs Secchi disk and PNF
- 5 Agassiz trawl deployments
- 30 zooplankton and ichtyoplankton samplings, including horizontal and vertical net tows, Hydrobios and RMT
- 3 surface microlayer sampling
- 6 piston cores and 12 box cores to collect seabed sediments
- 1 MVP transect (although 2 attemps were made)
- Dedicated multibeam and sub-bottom seafloor surveys in each fjord

A detailed scientific log for all sampling operations conducted during Leg 4b with the positions and depths of the visited stations is available in Appendices 1 and 2.

8.2.1 Timeline of operations

The first operations undertaken prior to reaching the northernmost fjord were collecting CTD and dissolved nutrient samples in a transect across the eastern end of Hudson Straight (Figure 8.1). Although the northern two stations (352 and 354) were completed successfully in the morning of 7 November, moderately heavy seas caused minor damage to Rosette electronics, which warranted cancellation of the southernmost Station 356 in order to repair and conserve the instruments for other operations farther south.

Specific science tasks undertaken in all fjords included a range of net tows for plankton and nekton (vertical, horizontal, and midwater nets); CTD-Rosette seawater sampling; marine optical measurements (optical profilers); epibenthic sampling (Agassiz trawl); sediment core collection (box cores and piston cores); and seabed bathymetric mapping and sub-bottom profiling. Operations at the last fjord (Anaktalak Bay; Stations 620-624) started in the afternoon of 12 November and were completed in the morning of 13 November, concluding the scientific activities for Leg 4b.

Operations in the northernmost fjord, Nachvak (Stations 600 to 606) took place on 8 November, starting at 2:00 during the night and ending at 23:30 in the evening. Saglek fjord (Stations 610-617) was sampled on 9 and 10 November and operations concluded at the mouth of the fjord (Station 617) in the morning of 10 November. Okak Bay (Stations 630-634) was sampled over 36 hours from late on 10 November to early morning of 12 November.

All these operations were fully successful overall but other operations had more limited success. MVP profiles were attempted in Nachvak and Saglek fjords, but instrument failure resulted in only partial success for Saglek Fjord, and no data for Nachvak Fjord. No further attempts with the MVP were made in the two southern fjords. Sea-surface microlayer sampling was undertaken in Saglek Fjord, Okak Bay, and Anaktalak Fjord. Low air temperatures resulted in incomplete data and sample collection.

Finally, one of the Schools on Board student participants, Bonita Leblanc, deployed a set of drifter bottles while at sea, from approximately 80 nm SE of Groswater Bay (Labrador). This deployment is part of an ongoing experiment undertaken by Ms. Leblanc, and more details are given in the Schools on Board Expedition Report.

8.3 Chief Scientist's comments

The students participating in the School on Board programs greatly enjoyed their experience onboard the ship and appreciated being able to help and perform some of the operations along with the scientists. Special thanks go to all the scientists who shared their knowledge and passion of oceanography with the School on Board participants.

The Chief Scientist, on behalf of the science participants, would like to thank the Commanding Officer and the officers and crew of the *Amundsen* for their invaluable help during scientific operations and their essential contribution to the success of this cruise.

9 BaySys – 27 July to 5 August 2009 – Hudson Bay

9.1 Objectives

The 2009 BaySys mission focused on servicing and turning over moorings and acquiring scientific data in southern and western Hudson Bay in mid-summer. The BaySys mission was carried out on board the CCGS *Pierre Radisson*.

9.2 Synopsis of operations

The science crew boarded the CCGS *Pierre Radisson* and began science operations at Kuujjuarapik on 27 July and ended in Churchill on 5 August 2009. Activities were conducted near the mouth of the Rivière de la Grande Baleine (Station 702 near Kuujjuarapik), across the mouth of James Bay (Stations 703, 709 and 704) and in western Hudson Bay near Churchill (Stations 706 and 707) and Nelson River (Stations 705 and 715) estuary to Cape Tatnam (Stations 713 and 714) (Figure 9.1).

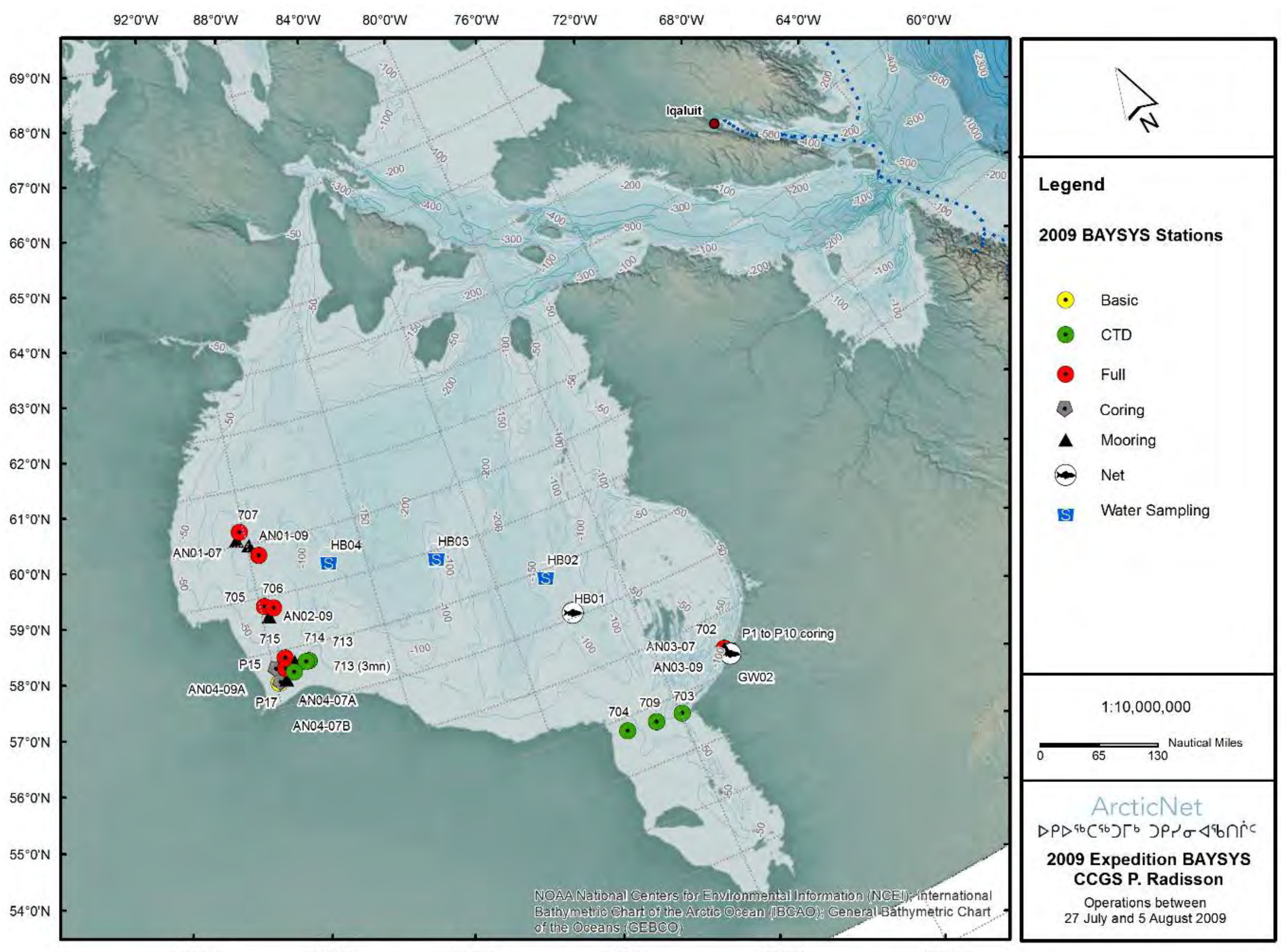

Figure 9.1. Map of Hudson Bay showing the locations of oceanographic sampling stations and mooring sites visited during the BaySys cruise in July-August 2009.

9.2.1 Ice conditions

The planned cruise track was blocked by a belt of ice stretching from western James Bay to north of Churchill. The ice was mostly old, rotten and discontinuous but included some large, solid floes of former land-fast ice. Canadian Ice Service maps of ice concentration in Hudson Bay at the beginning and end of the 2009 BaySys cruise show the evolution of this extensive ice cover (Figure 9.2).

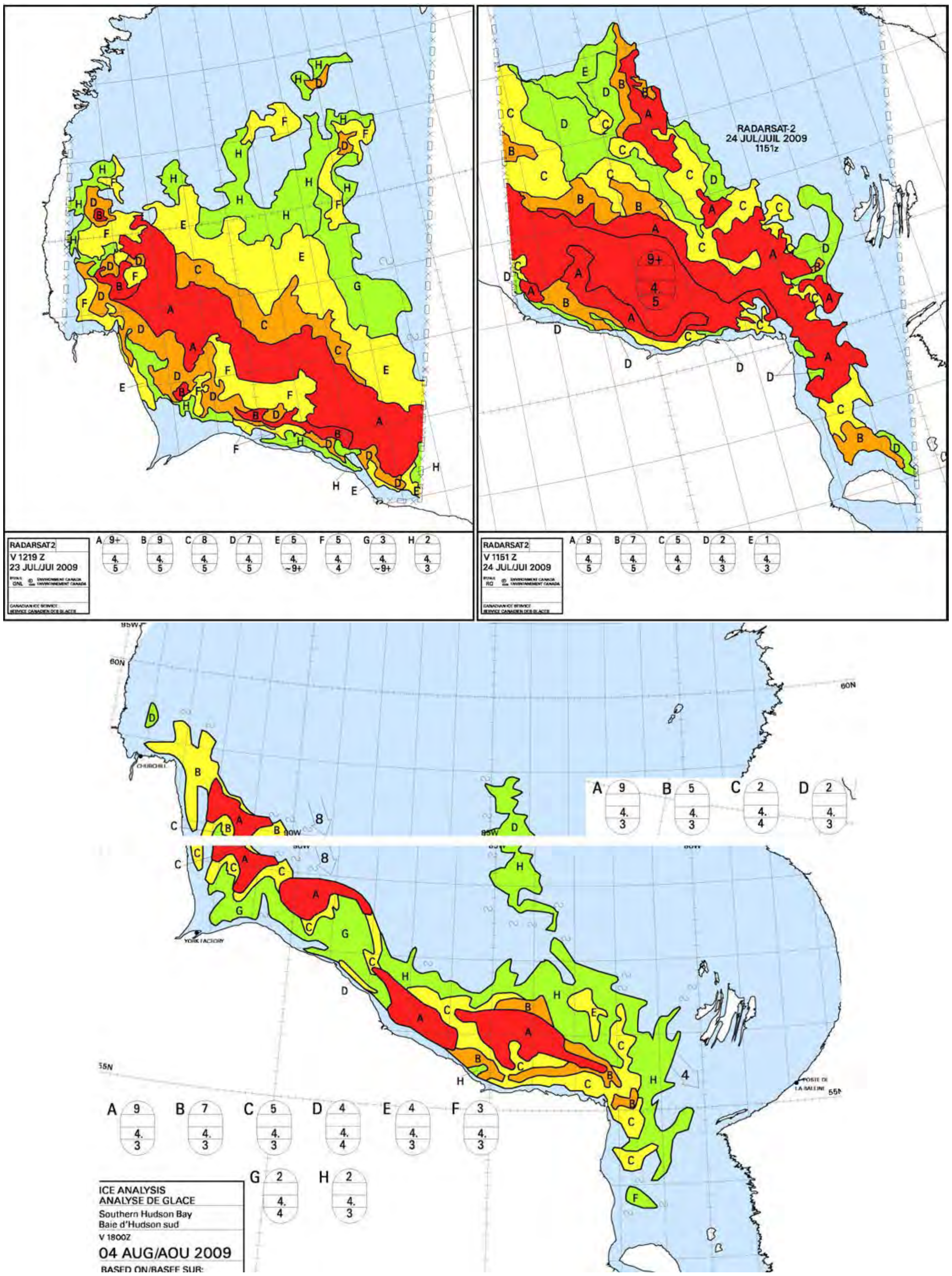

Figure 9.2. Canadian Ice Service maps of ice concentration in Hudson Bay for 23-24 July (top panel) and for 4 August (bottom panel, note that legends differ between N and S portion of the map).

A transit path avoiding most ice, first northward from James Bay and then westward to Churchill, was determined to be the fastest route to the stations in western Hudson Bay (Figure 9.3). It was an advantage of this route, directly to Churchill rather than first to the Nelson estuary, that the moorings team was able to calibrate all instruments in one shore visit, including instruments retrieved from the most northerly station 707.

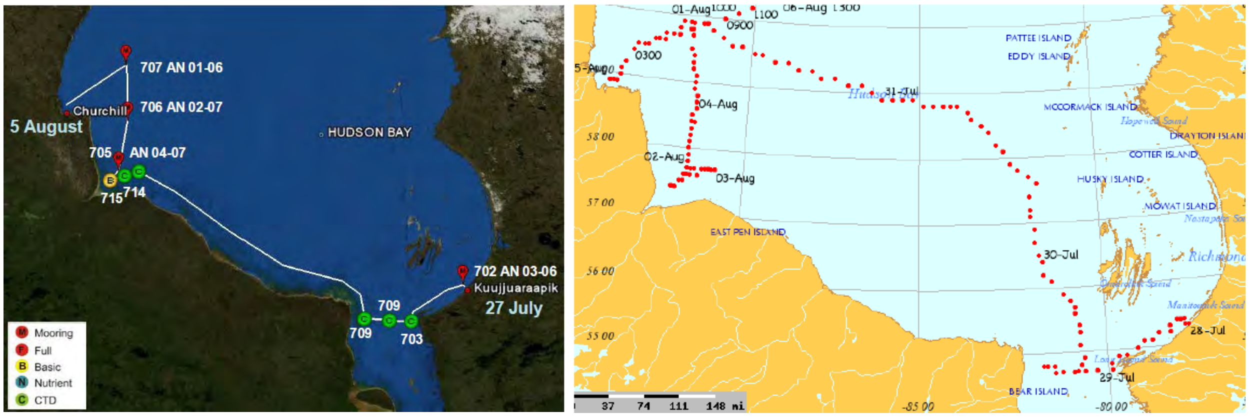

Figure 9.3. Ship track of the CCGS *Pierre Radisson* in Hudson Bay during the 2009 BaySys cruise. Top: Planned cruise track. Bottom: Actual cruise track.

9.2.2 Description of operations

Ten ArcticNet scientists and technicians were on board representing four groups tasked with 1) moorings retrieval and deployment, 2) zooplankton sampling, 3) water quality sampling and 4) sediment coring. Three of four moorings were successfully retrieved at Stations 702, 705 and 707 but it was impossible to communicate with the acoustic releases of the mooring at Station 706 in spite of two attempts. The first attempt was made on the southward transit, Churchill to Nelson estuary, and again on the return trip. New moorings were successfully deployed at all stations.

The zooplankton team made net hauls at Stations 702, 703, 706 and 707, and near Station 713. There was too little ice-free water at Stations 704, 709, 715 and 714 to deploy and tow without risk of damage to the net.

Ten cores measuring 2-3 m in length were obtained from a sedimentary basin at about 100 m depth off the mouth of the Rivière de la Grande Baleine on the east shore, and two were retrieved from sediments at 40-70 m depth in the estuary of the Nelson River on the southwest shore.

CTD profiles were completed at all Mooring/Full, Basic and CTD stations. The Université Laval CTD, equipped with conductivity, temperature, depth, transmissometer, oxygen and chlorophyll fluorescence sensors, was used at Stations 702-704 and 709. Unfortunately, it failed twice, although in each case, it recorded successfully on a second deployment. Consequently, the University of Manitoba CTD was used afterwards at Stations 705-707 and 713-714. This CTD was equipped with conductivity, temperature, depth, turbidity and

CDOM sensors. The two CTDs were deployed jointly at Station 709 providing duplicate data for intercalibration.

Water was collected at the surface (approximately 0.3 m depth) at all stations, and along two transects offshore from the mouth of the Rivière de la Grande Baleine and off Cape Tatnam. Samples were also collected at 4 locations while in transit between James Bay and western Hudson Bay. Due to severe waves, the planned transect off the mouth of the Nelson River was not completed. Water samples were filtered on board, and subsamples retained for analysis for dissolved and particulate OC, ON and P and for TSS, chlorophyll, CDOM, O-18 and salinity determination.

In addition, the University of Manitoba team collected several water column profiles of absorption and attenuation spectra off the mouth of the Rivière de la Grande Baleine. The same team also recorded surface reflectance spectra associated with water quality samples at several stations. Wave conditions and time constraints prevented successful retrieval of absorption and attenuation spectra in the Nelson River region.

9.3 Chief Scientist's comments

The Chief Scientist and all the science participants wish to thank the Commanding Officer Brulé and all of the crew members of the CCGS *Pierre Radisson* for their invaluable contribution to the success of this mission.

Part II – Project reports

1 Meteorological, oceanographic and navigation data – Legs 1, 2, 3 and 4

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1.1 Introduction

A suite of core data and information is collected during the CCGS *Amundsen's* annual expedition using various systems and instruments. Ship position and navigation data (CNAV and POS-MV) and meteorological information (AVOS, Environment Canada) are collected on a continuous basis. Oceanographic data is collected using a CTD-Rosette, a Moving Vessel Profiler (MVP), a ship-mounted current profiler (SM-ADCP) and an underway thermosalinograph (TSG) system.

The datasets collected are processed, archived and managed by the ArcticNet/*Amundsen* technical and data management team. All variables from the datasets are verified and quality controlled using time series and mapping plots, and spurious data and outliers are flagged. The processed datasets will be archived on the Polar Data Catalogue (PDC) at www.polardata.ca.

1.2 Description of systems and available data

1.2.1 Navigation and ship position information – POS-MV and C-Nav

The *Amundsen* is equipped with a POS-MV (Position and Orientation Systems for Marine Vessels) and a C-Nav DGNSS Precise Point Positioning systems. Both these systems record data continuously, with the POS-MV data having a better resolution and accuracy than the C-Nav data. Thus, C-Nav data are used only when POS-MV data are unavailable for a period of 20 seconds or longer. Both systems use WGS 84 Geographic Coordinates.

Table 1.1. Variables measured by the navigation systems onboard the CCGS *Amundsen*.

Variable	Units
Date	yyyy/mm/dd
Hour UTC	HH:MM:SS
Latitude	deg N
Longitude	deg E
GPS source	POSMV:1 CNAV:0

Variable	Units
Heading	deg N
Roll	deg
Pitch	deg
Heave	m
Track	deg N
Speed	Knt

Three types of datasets are issued from the navigation systems and are available for the two legs of the 2007 *Amundsen* Expedition:

- the complete data
- a 15-minute reduced version
- a ship track

The QA/QC process for the NAV data is described in the README file attached to the archived data on the PDC (CCIN 12447). The README file also includes a data acknowledgement statement and examples for data citations. The full reference for the NAV data is available in the reference section of this project report.

1.2.2 Meteorological information – AVOS (Environment Canada)

An Environment Canada Automated Volunteer Observing Ship (AVOS) system was continuously recording meteorological data on atmospheric pressure, wind speed and direction, air temperature and humidity during the 2009 *Amundsen* Expedition.

Table 1.2. List of meteorological instruments and recorded variables of the AVOS system.

Instrument	Variable	Specifications
Vaisala Digital Barometer – PTB-210	Atmospheric pressure	Range: 50 to 1100 hPa Accuracy: 0.35 hPa Resolution: 0.1 hPa
Young R.M. Anemometer - 05103	Wind speed	Range: 0 to 100 m/s Initial accuracy: 0.3 m/s
	Wind direction	Range: 0 to 360° Initial accuracy: 3°
Rotronic Meteorological – MP10	Air temperature	Range: -40 to 60°C Initial accuracy: 0.2°C
	Humidity	Range: 0 to 100% RH Initial accuracy: 1% RH

The QA/QC process for the AVOS data is described in the README file attached to the archived data on the PDC (CCIN 12518). The README file also includes a data acknowledgement statement and examples for data citations. The full reference for the AVOS data is available in the reference section of this project report.

1.2.3 CTD-Rosette

The *Amundsen*'s CTD-Rosette was used to perform vertical profiles of water column properties and to collect water samples. A description of the instruments and sensors used on the CTD-Rosette and the variables measured, as well as an account of the operations conducted during all legs, are provided in Section 9. The CTD logbook detailing the location, date and time, and depth of CTD-Rosette casts for each leg of the 2009 *Amundsen* Expedition is available in Appendix 3.

The CTD data are available in raw and processed formats on the PDC. The QA/QC process for the CTD data is described in the README file attached to the archived data on the PDC (CCIN 12713). The README file also includes a data acknowledgement statement and examples for data citations. The full reference for the CTD data is available in the reference section of this project report.

1.2.4 Moving Vessel Profiler (MVP)

The Moving Vessel Profiler (MVP) was used in Leg 3b, 4a and 4b. In Leg 3b, a total of 107 MVP casts were done along 4 transects. In Leg 4a, one MVP transect was done just south of Prince of Wales Strait. In leg 4b, transects were attempted in Nachvak and Saglak Fjords, but operations were cancelled due to technical problems,. More information on MVP operations can be found in Section 9.

1.2.5 Ship-mounted current profiler (SM-ADCP)

The *Amundsen* is equipped with a hull-mounted Acoustic Doppler Current Profiler (ADCP) continuously recording current velocity and direction under the ship and along the transit route. Data was collected during all leg, but datasets are unprocessed.

1.2.6 Underway thermosalinograph (TSG) system

An underway ThermoSalinoGraph (TSG) system was used to continuously record data on surface seawater temperature, salinity, fluorescence and sound velocity along the transit route.

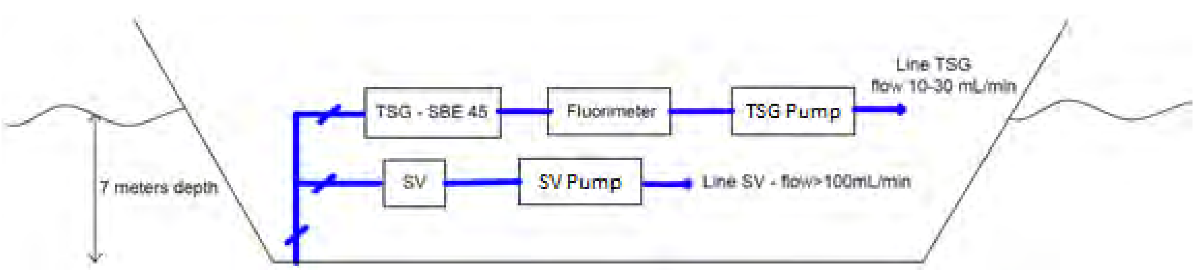

Figure 1.1. Schematic of the configuration of the TSG underway system.

Table 1.3. Instruments and variables measured by the underway TSG system during the 2009 *Amundsen* Expedition.

Instrument	Manufacturer	Variable	Specification	
SBE 45 MicroTSG	Sea Bird (SN# 4532465-076)	Temperature	Range (°C) Initial Accuracy (°C) Resolution (°C)	-5 to +35 0.002 0.0001
		Conductivity	Range (S/m) Initial Accuracy (S/m) Resolution (S/m)	0 to 7 0.0003 0.00001
		Salinity (derived value)	Initial Accuracy (psu) Resolution (psu)	0.005 0.0002
WETStar	Wetlabs (SN# 959P)	Fluorescence	Range (µg/l) Initial Accuracy (µg/l)	0.03 to 75 0.03
Smart SV	AML (SN# 4860)	Sound velocity	Range (m/s) Initial Accuracy (m/s) Resolution (m/s)	1400 to 1600 0.05 0.015

Periods and regions where the TSG was operational and the post-processed data recovery rates for each sensor are presented for each leg in Table 1.4.

Table 1.4. Periods and regions where the TSG system was operational and processed data recovery for each variable measured for each of the two legs of the 2009 Expedition.

Variable	Period of operation	Total good data (days)	Region(s) of operation [1]	Post-processed data recovery rate [2]
Leg 1				
Temperature	5 Jul – 16 Jul	10.5	BE, Ch, BS	24%
Salinity	5 Jul – 16 Jul	10.5	BE, Ch, BS	24%
Fluorescence	No data	0	-	0%
Sound velocity	No data	0	-	0%
Leg 2				
Temperature	21 Jul – 18 Aug	27.6	BS	66%
Salinity	21 Jul – 18 Aug	27.6	BS	66%
Fluorescence	No data	0	BS	0%
Sound velocity	No data	0	BS	0%
Leg 4				
Temperature	10 Oct – 16 Nov	32	BS, CAA, BB, Lab	78%
Salinity	10 Oct – 16 Nov	32	BS, CAA, BB, Lab	78%
Fluorescence	No data	0	BS, CAA, BB, Lab	0%
Sound velocity	No data	0	BS, CAA, BB, Lab	0%

[1] BB = Baffin Bay; BI: Baffin Island; BS = Beaufort Sea; CAA = Canadian Arctic Archipelago; Lab = Labrador Sea & Fjords
[2] Data recovery rate was calculated based on total number of days in each leg: Leg 1 = 43 days, Leg 2 = 43 days, Leg 3 = 0 days; Leg 4 = 41 days

The QA/QC process for the TSG data is described in the README file attached to the archived data on the PDC (CCIN 12715). The README file also includes a data acknowledgement statement and examples for data citations. The full reference for the TSG data is available in the reference section of this project report.

References

Amundsen Science Data Collection. CCGS *Amundsen* Navigation (NAV) data recorded during the annual science expeditions in the Canadian Arctic. [years]. Processed data. Version 1. DOI: 10.5884/12447. Archived at www.polardata.ca: https://doi.org/10.5884/12447. Accessed on [Date].

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2 Organic mercury in the lower atmosphere – Legs 1b, 4a and 4b

ArcticNet Phase 2 – Project titled *Effects of Climate Change on Contaminant Cycling in the Coastal and Marine Ecosystems*. ArcticNet/Phase2/Stern_Contaminants

Project leader: Holger Hintelmann[1] (hhintelmann@trentu.ca)
Cruise participant Leg 1b: Anabelle Baya[1]
Cruise participant Leg 4a: Anabelle Baya[1]
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2.1 Introduction

Mercury (Hg) is a global pollutant from both natural and anthropogenic sources that is persistent in the atmosphere and can thus be transported and accumulated in areas far from the emission sources. Mercury contamination in Arctic regions, for long considered pristine with virtually no natural or anthropogenic sources, is a good example of the long-range transport of mercury.

Due to the accumulation of Hg in the Arctic over the past decades, mercury contamination in the Arctic is currently an important environmental and health issue that raises great scientific interest. The aquatic wildlife and local communities are already exposed to high levels of mercury through the contamination of the food chain. During the past decade, steady progress has been made in the research of Hg cycling in Polar Regions. The atmosphere has been identified as the major pathway for its introduction into the Arctic environment. However, due to limited analytical methods, the presence of organic mercury, mainly dimethylmercury (DMHg) and monomethyl mercury (MMHg) in the atmosphere and thus the direct contribution of the atmosphere have not been investigated. Considerable knowledge gaps still exist on the pathways and delivery processes of mercury to the aquatic food chain. Furthermore, limited studies have been conducted to investigate the methylation and demethylation rates of mercury in aquatic ecosystems. A good understanding of the various MMHg sources to the aquatic ecosystem as well as the mechanisms controlling the methylation of Hg and the release and removal of MMHg is thus very important for the development of contamination control methods and mitigation processes to prevent toxicity.

2.1.1 Leg 1b – 30 June to 16 July 2009 – Victoria to Sachs Harbour

The aim of the project is to develop an analytical method for the measurement of organic mercury (monomethyl mercury, MMHg, and dimethylmercury, DMHg) in the Arctic lower atmosphere and investigate the possible sources of MMHg to Arctic ecosystems. The main objective for Leg 1b was to test the method developed to measure organic mercury.

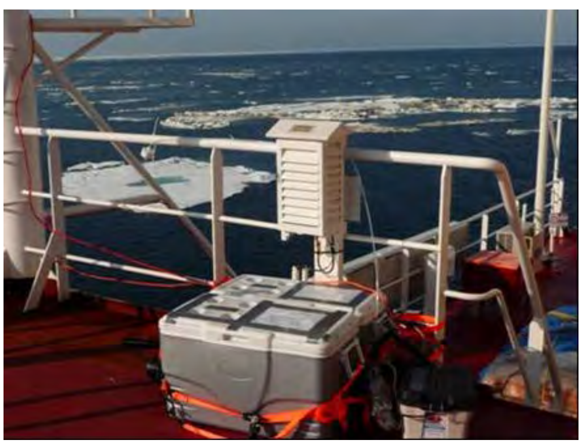
2.1.2 Leg 4a – 8 October to 6 November – Beaufort Sea, NW Passage, Baffin Bay
Leg 4b – 6 November to 18 November – Labrador fjords

From the knowledge gaps identified above, the main aim of the study conducted during Leg 4a was to gather information for a better understanding of the sources and fate of MMHg in the Arctic aquatic ecosystem. The specific objectives of the study were to:

- Measure organic mercury (monomethyl mercury, MMHg and dimethylmercury, DMHg) and inorganic mercury (Gaseous Elemental Mercury, GEM) species concentrations in the lower atmosphere and in open waters in the Arctic to investigate temporal and spatial trends in concentrations using a newly developed analytical method based on species specific mercury isotopic dilution and online ethylation.
- Investigate mercury methylation and demethylation rates in the Arctic aquatic environment by spiking and incubation of species specific Hg isotopic dilution.
- Identify the factors and processes controlling methylmercury production so that the sources can be identified and the fate better understood.

2.2 Methodology

2.2.1 Leg 1b – 30 June to 16 July 2009 – Victoria to Sachs Harbour



Organic mercury measurements were achieved by setting up an air sampling system on the deck of the *Amundsen* (Figure 2.1).

Figure 2.1. Set up for air sampling of monomethyl mercury (MMHg) and dimethylmercury (DMHg) during Leg 1b.

Air and water sampling were conducted during the period of the 9 to 15 July. Several air sampling tests were performed with varying sampling and pre-concentration times to optimize the sampling of organic mercury and the performance of the traps used for organic mercury trapping. Two types of traps were assessed (carbo traps and Tenax traps) and the sampling time varied from 2 hours to 6 hours.

The air sampled was passed through an online ethylation system and the ethylated monomethyl mercury if present in the sample was trapped on carbo or Tenax traps. Dimethylmercury was also expected to be trapped on the carbo traps while gaseous elemental mercury (GEM) was trapped on a gold trap situated at the end of the sampling line (Figure 2.2)

Figure 2.2. Mercury permeation system used to measure atmospheric organic mercury species and online ethylation set up onboard the *Amundsen* during Legs 1b and 4a.

Mercury enriched isotopes (MMHg, Hg^0 and DMHg) from a permeation source were added to the ethylation system to assess the ethylation efficiency of MMHg and the transformations that may occur during the sampling and online ethylation processes (Figure 2.3). The traps were collected after the sampling time and stored in the dark at 4ºC. The traps will be analyzed using a GC-ICPMS at the Worsfold Water Quality Centre at Trent University.

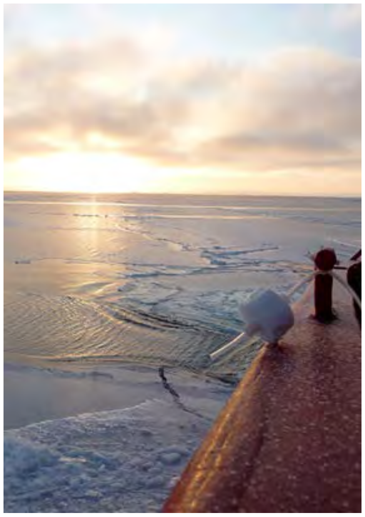
Water samples were also taken during the air sampling period for MMHg and DMHg determination in sea water. Seawater was sampled at a depth of 7 m through a pump located in the hull of the ship and with a bucket at the surface. The water samples collected were frozen and stored in the dark to be analyzed in the lab.

F

igure 2.3. Mercury permeation system used for atmospheric measurements in Legs 1b and 4a.

2.2.2 Leg 4a – 8 October to 6 November – Beaufort Sea, NW Passage, Baffin Bay
Leg 4b – 6 November to 18 November – Labrador fjords

Atmospheric sampling



Air was sampled for organic Hg determination during transit between the stations and mainly over open water. The air sample and permeation set up (Figure 2.3) was located in a container on the foredeck while the sample line was on the side of the ship so that air above the water could be sampled (Figure 2.4).

Figure 2.4. Sampling inlet for organic mercury measurements over water.

The air sampled was mixed with Hg species specific enriched isotopes ($^{202}Hg^0$, $CH_3{}^{200}HgCl$, $^{201}HgCl_2$, $(CH_3)_2{}^{196}Hg$) and passed through an online ethylation system. The ethylation system consisted of a 45 µm cellulose filter impregnated with freshly prepared ethylating reagent (100 ml acetate buffer with 50 ml of sodiumtetraethylborate). The ethylated monomethyl mercury and dimethylmercury if present in the air sample were trapped on carbo traps or Tenax traps, while gaseous elemental mercury (GEM) was trapped on a gold trap situated at the end of the sampling line. Mercury enriched isotopes from a permeation source were added to the ethylation system to assess the ethylation efficiency of MMHg and the transformations that may occur during the sampling and online ethylation processes. The traps were collected after the sampling time and stored in the dark at 4°C. The traps will be analyzed using a GC-ICPMS at the Worsfold Water Quality Centre at Trent University for the confirmation of the presence and concentrations of organic Hg in the Arctic lower atmosphere.

Twenty-two air samples of sampling time of either 3 hours or 6 hours were collected on the carbo traps and gold traps during Leg 4a. In Leg 4b, air was sampled for 2 hours while transiting in the fjords (Nachvak Fjord, Saglek Fjord, Okak Fjord, Anaktalak Fjord) for DMHg and MMHg using the online ethylation system.

GEM in the lower atmosphere was also sampled using the 2537A Tekran mercury vapor analyzer where continuous measurements were made at a resolution of 5 minutes. The GEM values obtained from the Tekran 2537A, a well-established and widely used method, will be valuable for comparison with the GEM concentration by the online ethylation system as well as give high resolution and reliable data on GEM concentrations in the arctic lower atmosphere.

Seawater sampling

Water was sampled at 3 different depths (surface, bottom and chlorophyll maximum or minimum oxygen) using acid-washed Teflon lined Niskin bottles (12 L) mounted on the Rosette.

The species of mercury measured in sea water were:

- Monomethyl Mercury (MMHg)
- Dimethyl Mercury (DMHg)
- Total Dissolved Gaseous Mercury (DGM)

For dissolved gaseous mercury and dimethylmercury determination, water was sampled from the Niskin bottles to sparging bottles and purged with argon gas for 30 min at a rate of 200 ml min^{-1}. Dissolved gaseous mercury and dimethylmercury were trapped on gold traps and carbo traps respectively. A soda lime trap will be attached before the carbo trap to capture moisture. Water samples for MMHg determination was collected separately in 500 ml bottles and stored at -20°C in the dark for analysis in the lab at the Worsfold quality centre, Trent University by ethylation, purging and trapping.

Fourteen stations were sampled for Hg species concentration during Leg 4a (Table 2.1) and eight stations were sampled in Leg 4b (Table 2.2).

Table 2.1. Stations and dates of water sampling and mercury incubation experiments during Leg 4a.

Sampling	Date	Station	Type	Depth (m)	Time of sampling	Sample depth for incubation	Sample 1 depth	Sample 2 depth	Sample 3 depth
1	12-Oct-09	437	Full	295	10/12/09 1:30	primary prod. Peak	Surface	170m	Bot
2	13-Oct-09	408	Full	205	10/12/09 6:30	Chloromax	Surface	65m, chloromax	Bot, 198m
3	15-Oct-09	405	Full	560	10/16/09 5:30	Primary Prod. Peak	Surface	45m	Bot
4	17-Oct-09	450	Basic	95	10/17/09 7:30	NA	Surface	60m, oxygen Min	Bot
5	19-Oct-09	308	Full	541	10/20/09 21:30	Temperature min.	Surface	473m, oxygen Min	Bot
6	24-Oct-09	304	Full	332	10/24/09 20:00	Surface, Chloromax	Surface	90m	Bot, 324m
7	25-Oct-09	323	Full	792	10/25/09 5:30	Oxygen min.	Surface	160m, oxygen Min	Bot
8	26-Oct-09	103	Full	161	10/26/09 0:12	Chloromax	Surface	75m, Chloromax	Bot,150m
9	27-Oct-09	105	Full	131	10/27/09 18:35	Chloromax	Surface	45m Chloromax	Bot, 303m
10	28-Oct-09	109	Full	448	10/28/09 7:20	Bottom	Surface	mid	Bot
11	28-Oct-09	111	Basic	560	10/28/09 18:00	NA	Surface	220m (oxygen min)	Bot
12	29-Oct-09	115	Full	667	10/29/09 18:00	Oxygen min.	Surface	350m, oxygen min	Bot, 660m
13	30-Oct-09	136	Full	804	10/30/09 18:00	Chloromax	Surface	300m, Chloromax	Bot, 800m
14	01-Nov-09	141	Full	423	11/1/09 16:30	Bottom	Surface	250m	Bot, 413m

Table 2.2. Stations and dates of water sampling and mercury methylation rate determination during Leg 4b.

Sampling	Date	Station	Type	Depth (m)	Time of sampling	Sample depth for incubation	Sample 1 depth	Sample 2 depth	Sample 3 depth
1	07-Nov-09	354	CTD	263	11/7/09 9:10	NA	Surface	20m, chloromax	Bottom
2	08-Nov-09	600	Basic	230	11/8/09 5:45	Bot, 230m	Surface	60m, Chloromax	Bottom
3	08-Nov-09	602	Basic	160	11/8/09 19:30	NA	Surface	'm, chloromax, O2 l	Bottom
4	09-Nov-09	612	Basic	128	11/9/09 6:36	Bot, 128m	Surface	45m	Bottom
5	10-Nov-09	617	Basic	127	11/10/09 6:51	NA	Surface	75m, Chloromax	Bottom
6	11-Nov-09	633	Basic	160	11/11/09 23:44	NA	Surface, Chloromax	30m	Bottom
7	11-Nov-09	630	Basic	50	11/11/09 18:11	NA	Surface	20m, O2 min	Bottom
8	12-Nov-09	634	CTD	95	11/12/09 1:51	Bot, 90m	Surface	55m	Bottom

Incubations were conducted to investigate the methylation and demethylation rate of Hg in water. Twelve incubations were done in Leg 4a (Table 2.1) and 3 incubations were performed during Leg 4b (Table 2.2). Samples were spiked with enriched isotope of Hg species (Table 2.3) and incubated for 24 hours. After spiking, the DGM and DMHg concentrations were determined by purging and trapping on carbo and gold traps respectively while water samples were collected for MMHg concentrations determination in the lab. Sub-sampling during incubations was done at 8-hour intervals over the 24-h incubation period (t=0, t=12, t=24). The samples were kept in acid cleaned bottles and frozen in the dark during storage. The incubations were done in triplicates for each sample interval.

Table 2.3. Spiking rate for enriched isotopes of Hg species for Hg methylation and demethylation rate investigation by incubation conducted during Legs 4a and 4b.

Hg species	Spiking rate
$^{200}Hg^{2+}$	40ng/ml
$CH_3{}^{199}Hg^+$	0.4ng/ml
$(CH_3)_2{}^{196}Hg$	0.125ng/ml

2.3 Preliminary Results

2.3.1 Leg 1b – 30 June to 16 July 2009 – Victoria to Sachs Harbour

From the results that will be obtained from the air and water samples, the online ethylation system will be optimized and further samplings will be done during Legs 4a and 4b.

2.3.2 Leg 4a – 8 October to 6 November – Beaufort Sea, NW Passage, Baffin Bay
Leg 4b – 6 November to 18 November – Labrador fjords

Samples were collected along the west-to-east transit through the Northwest Passage in the Canadian Archipelago, as well as in the fjords along the northern Labrador coast, which will give an overview of the distribution and range of concentrations and behaviors of the Hg species studied.

The air and water samples collected will be analyzed in the lab at Trent University. The results will allow confirming the presence of organic mercury in the atmosphere as well as giving indications for the optimization of the air sampling and online ethylation method. The results from the spiking and incubation of Hg species including DMHg are expected to provide some data that will contribute for a better understanding of the transformations and rate of reactions of the Hg species in the water column.

3 Surface climate, air-surface fluxes and carbon exchange dynamics – Legs 1b, 2a, 3b and 4a

ArcticNet Phase 2 – Project titled *Carbon Exchange Dynamics in Coastal and Marine Ecosystems*. ArcticNet/Phase2/Papakyriakou_Carbon_dynamics.

Project leaders: Tim Papakyriakou[1] (papakyri@cc.umanitoba.ca) and Imperial Oil (Legs 2a and 3b)
Cruise participants Leg 1b: Brent Else[1], Emmelia Stainton[1] and Meredith Pind[1]
Cruise participants Leg 2a: Imperial Oil, Tim Papakyriakou[1], Brent Else[1] and Vlad Petrusovich[1]
Cruise participants Leg 3b: Imperial Oil, Tim Papakyriakou[1] and Emmelia Stainton[1]
Cruise participants Leg 4a: Emmelia Stainton[1]
[1] *University of Manitoba, Centre for Earth Observation Science (CEOS), Wallace Building, 125 Dysart Rd, Winnipeg, MB, R3T 2N2, Canada.*

3.1 Introduction

The motivation for this research project stems from the general poor understanding of the processes that exchange nutrients, heat and momentum between the near ocean surface and atmosphere in the Arctic Ocean and peripheral seas. The group's focus is the exchange of CO_2, DMS, heat and momentum, and aims to achieve a better understanding of the role of sea ice (full and partial ice cover) and surface surfactants on the transport and exchange of the respective entities.

Specific objectives relate to the development of tools (observation, model and remote sensing) to assist with regional budgeting of (primarily) heat, CO_2 and momentum, and in the longer term, to develop the necessary process-level understanding of the exchange processes, to forecast how the ocean's response to climate change and variability will affect the atmosphere-ocean cycling of CO_2. In support of these objectives, the surface meteorology and flux program onboard the *Amundsen* is designed to record basic meteorological and surface conditions, and to study exchanges of momentum, heat and mass across the atmosphere-sea ice-ocean interface. Novel to the air-sea studies is the ship-based application of the eddy covariance technique for the direct measurement of heat, CO_2 and momentum. Eddy covariance represents the lone local scale (100s m to km) direct micrometeorological measurement of the respective fluxes.

In 2009, the monitoring and sampling program was expanded to accommodate the monitoring requirements of Imperial Oil within the Ajurak block of the southern Beaufort Sea. The emphasis of this expanded program was on-site specific time-series monitoring of near surface meteorology, surface wave parameters and near surface water currents, and upper ocean light, temperature and current profiles.

3.2 Methodology

3.2.1 Overview of measurements and variables

Table 3.1 and 3.2 provide inventories of the measurement programs related to both ship-based and buoy-based systems recording surface meteorology, air-surface fluxes and surface water characteristics.

Table 3.1. Inventory and application of ship-based variables monitored during the 2009 ArcticNet Expedition onboard the *Amundsen*.

Variable	Location of instrument	Purpose	Sample/Average Frequency (s)
air temperature (Ta)	foredeck tower	meteorological	1/60
relative humidity (RH)	foredeck tower	meteorological	1/60
wind speed (ws-2D)	foredeck tower	meteorological	1/60
wind direction (wd-polar)	foredeck tower	meteorological	1/60
barometric pressure (Patm)	foredeck tower	meteorological	1/60
surface temperature (Tsfc)	foredeck	meteorological	1/60
ship heading (H)	foredeck tower	ancillary information	1
ship speed over ground (SOG), course over ground (COG)[3]	foredeck tower	ancillary information	1
ship location (lat., lon.)	foredeck tower	ancillary information	1
incident solar radiation	wheel-house platform	heat budget and microclilmate	3/60
incident long-wave radiation	wheel-house platform	heat budget and microclilmate	3/60
photosynthetically active radiation (PAR)	wheel-house platform	heat budget and microclimate	3/60
ultra-violet A and B (uvA, uvB)	wheel-house platform	bioclimate	3/60
wind speed 3D (u, v, w)	foredeck tower	air-sea flux	0.1 (10 Hz)[1]
sonic temperature (Ts)	foredeck tower	air-sea flux	0.1 (10 Hz)[1]
atm. water vapour concentration (ρ_v)	foredeck tower	air-sea flux	0.1 (10 Hz)[1,2]
atm. concentration of CO_2 (ρ_c)	foredeck tower	air-sea flux	0.1 (10 Hz)[1,2]
rotational motion (accx, accy, accz, r x, r_y, r_z)	foredeck tower	air-sea flux	0.1 (10 Hz)[1]
upper sea water temperature (Tsw)	under-way system, forward engine room	air-sea flux and ancillary information	3/120
sea water salinity (s)	under-way system, forward engine room	air-sea flux and ancillary information	3/120
dissolved CO_2 in seawater	under-way system, forward engine room	air-sea flux and ancillary information	3/120
	under-way system, forward engine room	air-sea flux and ancillary information	3/120
dissolved O_2 in seawater	under-way system, forward engine room	air-sea flux and ancillary information	3/120

[1] Raw data at 10 Hz was archived. Fluxes can be computed over periods ranging in length from 10 min to 60 min.
[2] Variables were collected both from sensors on the tower, and in the control van aft of the tower (below).
[3] Position and heading were measured, but the ship's navigation system was used for precise information on ship translational motion to convert measured apparent winds to true winds.

Table 3.2. Inventory and application of buoy-based variables monitored during Leg 3b. A description of buoy types can be found in Section 2.2.4 below.

Variable	Buoy type	Purpose	Sample/Average Frequency (s/s)
air temperature (Ta)	3m Met/Ocean	meteorological	600 s sub-interval/ 3,600 s output
relative humidity (RH)	3m Met/Ocean	meteorological	600 s sub-interval/ 3,600 s output
wind speed (ws-2D)	3m Met/Ocean	meteorological	600 s sub-interval/ 3,600 s output
wind direction (wd-polar)	3m Met/Ocean	meteorological	600 s sub-interval/3,600 s output
barometric pressure (Patm)	3m Met/Ocean	meteorological	600 s sub-interval/3,600 s output
buoy heading (H)	3m Met/Ocean	wind correction	600 s sub-interval/3,600 s output [1]
buoy location (lat., lon.)	3m Met/Ocean	ancillary information	600 s sub-interval/3,600 s output
photosynthetically active radiation (PAR)	3m Met/Ocean	flux	3/60
wind speed 3D (u, v, w)	3m Met/Ocean	flux	0.1 (10 Hz)[2]
sonic temperature (Ts)	3m Met/Ocean	flux	0.1 (10 Hz)[2]
atm. water vapour concentration (rv)	3m Met/Ocean	flux	0.1 (10 Hz)[2]
atm. concentration of CO_2 (rc)	3m Met/Ocean	flux	0.1 (10 Hz)[2]
rotational motion (accx, accy, accz, r x, r_y, r_z)	3m Met/Ocean	flux	0.1 (10 Hz)[2]
wave parameters: max. ht. (m), sig. ht. (m), peak period (s), mean wave direction (deg), mean spread (deg)	3m Met/Ocean	oceanographic	1,200 s sub-interval/3,600 output
upper sea water temperature[3] (Tsw)	3m Met/Ocean / MLB	oceanographic	60/60
upper sea water salinity3 (s)	3m Met/Ocean / MLB	oceanographic	60/60
dissolved CO_2 in upper seawater	3m Met/Ocean	oceanographic	3600/3600
near-surface currents (u,v,w in upper 50m at 2 m bins)	3m Met/Ocean	oceanographic	600 s ensemble average
indices of surface water quality: s, T, pH, DO, Fl	3m Met/Ocean / MLB	oceanographic	60/60
water currents (u,v) – upper 50 m	MLB	oceanographic	600 s ensemble average
water salinity (s) – upper 50 m	MLB	oceanographic	60/60
transmitted PAR – upper 50 m	MLB	oceanographic	60/60

[1] Data were used to convert apparent to true winds.
[2] Raw data at 10 Hz was archived. Fluxes can be computed over periods ranging in length from 10 min to 60 min.
[3] Data were available from more than one sensor.

3.2.2 Micrometeorology and eddy covariance flux tower

The micrometeorological tower located on the front deck of the *Amundsen* (Figure 3.1) provided continuous monitoring of meteorological variables and eddy covariance parameters. The tower consisted of slow response sensors that recorded bulk meteorological conditions (air temperature, humidity, wind speed/direction, surface temperature) and fast response sensors that recorded the eddy covariance parameters (CO_2/H_2O concentration, 3D wind velocity, 3D ship motion, air temperature) (Table 3.3). In addition, radiation sensors (Figure 3.1, Table 3.3) were installed on the roof of the wheelhouse to provide information on incoming longwave, shortwave and photosynthetically active radiation (PAR). All data was logged to Campbell Scientific dataloggers; a model CR3000 logger was used for the eddy covariance data, a CR1000 logger for the slow response met data, and a CR23X for the radiation data. All loggers were synchronized to UTC time using the ship's GPS system as a reference. Ship heading and location (latitude, longitude coordinates) were measured, and can be used to screen data. However, location and navigation data from the ship's navigation system was used, which was more accurate, to convert measured apparent wind information to true wind information, thereby compensating for the effect of ship direction and motion on the wind measurements.

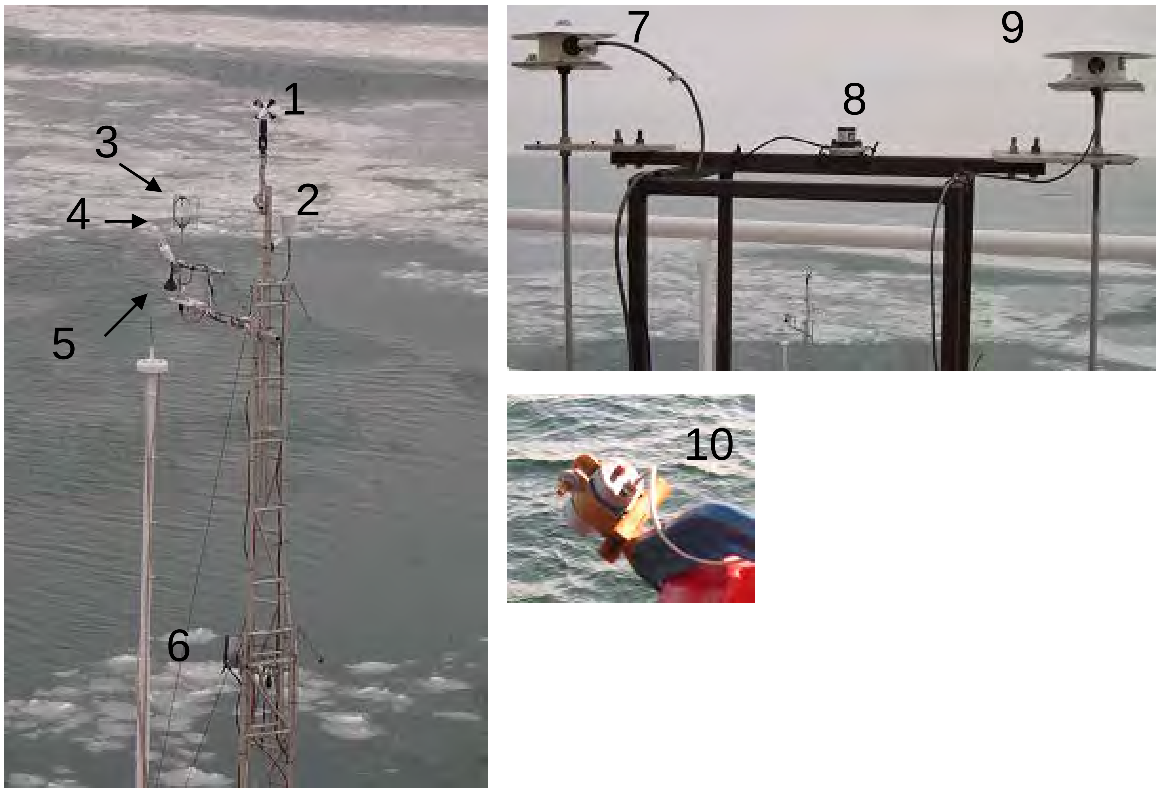


Figure 3.1. Meteorology and flux program instrument setup. See Table 3.3 for a description of instruments based on the labeled numbers. Note that on 18 November the Motion Pak (6) was moved to the rear face of the tower to facilitate easier motion correction.

Table 3.3. Description of instruments equipped on the flux tower (numbers refer to labels in Figure 2.1).

# Fig	Sensor	Variable	Unit	Height (m)[a]	Scan (s)/ Avg (min)	Specs / Accuracy
1	Wind monitor (RM Young 05103MA)	Horizontal wind speed and direction (ws and wd[b])	m/s; °	8.45 (Leg1) 8.11 (Legs2,3)	2 sec/ 1 min	±0.6 m/s ±3° deg
2	Temperature/relative humidity probe (Vasailla HMP45C212)	Temperature and relative humidity (T and RH)	ºC %	7.53(Leg 1) 7.2 (Legs2,3)	2 sec/ 1 min	Humidity ±2% 0-90% @ 20ºC ±3% 90-100% @ 20ºC 0.05% RH/ºC Temperature ± 0.1 ºC

# Fig	Sensor	Variable	Unit	Height (m)[a]	Scan (s)/ Avg (min)	Specs / Accuracy
7	Pyranometer (Eppley, model PSP)	Incoming shortwave radiation (SW_in)	W/m^2	7.0	2 sec/ 1 min	~±5%
9	Pyrgeometer (Eppley, model PIR)	Incoming longwave radiation (LW_in)	W/m^2	7.0	2 sec/ 1 min	~±10%
8	PAR/Quantum sensor (Kipp & Zonenm PARLite)	Photosynthetic Active Radiation PAR	$\mu mol/m^2$	7.6	2 sec/ 1 min	~±5%
Not shown	Pressure transducer (RM Young 61205V)	Patm	kPa		2 sec/ 1 min	
10	Temperature transducer (Everest infrared transducer, model 4000.44 ZL)	Surface temperature (T_{srfc})	ºC	1.6	3 sec/ 1 min	±0.5 ºC accuracy
6	Multi-axis inertial sensor (MotionPak, Systron Donner)	3D acceleration and angular rate (x,y,z) of tower	º/s g	6.48 (Leg1) 4.59 (Leg2)	10 Hz	rate <0.004º/s acc <10 µg
4	Gas Analyzer (LI-COR LI-7500)	CO_2 concentration (ρCO_2)	$\mu mol/m^3$	7.1 (Leg 1) 6.82 (Legs2,3)	10 Hz	RMS noise ±0.1 µmol/mol zero drift 0.1 µmol/mol/ºC gain drift 0.1%/ºC
		H_2O concentration (ρO_2)	$mmol/m^3$	7.1 (Leg 1) 6.82 (Legs2,3)	10 Hz	RMS noise ±0.14 mmol/mol zero drift 0.3 %/ºC gain drift 0.15%/ºC
5 (inlet only)	Gas Analyzer (LI-COR LI-7000)	CO_2 concentration (ρCO_2)	$\mu mol/m^3$	7.1 (Leg 1) 6.49 (Legs2,3)	10 Hz	RMS noise ±0.1 µmol/mol zero drift 0.3 µmol/mol/ºC gain drift 0.2%/ºC
		H_2O concentration (ρO_2)	$mmol/m^3$	7.1 (Leg 1) 6.49 (Legs2,3)	10 Hz	RMS noise ±0.14 mmol/mol zero drift 0.02 mmol/mol/ºC gain drift 0.4%/ºC
3	Wind fluctuations (Gill R3 ultra-sonic anemometer)	3-dimensional wind vector (u,v,w) speed of sound (SOS)	m/s	7.1 (Leg 1) 6.36 (Legs2,3)	10 Hz	RMS noise <1% offset <0.01 m/s SOS < 0.5% accuracy
Not shown	GPS Receiver (Garmin GPS16X-HVS)	lat, lon, SOG, COG	º,kts, º		1	Position: <15m Velocity: 0.1 knots
Not shown	Digital compass (Ocean Server OS5000)	H, pitch, roll	º		1	Precision: 0.5 deg (heading) <1 deg (roll/pitch)

The eddy covariance system on the tower made use of two separate gas analyzers and a single 3D sonic anemometer. The dual gas analyzers system allowed using both closed path and open path eddy covariance systems. The open path gas analyzer had the benefit of making measurements concurrently with the sonic anemometer, but the closed path gas analyzer was not as easily disturbed by adverse weather conditions.

In order to ensure that the two systems were comparable, careful calibrations were performed on both instruments. The closed path system was based on a LI-7000 gas analyzer which employed two optical cells, one of which was used to monitor the drift of the instrument by constantly passing a stream of ultra-high purity N_2. In addition, the sample cell of the instrument was calibrated daily using the ultra-high purity N_2 to zero the CO_2 and H_2O measurements, and a reference gas of known CO_2 to span the instrument. Occasionally, a span calibration of the H_2O sensor was performed using a dew point generator (model LI-610). The open path gas analyzer (LI-7500) could not be calibrated as conveniently, and so it was calibrated approximately every three weeks. In general, this was effective for this particular instrument, which did not drift significantly over time.

The ship motion correction necessary for the application of the eddy covariance technique required accurate measurement of ship motion (3 axis measurement of angular acceleration and rate), heading and location. Rotational motion was monitored using a multi-axis inertial sensing system. Data related to heading and location was available from the ship's GPS and gyro. Using these data yaw, pitch and roll, in addition to translational motion was calculated, and collectively this information was used to correct the 3D wind measurements.

In addition to the eddy covariance solution to air-sea fluxes, data were collected for the more commonly used bulk approximation. Note however that the bulk approximation is unable to deal with ice in the flux footprint. This last point is a central research theme.

<u>Leg 1b – 30 June to 16 July 2009 – Victoria to Sachs Harbour</u>

The main goal of this leg was to get the flux tower operational before entering the Ajurak IOL study area and Leg 2a. The flux tower went operational on 13 July, but data between this date and the end of the leg is of somewhat lower quality than normal due to ongoing troubleshooting and maintenance. The closed path eddy covariance system has not yet been turned on, but the sample line and system has been assembled. The tower should be operating normally by the beginning of Leg 2a.

<u>Leg 2a – 16 July to 30 July 2009 – Beaufort Sea</u>

Much of the flux tower was operational on 13 July, prior to the start of Leg 2a, and the system was fully operational by 16 July. The slow sequence largely meteorological variables were scanned at 1 second intervals and saved as 1 min averages. In regard to wind speed and direction, ship motion correction was applied during post-processing.

The high frequency variables associated with the eddy covariance system were scanned at 0.1 s intervals and was stored as raw data and as 1 minute averages. The raw data were used to compute the fluxes (heat, mass and momentum) over time intervals that can range from 10 min to 60 min, and fluxes were computed during post processing.

<u>Leg 3b – 12 September to 08 October 2009 – Beaufort Sea</u>

Frost, rime and aggressive sea spray affected the high frequency measurements of 3D wind and gas concentrations. Periods associated with these events were evident in the data, and will need to be removed prior to processing. Fluxes were computed during post processing.

Leg 4a – 08 October to 06 November – Beaufort Sea, NW Passage, Baffin Bay

The flux tower was fully operational starting on 16 July, early in the 2009 Expedition. All sampling operations were stopped on 02 November, and packing was completed on 05 November prior to arrival in Quebec City.

3.2.3 On-track pCO_2 flow-through system

Fluxes of CO_2 were measured by the eddy covariance technique, which is dependent only on atmospheric measurements. Although measurement of these fluxes is extremely useful information, it is essentially meaningless without an understanding of the amount of dissolved CO_2 (pCO_{2sw}) present in the surface ocean.

A General Oceanics 8050 *p*CO_2 system was utilized to measure dissolved CO_2 at the sea surface in near real time. The system (Figure 3.2) was located in the engine room of the *Amundsen*, and drew sample water from the ship's clean water intake. The water was passed into a sealed container through a shower head, maintaining a constant headspace. This set up allowed the air in the headspace to come into equilibrium with the CO_2 concentration of the seawater, and the air was then cycled from the container into an LI-7000 gas analyzer in a closed loop. A temperature probe was located in the equilibrator to provide the equilibration temperature. The system also passed subsample of the water stream through an Idronaut Ocean Seven CTD, which measured temperature, conductivity, pressure, dissolved oxygen, pH and redox. All data was sent directly to a computer using software customized to the instrument.

Figure 3.2. The on-track pCO_2 system located in the engine room of the *Amundsen*. The equilibration chamber is the clear cylinder (left, vertical with black top) and the gas analyzer is the green box behind the computer display.

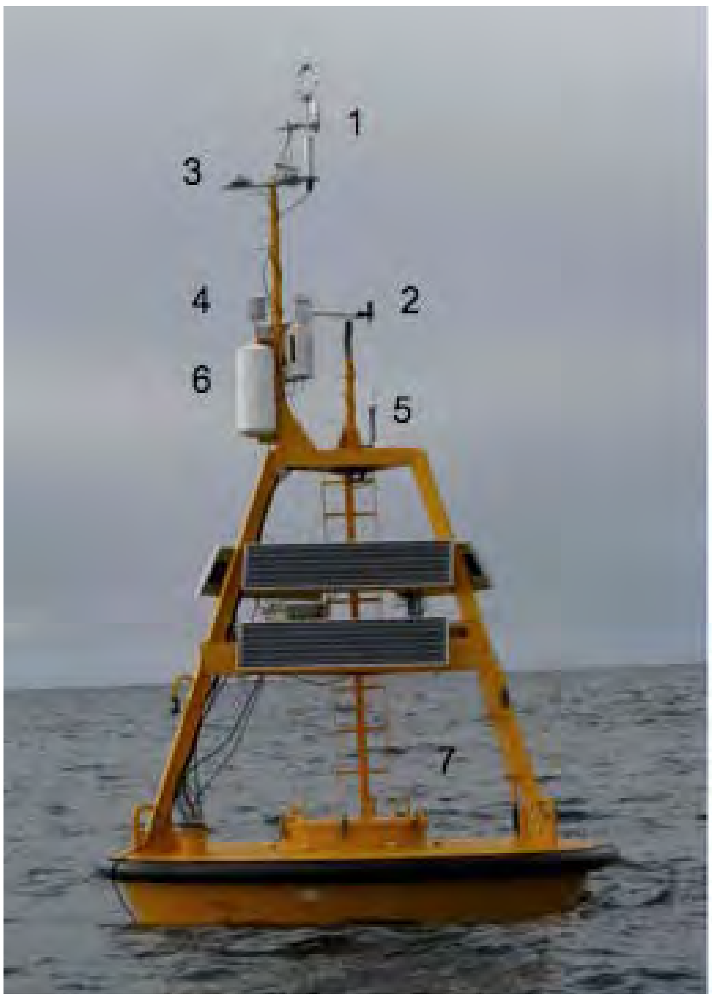
The LI-7000 gas analyzer was calibrated daily using ultra-high purity N_2 as a zero gas, and a gas with known CO_2 concentration as a span gas. Spanning of the H_2O sensor was not necessary because a condenser removes H_2O from the air stream before passing into the sample cell.

3.2.4 Surface Met/Ocean buoy program

Leg 2a – 16 July to 30 July 2009 – Beaufort Sea

Four buoys were to be deployed during Leg 2a to obtain data on the surface meteorology, fluxes, and characteristics of the water column's upper 50 m. Two buoys were to be deployed at two locations within the Ajurak Block: (1) shallow (~150 m) and (2) deep (~600 m). The buoy pairs consisted of a 3 m discus buoy (Figure 3.3) and a surface float on which was suspended a 50 m string of sensors within the water column (not shown). Where possible, identical sensors were used for the buoys, and the ship's other installations. However, due to space limitations on the *Amundsen* during mobilization, only one of the 3 m discus buoys was loaded onto the ship. The 3 m buoy was commissioned for deployment, but heavy ice conditions within the Ajurak block prevented its launch, and that of the surface floats.

Additional information and preliminary results can be found in the mooring section of this report (Section 6).



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igure 3.3. Above-water instrumentation associated with the Met/Ocean buoy. 1) Eddy covariance sensors: sonic Anemometer, gas analyzer, compass; 2) wind monitor; 3) PAR sensor; 4) temperature-relative humidity probe; 5) GPS antennae and Iridium transmitter; 6) RADAR reflector; 7) in the hold: directional wave sensor, logger, iridium modem, multi-axis accelerometer, battery banks. Sensor specifications appear in Table 3.6. (Photo: T. Papakyriakou)

Figure 3.4. Underwater instrumentation associated with the Met/Ocean buoy. Nortek® Aquadopp surface current meter (left), RBR® multi-probe (middle) and Pro-Oceanus® pCO_2-pro (right) installed on the anchor yoke (lower panel). Sensor specifics appear in Table 3.4 and 2.5. Photos: E. Stainton and IOL.

Table 3.4. Variables and equipment associated with the Met/Ocean surface floats during Leg 2a.

Variable	Sensor Model	No. per Float
Light intensity (PAR)	JFE ALEC©, model MDS MkV-L	8
Temperature and salinity	JFE ALEC©, model ACT-HR Compact CT	8
1D current meter	JFE ALEC©, model AEM-USB	2
Downward looking ADCP – surface currents	Nortek Aquadopp	1

Leg 3b – 12 September to 8 October 2009 – Beaufort Sea

Three Met/Ocean buoys were deployed during Leg 3b to obtain data on the surface meteorology, fluxes and characteristics of the water column's upper 50 m. A 3 m discus buoy was used to monitor variables associated with the air-sea coupling and this buoy is referred to as Met/Ocean buoy. This installation acted to extend measurements recorded from moorings to the near-surface ocean and across the air-ocean interface. In addition, it provided: (1) a stationary platform to monitor changing conditions at a point over time, which is not possible onboard the ship and (2) a platform allowing measurements to be made close to the water surface without the distorting influence of the ship.

Two secondary buoys (termed Mixed Layer Buoys - MLB) suspended sensors within the upper 50 m of the water column, and their purpose was to monitor vertical gradients in light, currents, conductivity and temperature. Details on the instrumentation are provided in Table 3.6, and the installations are shown in Figure 3.3 to 3.6. Additional information and preliminary results can be found in the mooring section of this report (Section 6).

Table 3.5. Variables and equipment associated with the Met/Ocean 3 m discus buoys during Leg 3b.

Variable	Sensor Model	Function
air temperature	Vaisala©, model HMP45C212	meteorology
relative humidity	Vaisala©, model HMP45C212	meteorology
wind speed and direction (horizontal)	RM-Young©, model 05106-10	meteorology
atmospheric pressure	RM-Young©, model 61205V	meteorology
logger	AXYS©, Watchman 500	meteorology
directional wave parameters	AXYS©, TriAXYS OEM motion sensor	sea state
satellite telemetry	Iridium modem	telemetry of sea state and meteorological parameters
3D wind speed	Gill©, Windmaster ultra sonic anemometer	flux
atm. concentrations of CO_2 and H_2O	LI-COR©, model LI-7500 gas analyzer	flux
rotational motion (3-axis)	Systron Donner ©, MotionPak	flux
surface sea water properties: DO, CO_2, pH, CT, FL	RBR©, model XR-420CTD+DO+pH+FL	sea water characterization

Table 3.6. Variables and equipment associated with the Mixed-Layer (MLB) and Met/Ocean Buoys (Met/Ocean) during Leg 3b.

Variable	Buoy	Sensor, Model	Ht. to water	Units	Specification
near-surface current (u,v)	MLB	JFE ALEC©, model AEM-USB	-4.4, -21.4 (-4.4, -21.4)	cm/s velocity, direction	± 01 cm/s or 2% velocity, ±2º direction
conductivity, temperature (CT)	MLB	JFE ALEC©, model ACT-HR Compact	-3.4,-6.4,-9.4,-12.4,-15.4,-20.4,-30.4,-45.4 (-3.4,-6.4,-9.4,-12.4,-15.4,-20.4,-30.4,-45.4)	mS/cm, ºC	±0.05ºC, ±0.05 mS/cm
light intensity (PAR)	MLB	JFE ALEC©, model MDS MkV-L	-3.4,-6.4,-9.4,-12.4,-15.4,-20.4,-30.4,-45.4 (-3.4,-6.4,-9.4,-12.4,-15.4,-20.4,-30.4,-45.4)	mmol/m2/s1	±4% full scale
surface sea water properties: DO, pH, CTD, FL	MLB	RBR®, model XR-420CTD+DO+pH+FL	(-5.5)	% sat., pH, mS/cm, ºC, dBar, µg/L	±2% DO, ±0.1 pH, ±0.003 mS/cm, ±0.002ºC, ±0.05 full scale, ±2%
air temperature (Ta)	Met/Ocean	Vaisala®, model HMP45C212	3.9	ºC	± 0.1 ºC
relative humidity (RH)	Met/Ocean	Vaisala®, model HMP45C212	3.9	%	±2% 0-90% @ 20ºC, ±3% 90-100% @ 20ºC, 0.05% RH/ºC
wind speed (ws-u,v)	Met/Ocean	RM-Young®, model 05106-10	3.9	m/s	±0.6 m/s
wind direction (wd-polar)	Met/Ocean	RM-Young®, model 05106-10	3.9	º	±3º deg
Logger (met. and w package)	Met/Ocean	AXYS®, Watchman 500	0	-	-
barometric pressure (Patm)	Met/Ocean	RM-Young®, model 61205V	0	kPa	±0.05 kPa
photosynthetically active radiation (PAR)	Met/Ocean	quantum sensor (Kipp & Zonen,	4.7	$\mu mol/m^2/s^1$	~±5%

Variable	Buoy	Sensor, Model	Ht. to water	Units	Specification
		PARLite)			
wind speed 3D (u, v, w, Ts)	Met/Ocean	3D wind velocity (Gill Windmaster P ultra-sonic anemometer)	5.4	m/s	RMS noise <1%, offset <0.01 m/s, SOS < 0.5% accuracy
atm. water vapour concentration (rv)	Met/Ocean	LI7500 open path gas analyzer	5.4	mmol/mol	RMS noise ±0.1 mmol/mol zero drift 0.1 mmol/mol/ºC gain drift 0.1%/
atm. concentration of CO_2 (rc)	Met/Ocean	LI7500 open path gas analyzer	5.4	mmol/mol	RMS noise ±0.1 mmol/mol, zero drift 0.1 mmol/mol/ºC, gain drift 0.1%/
rotational motion (accx, accy, accz, r_x, r_y, r_z)	Met/Ocean	multi-axis inertial sensor (MotionPak, Systro Donner)	0	º/s; g	rate <0.004º/s acc <10 mg
wave parameters: m ht. (m), sig. ht. (m), peak period (s), mean wave direction (deg), mean spread (deg)	Met/Ocean	AXYS®, TriAXYS OEM motion sensor	0	max. ht. (m), sig. (m), peak period mean wave direction (deg), mean spread (deg)	±0.01 m ±0.01 ±0.1 s ±3º ±3º
surface sea water properties: DO, pH, CTD, FL	Met/Ocean	RBR®, model XR-420CTD+DO+pH+	-1.5	% sat., pH, mS/cm, ºC, dBar,µg/L	±2% DO, ±0.1 pH, ±0.003 mS/cm, ±0.002ºC, ±0.05 full scale, ±2%
near-surface current (u,v,w in upper 50m 2 m bins)	Met/Ocean	Nortek® Aquadopp 600 kHz Profiling Current Meter	-1.5	cm/s	±2.2 cm/S for u 0.7 cm/S for w

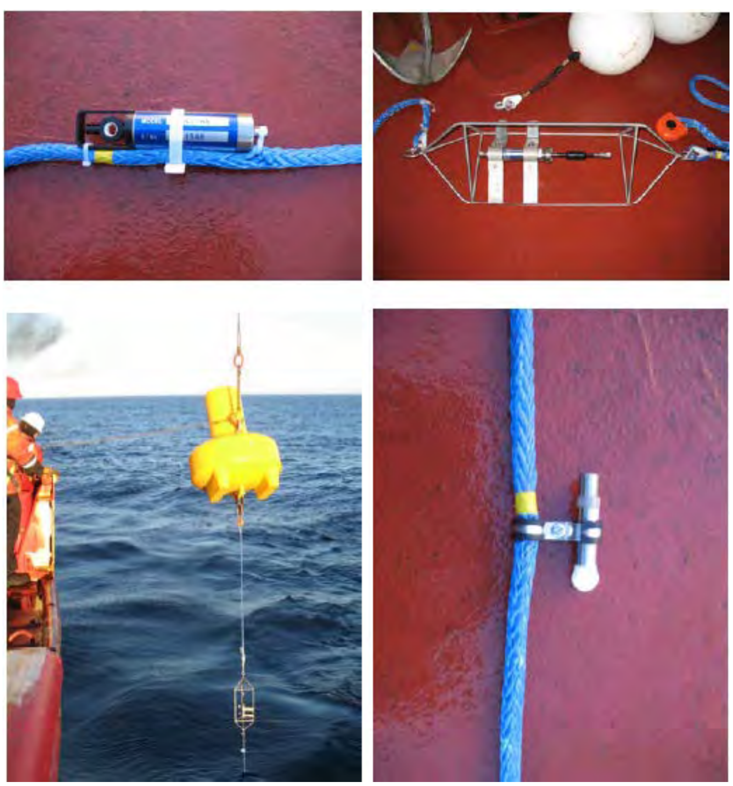

Figure 3.5. Mixed-Layer buoy (MLB) deployment with subsurface string of sensors. Clockwise from top left: Alec CT sensor, Alec EM current meter, Alec PAR sensor, surface float deployment. Not shown is the RBR Multi-probe (see Figure 3.4). Photos: E. Stainton.

Two buoys were deployed at a deep-water station: Site A (546 m, 70°43.918’N, 136°01.036’W). The deployment of the 3 m Met/Ocean buoy (Figure 3.3) took place at 19:44 GMT on 15 September, while the secondary (mixed layer, or MLB) buoy (Figure 3.5) deployment occurred at 15:41 GMT on 16 September. A second MLB was deployed at the shallower station - Site B (132 m, 70° 39.279’N, 135 38.049’W), at 17:10 GMT on 16 September.

Met/Ocean Buoy: The Met/Ocean buoy was recovered at 00:34 GMT on 30 September. Meteorological and wave movement data were transmitted hourly from the Met/Ocean buoy via Iridium satellite modem. Data were also stored on datalogger memory and flash card. All sub-surface instruments had internal loggers, which were downloaded upon recovery. All sensors associated with the meteorology and wave package functioned properly. A malfunction in the charge regulator associated with the flux package prevented the charging of those batteries dedicated to the flux sensors, and as a result the batteries were lowered below a critical voltage after one-day of deployment. Of the underwater sensors, only the pCO_2 sensor failed to work up to expectations. This sensor did not power-up on deployment, despite passing pre-deployment checks.

Mixed-Layer Buoys: The MLB at Site B was recovered on 30 September (14:45 UTC), while the MLB at Site A was recovered on 1 October (20:50 UTC). Note that sea ice entered the Ajurak Block on 30 September and effectively dragged secondary buoy A approximately 5.5 nm to the south of its original location. The buoy (A) was retrieved at 70° 39.956’N, 136° 13.725’W. At this point it is not known exactly when between 30 September and 1 October the buoy was moved off-station.

Data from the MLBs were downloaded upon recovery. Unfortunately, two conductivity/ temperature (CT) sensors were not recovered from the two bottom depths of site MLB “B” (serial numbers 1580 and 1581). It is likely that they were sheared from the mooring line during deployment. All other CT sensors at site B functioned properly throughout deployment. All PAR sensors were recovered from the MLB “B” surface float, however the uppermost sensor (serial number 201281) did not record data properly.

All sensors were recovered from MLB “A”, however one CT sensor (serial number 1517) and one PAR sensor (serial number 201293) did not record data properly. All instruments that did not function properly will be examined to determine the cause of the malfunction, and if necessary returned to the manufacturers.

3.3 Preliminary results

3.3.1 Leg 1b – 30 June to 16 July 2009 – Victoria to Sachs Harbour

The main goal of this leg was to get the flux tower operational before entering the IOL study area and the beginning of Leg 2a. The flux tower went operational on 13 July, but data between this date and the end of the leg is of somewhat lower quality than normal due to ongoing troubleshooting and maintenance. The closed path eddy covariance system has not yet been turned on, but the sample line and system has been assembled.

The on-track *p*CO_2 system was active from 7 July for the duration of Leg 1b, with some minor interruptions for maintenance. There was initially a problem with the outlet pump float switch that failed on 5 July resulting in a significant amount of water overflowing into the ship's bilge. This problem was rectified on 6 July and an additional float switch was attached to the *p*CO_2 system inlet pump that will switch off the inlet pump if the outlet pump were to fail. An example of a single day of CO_2 data (10 July) recorded by the on-track system, along with water temperature, is shown in Figure 3.6. Further processing must still be undertaken to correct the values for changes in temperature that occur due to the length of the sample line, and to properly calculate *p*CO_2.

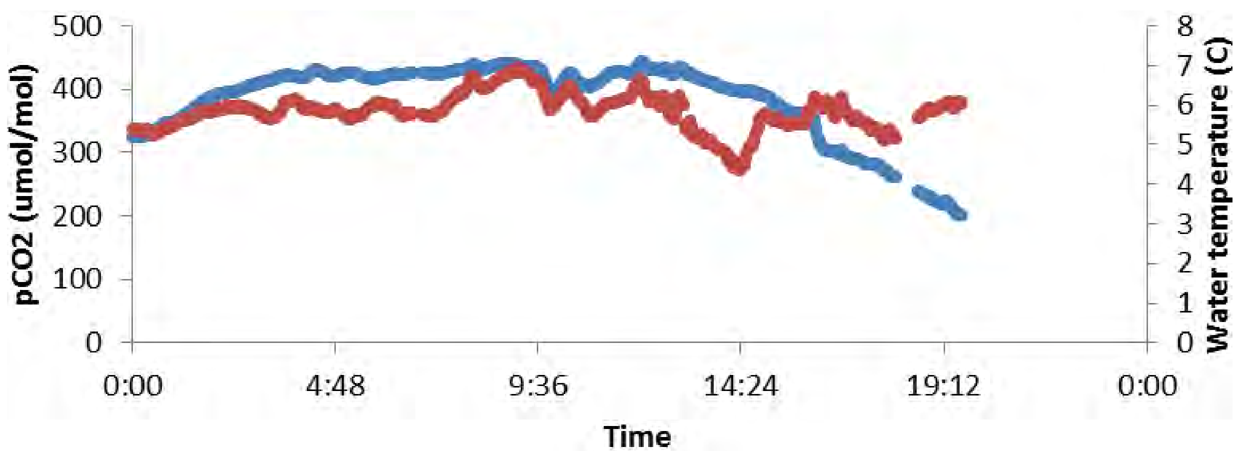

Figure 3.6. Sample data of pCO_2 (blue) and surface temperature (red) from the underway pCO_2 system obtained on 10 July during Leg 1b.

3.3.2 Leg 2a – 16 July to 30 July 2009 – Beaufort Sea

<u>Ship based meteorology</u>

Time series of selected meteorological variables are shown in Figure 3.7 and 2.8.

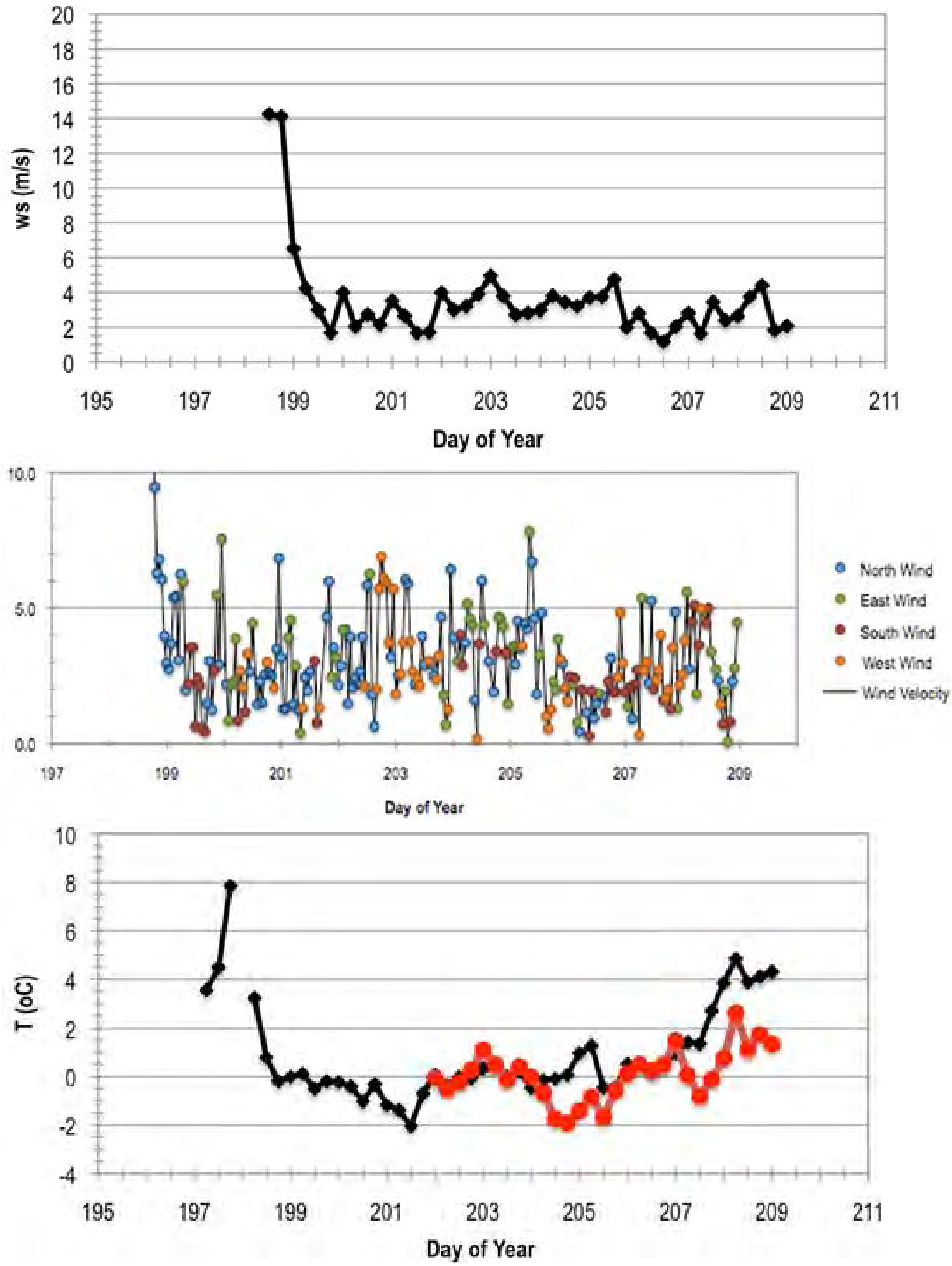

Figure 3.7. Six hour averages of wind velocity (top panel, black line), wind direction by quadrant (middle panel, colored dots) and air temperature (bottom panel, black) and surface ocean temperature (bottom panel, red) observed over the Ajurak Block between 16 and 27 July during Leg 2a.

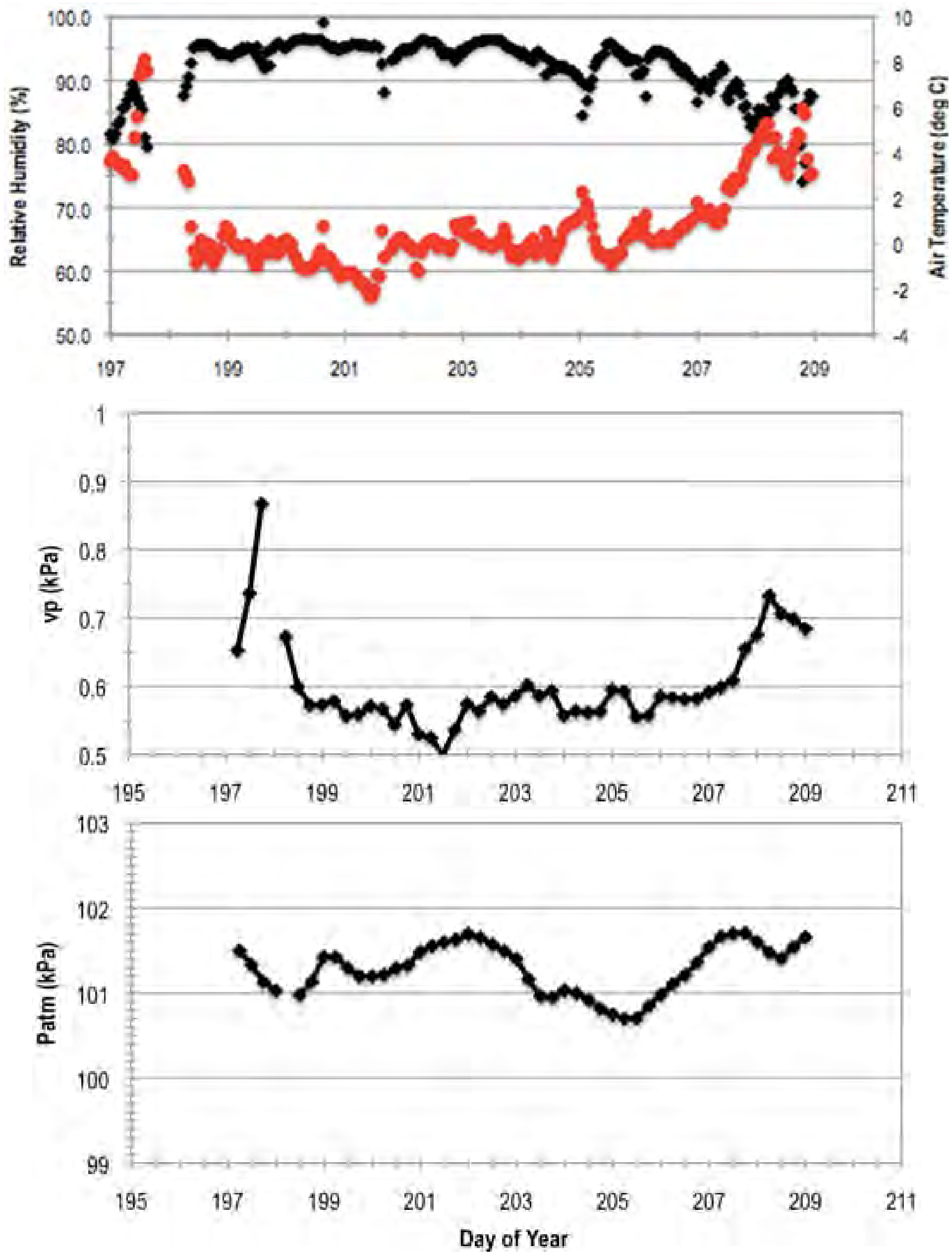

Figure 3.8. Air temperature (top panel, red dots) and relative humidity (top panel, black dots) shown with six hour averages of water vapour pressure (middle panel, vp, kPa) and atmospheric pressure (bottom panel, Patm, kPa) calculated from relative humidity and air temperature between 16 and 27 July 2009 during Leg 2a.

Ship based fluxes

Flux calculations will be computed during post processing by eddy covariance and bulk formulations using data from the foredeck tower. Below is a sample of the data from the 3D sonic anemometer – vertical wind velocity and sonic temperature (Figure 3.9). The time-averaged covariance (with corrections) provides a measure of the sensible heat flux.

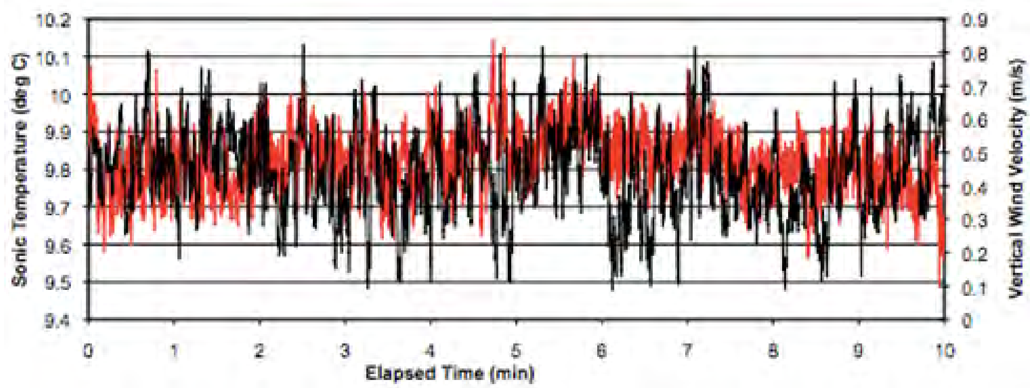

Figure 3.9. 10 minute trace of vertical wind velocity (black line) and sonic temperature (red line) measured by the 3D sonic anemometer during Leg 2a.

Radiation

Time series (6 hour averages) of the main variables associated with the radiation platform appear in Figure 3.10.

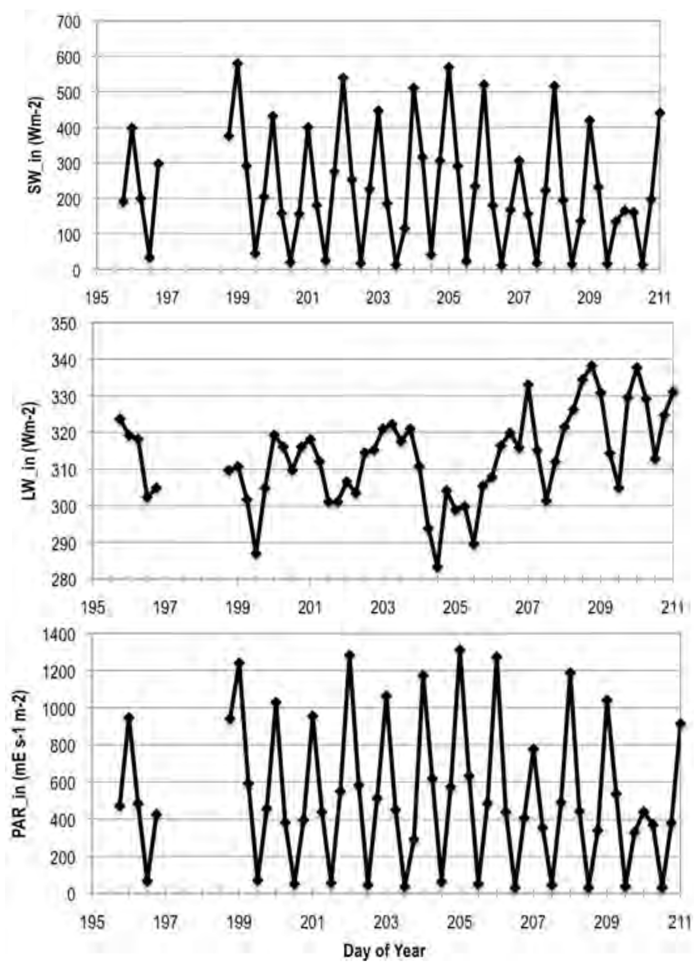

Figure 3.10. Six hour averages of incoming solar radiation (top, SW), long-wave radiation (middle, LW) and photosynthetically active radiation (bottom, PAR) measured from 13 to 29 July during Leg 2a.

Underway system

Time series (6 hour averages) of the main variables associated with the underway system are provided in Figure 3.11. Note data shown prior to July 13 (DOY 195) are from Leg 1b.

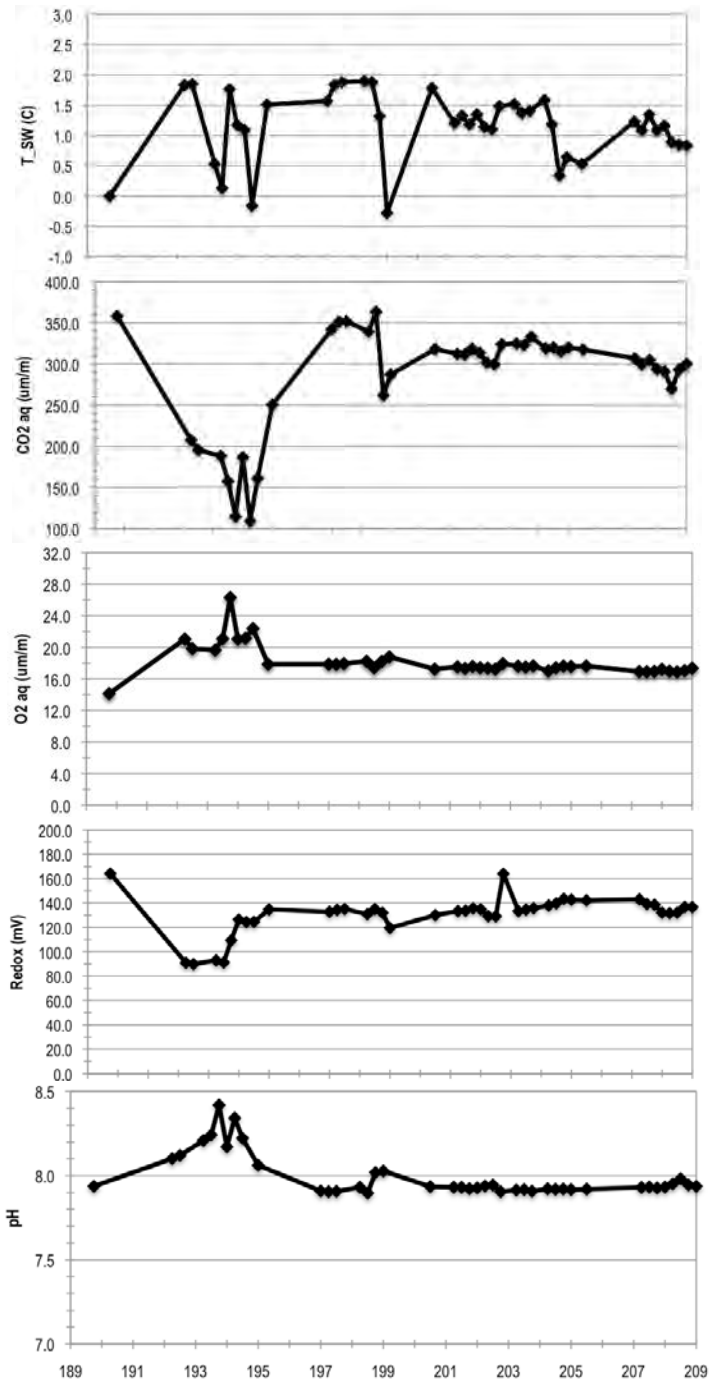

Figure 3.11. Time series (6 hour averages) of seawater temperature (T_SW), dissolved CO_2 (CO2 aq), dissolved O_2 (O2 aq), oxidation-redox potential (Redox) and pH in the surface sea water (upper 5 m) from 7 to 26 July during Legs 1b and 2a.

4 Sea-surface microlayer and its effect on air-sea gas exchange of CO_2 – Legs 4a and 4b

ArcticNet Phase 2 – Project titled *Carbon Exchange Dynamics in Coastal and Marine Ecosystems*. ArcticNet/Phase2/Papakyriakou_Carbon_dynamics

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Cruise participants Legs 4a and 4b: Oliver Wurl[1] and Eunice Tong[1]

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4.1 Introduction

The sea-surface microlayer (SML), the 60-120 µm thick interfacial region between ocean and atmosphere, is enriched in naturally occurring surfactants affecting air-sea gas exchange processes by creating a laminar water layer (Frew et al. 2002). Furthermore, the enrichment of bacterial communities in the SML may further control air-sea gas exchange (Reintahler et al. 2008). Recent studies by Reinthaler et al. (2008) and Wurl et al. (2009) have shown that the SML exists at oceanic conditions exceeding the global average wind speed of 6.6 m/s (Archer and Jacabson 2005) and therefore its role in controlling the fate of atmospheric greenhouse gases is of global proportion. Accurate estimates of air-sea gas exchange processes are essential for understanding the global cycles of climate active trace gases such as carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O) and dimethylsuphide (DMS).

During Leg 4a, the objective of the project was to simultaneously assess the distribution of the SML and CO_2 fluxes in the Canadian Arctic Archipelago, a region of high oceanic CO_2 uptake, and to answer the key question to what extent the SML affects the air-sea gas exchange of CO_2.

During Leg 4b, the objective was to assess the distribution of the SML in the Labrador Fjords with the overall aim of determining to what extent the SML affects the air-sea gas exchange of CO_2.

The formation and sinking of biogenic particles mediate vertical mass fluxes in the water column. Research on particle production in marine surface waters has focused primarily on phytoplankton growth while the assembly of organic macromolecules is a mechanism that has largely been neglected. TEPs do not originate directly from cell growth, but spontaneous assembly of dissolved polysaccharides. Owing to their surface-reactive nature, TEP support coagulation processes and enhance the formation of large particle aggregates (marine snow), which in turn accelerate carbon export to the deep sea.

It has been shown that gel-like unballasted TEPs are enriched in the sea-surface microlayer (SML) which gives the microlayer a gelatinous composition (Wurl and Holmes 2008). The 2009 ArcticNet Expedition was an opportunity to extend the database on TEP aggregation rates from the North Pacific and offshore Hawaii to the Arctic, and further confirm the hypothesis that enhanced particle aggregation occurring in the SML due to TEP accumulation plays a leading role in the marine carbon cycle.

4.2 Methodology

Sampling of the SML was planned to be conducted using DFO-IOS' remote-controlled glass disk sampler, the so-called Little Kilo Moana (Figure 4.1) but the strong winds, cold weather, extensive ice coverage or non-operational small boat, precluded its deployment at most station. The Little Kilo Moana was deployed once in Frobisher Bay (Leg 4a) and the glass plate technique (Figure 4.1) was used to sample the microlayer at the other sites, either from the barge or using the ice cage (Figure 4.1).

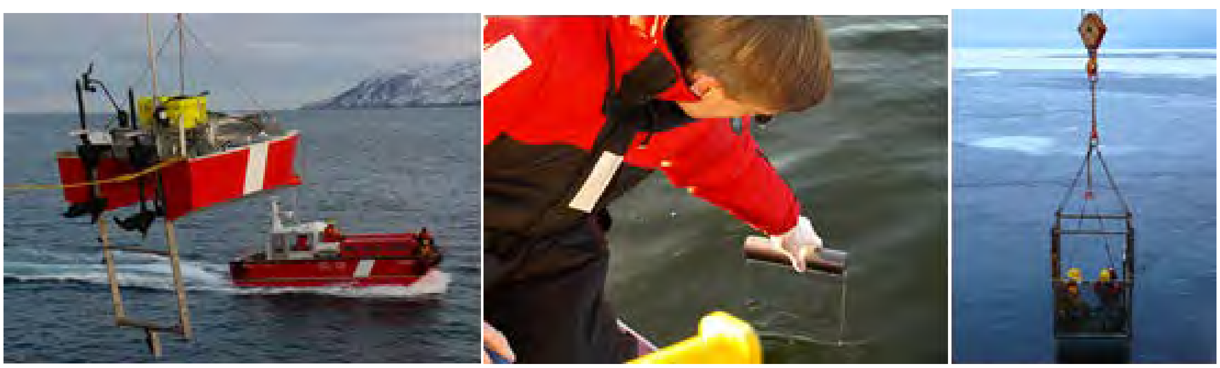

Figure 4.1. Microlayer sampling techniques used during Legs 4a and 4b: Left: Little Kilo Moana during deployment from the CCGS *Amundsen*, Middle: glass plate sampling (at Saanich Inlet, BC) and Right: sampling from the ice cage deployed from the *Amundsen*.

Glassplate sampling over open waters were limited to three opportunities in Leg 4a and in 2 fjords (Okak and Anaktalak) in Leg 4b. Samples of the bulkwater from underneath the microlayer were collected at 1 m depth by suction through a 60 mL syringe. SML and bulkwater samples were analyzed onboard on surface-active substances with a polarographic analyzer.

Wind speeds were measured during sampling with a handheld anemometer. Chlorophyll samples, Secchi depth and surface PAR measurements were also taken to estimate primary production. Primary production (i.e. the source of natural surfactants) and wind speeds (dispersion and mixing) are the main factors controlling the distribution of the SML.

The weather conditions also precluded the deployment of the floating gas chamber within the sampled surfactant field. Attempts were made to modify the chamber for stabilization on the water surface, but the 90 minutes required to conduct the flux measurement this way was too long to keep it floating. Instead, CO_2 flux data from the same leg using the Eddy Correlation Technique (T. Papakyriakou, U. Manitoba) were used, although this technique assesses CO_2 fluxes on a much larger spatial scale. Alternatively, Frew et al. (2002) correlation of surfactant concentration and reduction in gas mass transfer velocity can be used to estimate the effect of the collected SML in air-sea gas exchange.

Samples from the SML and water column were analyzed onboard for TEPs after staining and spectrophotometric analysis (Passow and Alldredge 1995) and for mono- and polysaccharide according to Myklestad et al. (1999). The data will be input into an aggregation model based on Smoluchwski equations (Engel et al. 2004).

4.3 Preliminary results

SML distribution in the Beaufort Sea at low and high wind conditions shows, as reported for other regions, that a SML can form and exist even in relatively strong wind conditions in Arctic waters (Table 4.1).

Table 4.1. Enrichment factor of surfactants in the SML relative to bulkwater in the Beaufort Sea (Leg 4a) under low and high wind conditions.

Condition/Date/Station	Enrichment of surface-active substances	Wind (m/s)
Low Wind Condition 14 Oct / Station 437	3.6	2.1
	5.6	3.6
	2.9	2.4
High Wind Condition 16 Oct / Station 405	1.9	8.7
	1.4	9.7
	1.5	7.9

Sampling from the ice cage allowed collecting the SML between ice floes, which led to the new observation that the SML exists in partly ice-covered waters and that surfactants were also enriched in the SML relative to bulkwater (Table 4.2). Samples collected offshore Greenland in Baffin Bay at Station 115 from the small boat showed enrichments of surfactants in the range of 1.9 to 3.9 at wind speeds of 4.4 to 5.3 m/s.

Table 4.2. Enrichment of surfactants in the SML relative to bulkwater in partly ice-covered waters of the Canadian Arctic Archipelago and northern Baffin Bay in Leg 4a.

Date/Station	Enrichment of surface-active substances	Wind (m/s)
25 Oct / Stn 323	2.5	6.2
	2.3	6.2
	2.2	6.2
26 Oct / Stn 103	1.5	3.1
	1.5	3.1
	1.9	3.1
27 Oct / Stn 105	1.6	1.0
	2.2	1.0
	2.3	2.8

Date/Station	Enrichment of surface-active substances	Wind (m/s)
1 Nov / Stn 141	4.9	0.7
	5.1	0.7
	3.8	0.7

The Little Kilo Moana was deployed in Frobisher Bay and the operation was successful even though the sampling tube used to collect the SML and bulkwater froze up quickly after deployment. Therefore, no discrete water samples and in-situ CDOM data could be collected at this station.

The data on aggregation in the SML and water column will be obtained after completion of sample analysis onboard.

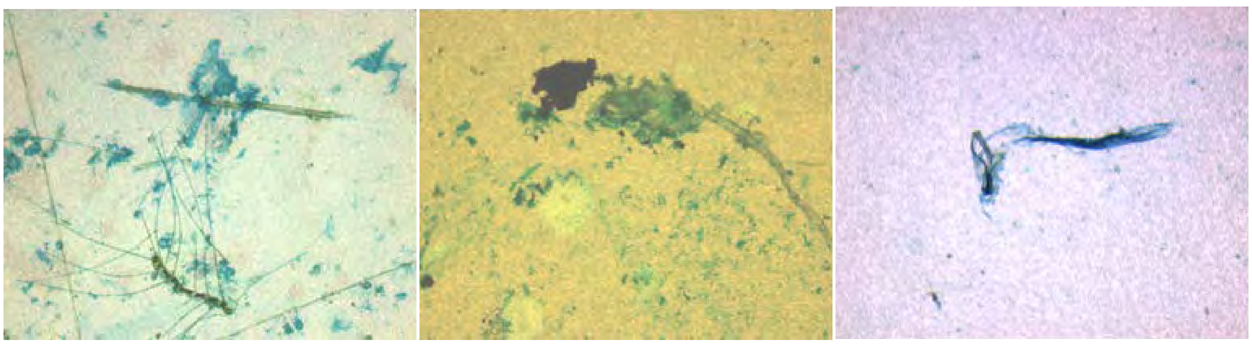

Figure 4.2. Example of stained TEPs collected offshore Greenland in November 2009 during Leg 4a from 20 m depth (left) and from the sea-surface microlayer (middle) and from Okak Fjord in northern Labrador during Leg 4b.

4.4 Comments and recommendations

Due to the limited sampling opportunities in Leg 4a, it was decided that the team would stay onboard for Leg 4b and try to deploy the Little Kilo Moana in the Labrador fjords as weather conditions and operations schedule will permit.

Projects requiring the use of the small boat for their operations should be scheduled and planned in advance to allow for more sampling opportunities.

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5 Ocean – sea ice – atmosphere processes – Legs 1b, 2a, 3a, 3b, 4a and BaySys

ArcticNet Phase 2 – Project titled *The role of sea-ice in ArcticNet IRISes*.
ArcticNet/Phase2/Barber_Sea ice
ArcticNet Phase 2 – Project titled *Freshwater-Marine Coupling in the Hudson Bay IRIS*.
ArcticNet/Phase2/Barber_Freshwater-marine_coupling

Project leaders: David Barber[1] (dbarber@cc.umanitoba.ca) and Imperial Oil (Legs 2a and 3b)
Cruise participants Leg 1b: Klaus Hoccheim[1], John Iacozza[1], Lauren Candlish[1] and Kerri-Ann Warner[1]
Cruise participants Leg 2a: Imperial Oil, Matthew Asplin[1], John Iacozza[1], Tao Li[1] and Chris Stammers[1]
Cruise participants Leg 3a: David Barber[1], Simon Prinsenberg[2], Matthew Asplin[1], Ryan Galley[1], Mukesh Gupta[1] and Kerri Warner[1]
Cruise participants Leg 3b: Imperial Oil, Klaus Hoccheim[1], Mukesh Gupta[1], Lauren Candlish[1] and Tao Li[1]
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5.1 Introduction

5.1.1 Leg 1b – 30 June to 16 July 2009 – Victoria to Sachs Harbour

Most of the activities for Leg 1b revolved around the setup of instrumentation for following Legs in ArcticNet /IOL while the ship was in transit from Victoria BC to Sachs Harbour. Some limited sampling occurred and is summarized below.

5.1.2 Leg 2a – 16 July to 30 July 2009 – Beaufort Sea
Leg 3a – 27 August to 12 September 2009 – Beaufort Sea
Leg 3b – 12 September to 8 October 2009 – Beaufort Sea
Leg 4a – 8 October to 06 November – Beaufort Sea, NW Passage, Baffin Bay

Active ArcticNet sampling programs, such as ice geophysics and dynamics, ice distribution and thickness, are of particular interest to Imperial Oil for the reasoning and development of potential future offshore drilling platforms. This document represents the data report for the Centre for Earth Observation Science (CEOS) under the "Sea Ice" project of the ArcticNet Network scientific program.

This team was actively involved in research that revolves around improving understanding of ocean-sea ice-atmosphere dynamic and thermodynamic coupling, as well as how this coupling impacts the ecology of the sea ice, and the waters immediately beneath. A large ensemble of ship-based sensors was employed, as well as physical sampling equipment that collected sensor-based atmospheric, oceanic and sea ice data. The data collection efforts were driven by many interlinked objectives, some of them relevant to the partnership with Imperial Oil and operations focusing in the Beaufort Sea. Data collection in the Beaufort Sea region during Legs 2a, 3a and 3b as well as in the High Canadian Arctic during Leg 4a, fulfilled many objectives:

1) Evaluate the sea ice climatology of the Southern Beaufort Sea, including in the Ajurak Block lease area in partnership with Imperial Oil (Legs 2a and 3b).
2) Develop a dataset of ice thickness, ice concentration and ice roughness for use in future engineering purposes.
3) Develop and improve satellite-based remote sensing of sea ice through an extensive ship-based EM sampling program, and physical sampling of sea ice geophysical and electrical properties.
4) Improve understanding of atmospheric coupling of sea ice dynamics and thermodynamics by monitoring atmospheric conditions, sea ice motion, sea ice roughness, and growth and ablation of sea ice.
5) Improve modeling of dynamic and thermodynamic ocean-sea ice-atmosphere processes.

5.1.3 BaySys – 27 July to 5 August 2009 – Hudson Bay

Hyperspectral surface measurements for ocean color were conducted at various stations throughout the Hudson Bay during the BaySys cruise onboard the CCGS *Pierre Radisson* (see Section 5.4.1 below).

5.2 Sea ice methodology

5.2.1 General ice conditions

<u>Leg 3a – 27 August to 12 September 2009 – Beaufort Sea</u>

Seas were initially ice free at the crew change location of Paulatuk, NWT. After completing a short Rosette station in open water, the ship headed northward to the first long station at L1. En route, large, thick and rotted first-year ice floes, and some multi-year floes, were encountered. The ship was moored to a small, but sizeable multi-year ice floe, and remained there for two days (Figure 5.1). Ice floe sizes ranged from a few hundred meters to several nautical miles in diameter. The northward transect into the old pack ice revealed that ice that had been classified as 9/10+ old and multi-year ice, was in fact, no more than 6/10's concentration, and was mostly very rotted, wet first year ice. It was impossible to find any multi-year ice to moor the ship to for station L2.

Figure 5.1. CCGS *Amundsen* moored to a multi-year ice floe at station L1 during Leg 3a.

Given the unexpected lack of multi-year ice, a plan was devised to travel eastward, and transit through McClure Strait, and down the Prince of Wales Strait, expecting to sample multi-year ice along the way. The ship turned eastward, with an intended station near large multi-year ice floes at 73°54.491' N, 133°48.944' W but while preparing to deploy on the ice, the beginning of a swell propagating into the ice was noted. Over the course of a few hours, the MYI completely broke up into small pieces (50 to 100 m in size). After some discussion, the decision was made to return out of the old MY pack towards the west and then north to 73°30' N to conduct Station L2. The swell which broke up the MY ice was clearly evident the next day as the ship headed out of the MY pack to an area more towards the edge of the ice. The swells had caused significant damage to the pack, breaking it up into small pieces. The strong westerly winds and large swells were attributed to a large, deep cyclone that was situated northwest of the sampling region, producing high seas in open water in the Canada Basin, and Western Beaufort Sea.

Station L3 was conducted at 75°N, 140°W, and involved primarily Rosette casts and onboard sampling. Helicopter surveys were limited due to bad weather at L3, but were conducted on the transit south to Station L1.1 (72°30' N, 137°12' W) through wide areas of first-year ice that had been broken up by the large swells from the Beaufort Sea cyclone.

Leg 3b – 12 September to 8 October 2009 – Beaufort Sea

The Ajurak Block was ice free for most the leg. In early October a low concentration ice tongue from the main pack ice extended into the block (Figure 5.2). During the same period, relatively calm winds and -4 to -8°C temperatures prompted the formation of nilas, frazile and pancake ice. The pack ice remained 50-60 nm to the north throughout Leg 3b. High winds (20-30 kt) during 3-4 October quickly dissipated any "new ice" in the area.

Figure 5.2. Ice within the northern portion of the Ajurak Block (2 October). Left: Ice streamer from the pack ice (SIC<30%), Right: pancake ice formation (dark grey) and isolated second year ice (white).

5.2.2 Helicopter-based EMI ice surveys

Leg 1b – 30 June to 16 July 2009 – Victoria to Sachs Harbour

During Leg 1b, sea ice thickness and surface roughness surveying using the Electro Magnetic Induction (EMI) system was not conducted due to a combination of local ice conditions and unfavorable flying conditions primarily related to fog and low ceilings. EMI surveys started on Leg 2a. However, a photogrammetric camera was fitted to the helicopter and a test flight was completed 15 July.

Leg 2a – 16 July to 30 July 2009 – Beaufort Sea

Ice thickness and roughness were assessed using EMI helicopter at Stations F-09, 05, 07, 12, 02, 20, and during the deployment of the Cornell University hydrophones. In total, over 300 transects were sampled for sea ice thickness and surface roughness. In addition, CTD measurements along with ice thickness were sampled at a point along one transect for Station 12.

Figure 5.3. EM induction system mounted on the front of the helicopter.

The helicopter-based EM induction system (or IcePic: Figure 5.3) was used during Leg 2a to derive snow + ice thickness and surface roughness for mobile first-year and multi-year ice in the Ajurak Block. The BIO EMI system was used for all transects. Each transect was approximately 2 nautical miles in length, except for the transects sampled during the ice beacon deployment operations.

Table 5.1. Helicopter EMI transect surveys summary for Leg 2a.

Station ID	Date	Number of Sites	Number of Transects
20	July 23, 2009	20	37
F-09	July 24, 2009	2	12
07	July 25, 2009	9	53
Hydrophones	July 26, 2009	13	78
12	July 27, 2009	24	68
5	July 28, 2009	7	40
Beacon deployment	July 29, 2009	5	8 (long)

In addition, digital images were acquired along each transect. These photos were geotagged and could be linked with the helicopter EMI survey data. A table of start and end locations for each transect was unavailable at the end of the leg, and will be produced during the post-cruise data processing. Examples of helicopter EMI survey data showing transects conducted at floes 2-05 and 6-05 on 28 July 2009 are shown in the results section below.

Leg 3a – 27 August to 12 September 2009 – Beaufort Sea

The helicopter-based EM induction system (or IcePic: Figure 5.3) was used during Leg 3a to derive snow & ice thickness and surface roughness for mobile first-year and multi-year ice. The BIO Pic was used for all transects. Each transect was approximately 2 nautical miles in length (except for the transects sampled during the beacon deployment).

In addition, digital images were acquired along each transect. These photos were geotagged and could be linked with the helicopter EMI survey data. A table of start and end locations for each transect is unavailable at the time of this report, but will be produced after the cruise as part of the data processing. An example of EMI helicopter data is presented in the preliminary results section below, and shows triangular beacon deployments on 4 September and 8 September with HEMI flight data.

Leg 3b – 12 September to 8 October 2009 – Beaufort Sea

Due to the remoteness of the sea ice relative to the ship and the generally poor and highly variable weather conditions, only two EMI flights were conducted, on 16 September and 2 October.

The 16 September survey was conducted 50 nm north of the Ajurak Block along the fringe of the ice pack. Low fog over the main pack ice area limited horizontal visibility and was therefore not accessible. Four transects were flown over first year ice, including video and aerial photography (60% overlap). The first “floe” or area consisted of tightly packed unconsolidated ice, the second floe was a large area of consolidated ice. The second EMI flight occurred in the evening on 2 October, over a large multiyear floe approximately 10 nm from the ship. Only one transect was flown over the ice due to very poor surface contrast (flat light). Details regarding the locations of transects and ice thickness are summarized in Table 5.2 and preliminary data can be found in the results section below.

Table 5.2. Summary of helicopter EMI transects flown during Leg 3b.

Date	Transect ID	Start		End		Avg ice thickness	Med ice thickness
		Latitude N	Longitude W	Latitude N	Longitude W		
09/16/09	F1_T1_W	71°24.618	135°40.595	71°23.064	135°47.703	1.18	0.93
09/16/09	F1_T2_E	71°22.831	135°46.216	71°24.053	135°40.554	1.47	1.24
09/16/09	F2_T1_W	71°28.488	135°31.754	71°28.520	135°41.008	1.34	1.34
09/16/09	F2_T2_E	71°27.904	135°40.592	71°27.892	135°33.753	1.53	1.30
10/02/09	T1	70°44.091	135°42.455	70°42.984	135°46.184	1.15	0.95

Leg 4a – 8 October to 6 November – Beaufort Sea, NW Passage, Baffin Bay

The helicopter-based EM induction system (IcePic) was used during Leg 4a to derive snow and ice thickness and surface roughness for mobile first-year and multi-year ice opportunistically along the ship's track as weather and other sampling activities permitted. The BIO Pic was used for all transects. Each transect was approximately 20 nautical miles in length. Digital images were acquired along each transect and these photos may be georeferenced using the IcePic GPS data that was collected simultaneously, as the video GPS was not functioning. A table of start and end locations for each flight will be produced as part of the data processing to be done after the cruise.

5.2.3 ASD spectroradiometer

The ASD FieldSpec@3 Spectroradiometer is a general-purpose spectrometer useful in many application areas requiring the measurement of reflectance, transmittance, radiance and irradiance.

Leg 2a – 16 July to 30 July 2009 – Beaufort Sea

The only ASD measurement during Leg 2a was conducted at Station 20 with the helicopter. The reflectance of melting snow and pond with frozen and water surface was obtained.

5.2.4 Ice motion beacons (or ice drift buoys)

Leg 2a – 16 July to 30 July 2009 – Beaufort Sea

Three ice motion beacons were deployed on 29 July 2009 on the sea ice northwest of the AJURAK block (Table 5.3). The remaining 17 beacons will be deployed during Legs 3a and 4a.

Table 5.3. Summary of ice motion beacon deployments for Leg 2a.

Beacon ID	Deployment Location

	Latitude N	Longitude W
282100	71°46.205	134°37.077
282060	71°32.954	133°55.681
282070	71°34.449	133°16.870

Leg 3a – 27 August to 12 September 2009 – Beaufort Sea

Eleven ice motion beacons were deployed during Leg 3a and are summarized in Table 5.4. Nine of the eleven beacons were deployed in a triangular configuration, with HEMI ice thickness surveys to follow.

Table 5.4. Summary of ice motion beacon deployments for Leg 3a.

Beacon ID	Date and Time (LST)	Latitude N	Longitude W
289100	Sept 2, 1922	71° 06.388	139° 01.420
288100 (N)	Sept 4, ~1030	74° 33.720	137° 09.090
283100 (SE)	Sept 4, ~1030	74° 33.230	137° 24.090
288060 (SW)	Sept 4, ~1030	74° 39.090	137° 13.228
20590 (single)	Sept 6, 1600	74° 26.266	133° 23.141
281100 (N)	Sept 8, 0941	73° 05.680	135° 33.250
284060 (S)	Sept 8, 1003	72° 59.610	135° 38.920
286060 (W)	Sept 8, 1014	73° 04.150	135° 53.360
287060 (S)	Sept 8, 1524	72° 27.530	136° 41.330
280110 (E)	Sept 8, 1549	72° 30.760	136° 24.050
282070 (N)	Sept 8, 1405	72° 33.770	136° 41.880

5.2.5 Ice mass-balance buoys

Leg 3a – 27 August to 12 September 2009 – Beaufort Sea

One ice mass-balance buoy was deployed on 9 September during Leg 3a, on a 1.9 m thick first-year ice floe near station L1.1.

Leg 4a – 8 October to 6 November – Beaufort Sea, NW Passage, Baffin Bay

CEOS_IMB02 was installed in the southeast end of McClure Strait via BO-105 helicopter on 17 October 2009 at 73° 34.323’ N and 115° 11.465’ W. A large multi-year ice floe was selected using the helicopter-mounted IcePic system that was 2.20 m thick at the installation site. No snow existed on the surface of the floe at the installation site.

CEOS_IMB03 was installed in the eastern end of Viscount Melville Sound (~100°W) by helicopter on 22 October 2009. The installation team was able to stay at the installation site for the IMB to make a successful set of measurements but could not stay for a data transmission cycle due to sunlight restrictions on the flight of the helicopter. The ice thickness at the installation site was 2.49 m and no snow existed on the surface of the floe.

5.2.6 Ship-based EM measurements

<u>**Leg 1b – 30 June to 16 July 2009 – Victoria to Sachs Harbour**</u>

The C-band scatterometer (5.6 GHz) was setup and tested and was operational for ice activities when they commenced in Leg 2a (Figure 5.4). The passive microwave radiometers (37 & 89 GHZ) were also operational and collected data continuously during transit (Figure 5.4). Sky measurements (for instrument calibration) occurred every three hours coincident with meteorological observations. Passive microwave data during transit was recorded at 53° incidence. The IR transducer was still being worked on and should be up and running on Leg 2a. The data logged during Leg 1b is summarized in Table 5.5.

Figure 5.4. Left: Scatterometer, Right: Passive microwave radiometers (SBR) (37 and 89 GHz) installed on port side of the *Amundsen* ~10 m above sea level.

Table 5.5. Partial log of passive microwave data collected during transit between Victoria BC and Sachs Harbour during Leg 1b.

Date in 2009	Activity	Time Start	Time End	Latitude N	Longitude W
10-Jul	First scan				
11-Jul	sky scan transit	16:34	16:38	67° 42.043	168° 15.16
11-Jul	sky scan transit		22:57	69°06.000	167°05.400
12-Jul	sky scan transit	15:12	15:17	71°11.400	159°24.000
12-Jul	sky scan transit	20:30	20:39	71°27.000	156°23.400
12-Jul	sky transit	00:00	00:07	71°27.000	155°01.800
12-Jul	sky transit	03:26	03:34	71°27.000	153°08.400
13-Jul	sky BACKUP transit	18:01	18:06	70°26.400	144°07.800
13-Jul	sky transit	20:19	20:25	70°23.400	143°19.800

Date in 2009	Activity	Time Start	Time End	Latitude N	Longitude W
13-Jul	sky transit	00:00	00:06	70°18.600	140°23.400
13-Jul	sky transit	03:03	03:08	70°21.600	138°22.200
14-Jul	sky transit	15:05	15:11	70°28.200	135°30.600
14-Jul	sky transit	18:22	18:25	70°27.000	135°27.000
14-Jul	sky transit	21:02	21:11	70°21.600	136°03.600
	sky	23:59	00:02	70°27.600	136°07.200

Leg 2a – 16 July to 30 July 2009 – Beaufort Sea

Ship-based EM measurements were not conducted during Leg 2a. Regular physical sampling of snow and sea ice salinity, temperature profiles, and conductivity, coupled with EM measurements using a C-Band Scatterometer and dual polarized radiometers will resume on 27 August 2009, and continue throughout Legs 3a and 3b until the end of the ArcticNet / Imperial Oil field program in the Beaufort Sea.

Leg 3a – 27 August to 12 September 2009 – Beaufort Sea

EM measurements using a C-Band Scatterometer and dual polarized radiometers operating at 37 GHz and 89 GHz, were conducted throughout Legs 3a and 3b in order to observe the interaction of electromagnetic radiation with various ice conditions. The collected data will be used in electromagnetic modeling studies and for calibration of satellite remote sensing data and will allow to improve knowledge of the temporal evolution of sea ice physical, thermodynamic, and electrical properties during the late summer and early ice formation season (Late August and September). Examples of VV and HH polarization for first-year ice, and old ice collected during Leg 3a are shown in the preliminary results section below.

Leg 3b – 12 September to 8 October 2009 – Beaufort Sea

Passive microwave data was obtained at 37 and 89 GHz continuously throughout Leg 3b while the ship was in transit mode (53°). This data is to be used for surface validation of space borne data. Additional scans were made at coring/mooring stations (total of 17 scans as of 5 October) representing different sea states and or sea ice types. Scans were made at depression angles of 30°-70° at 0°azimuth. Sky measurements were made at 125° for calibration purposes. Pictures of the field of view (FOV) of SBR were also taken at station to record surface conditions. New ice (frazil ice, grease ice, nilas and early pancakes) was scanned in Ajurak block (1-2 October) associated with the ice tongue that pushed into the block from North. Table 5.6 summarizes the scans made at fixed locations.

Table 5.6. Summary of SBR scan data collected at coring/mooring stations during Leg 3b.

Ship date in 2009	Mode	GPS coordinates		File name	Comments
		Latitude N	Longitude W		
Sep. 19	Scan (30°-70°)	70° 48.278	136° 03.070	RADDAT-2009-09-20-175835	Open water
Sep. 21	Scan (30°-70°)	70° 43.902	136° 15.276	RADDAT-2009-09-21-174323	Open water, snowing, rough sea
Sep. 21	Scan (30°-70°)	70° 33.473	135° 57.175	RADDAT-2009-09-21-232245	Open water, snowing, rough sea
Sep. 24	Scan (30°-125°)	70° 37.127	135° 58.180	RADDAT-2009-09-24-201050	Open water, overcast, very rough sea
Sep. 25	Scan (30°-125°)	70° 40.279	136° 14.449	RADDAT-2009-09-25-201103	Open water, bit sunny
Sep. 26	Scan (30°-125°)	70° 44.873	136° 20.645	RADDAT-2009-09-26-175503	Open water, bit snowing, calm
Sep. 27	Scan (30°-125°)	70° 37.434	135° 45.037	RADDAT-2009-09-27-203949	Open water, overcast, windy, UPS battery exploded and replaced
Sep. 28	Scan (30°-125°)	70° 43.273	135° 51.832	RADDAT-2009-09-28-182054	Open water, heavily snowing
Sep. 29	Scan (30°-125°	70° 37.629	136° 03.122	RADDAT-2009-09-29-193737	Open water, bit sunny and snowing, calm, MOB deployed
Sep. 30	Scan (30°-125°)	Recording cancelled after one scan		RADDAT-2009-09-30-172322	Ice edge, ship moved- recording cancelled, Only one scan
Oct. 1	Scan (30°-125°)	70° 45.547	136° 60.730	RADDAT-2009-10-01-173950	New ice, nilas, pancake, water mix
Oct. 1	Scan (30°-125°)	70° 47.184	136° 06.551	RADDAT-2009-10-01-004025	New ice, nilas, pancake
Oct. 2	Scan (30°-125°)	70° 45.671	136° 00.786	RADDAT-2009-10-02-173254	Ice edge, open water
Oct. 2	Scan (30°-125°)	70° 44.528	136° 22.702	RADDAT-2009-10-02-215502	New ice, nilas, pancake, slush
Oct. 3	Scan (30°-125°)	70° 29.760	135° 07.990	RADDAT-2009-10-03-181547	Open water, 20 knots wind
Oct. 4	Scan (30°-125°)	70° 48.064	136° 04.143	RADDAT-2009-10-04-181633	Open water, foggy
Oct. 5	Scan (30°-125°)	70° 46.049	136° 18.965	RADDAT-2009-10-05-172239	Open water, windy

Leg 4a – 8 October to 6 November – Beaufort Sea, NW Passage, Baffin Bay

EM measurements using the C-Band Scatterometer, and dual polarized radiometers were conducted throughout Leg 4a to observe the interaction of electromagnetic radiation with various ice conditions. The collected data will be used in electromagnetic modeling studies and for calibration of satellite remote sensing data and will allow to improve knowledge of the temporal evolution of sea ice physical, thermodynamic, and electrical properties during the season of ice formation (October).

A total of 10 different sites were scanned using the C-Band scatterometer on the following dates: 10 October, 21 October, 22 October, 23 October and 27 October. Out of the 10 floes that were scanned, physical measurements were taken on 6 of the floes.

5.2.7 Ship-based sea ice observations

Leg 1b – 30 June to 16 July 2009 – Victoria to Sachs Harbour

Tests of the shipboard photogrammetric camera system were made during Leg 1b. The system was comprised of two high resolution digital cameras that were synchronized and remotely triggered which were located off the port side of the ship near the radiometers. The data collected were obtained coincident with microwave data acquisitions and will be used for 3D modeling of the ice surface. Some testing of the system was done on an opportunistic basis primarily to address concerns about the best strategy to ensure proper exposure of images in a mix sea-ice/water environment. A methodology was developed to optimize sea exposures for sea ice and/or water for 3D modelling and camera calibration was completed.

The ice thickness camera on the port side, adjacent to scatterometer, started logging on 13 July at 16:47 UTC at a rate of 6 frames per minute on a continuous basis. The site camera for SBR and scatterometer was operational on 8 July (20:40 UTC) and recorded sea state and ice conditions in transit at a rate of 60 frames per hour.

Leg 2a – 16 July to 30 July 2009 – Beaufort Sea

Leg 3a – 27 August to 12 September 2009 – Beaufort Sea

Physical sampling of individual ice floes was limited to roughness and thickness surveys during helicopter EMI surveys. Ship-based monitoring using cameras and manual observations of sea ice concentration was also carried out. An obliquely-mounted AXIS netcam took pictures at 10-minute intervals off the port side of the ship, allowing to assess sea ice conditions on station and during transit. A downward-looking camera monitored ice thickness where ice breaking was necessary: when breaking through ice, some of the broken ice floes will turn on their side. Manual post-process estimates of ice thickness will be derived from this photography where possible.

Leg 4a – 8 October to 6 November – Beaufort Sea, NW Passage, Baffin Bay

Ship-based monitoring was conducted using cameras and manual observations of sea ice concentration in close proximity to the ship. The obliquely-mounted AXIS camera off the port side of the ship (pictures at 10-minute intervals) and the downward-looking camera monitoring ice thickness when the ship was ice breaking were used as described above for Legs 2a and 3a.

5.2.8 *On-ice physical sampling activities*

Leg 3a – 27 August to 12 September 2009 – Beaufort Sea

Regular physical sampling of snow and sea ice salinity, temperature profiles, and conductivity, coupled with C-band scatterometer and ship-based radiometer measurements started during Leg 3a and continued until the end of the ArcticNet / IORVL partnership 2009 field program. Extensive on-ice physical sampling activities were conducted, in parallel with remote sensing and ship-based EM scanning programs during Leg 3a. A team of scientists collected this data via deployment by ice cage, or directly onto the floe. The following data was collected during these activities:

- Ice thickness and freeboard
- Ice temperature profile
- Ice salinity
- Snow temperature, salinity, and density samples (where snow exists)
- Snow grain size
- Melt ponds (area, long-axis dimensions, roughness, fetch, depth)
- On-ice winds
- Site photography

Leg 4a – 8 October to 6 November – Beaufort Sea, NW Passage, Baffin Bay

Physical sampling of snow and sea ice salinity, temperature coupled with C-band scatterometer and ship-based radiometer measurements was performed in Leg 4a. Cores were also cut to be processed for sea ice density at the CEOS cold-lab. The ice team was able to conduct physical sampling at two sites on 10 October, at one site on 21 October and on 22 October, and the two final stations occurred on 27 October.

5.3 Atmosphere and meteorology methodology

5.3.1 *Manual weather observations*

Manual weather observations were recorded every 3 hours (00:00, 03:00, 06:00, etc.; UTC time) and included:

- GPS location (latitude, longitude)
- Cloud fractional coverage (8/8, 7/8, etc.)
- Precipitation type and amount (light, med, heavy)
- Visibility (approx 20 nm, 10 nm, fog, etc.)
- AAVOS recording (temperature, wind speed and direction)
- Ship's ecpins system (wind speed and true direction)
- Sea ice percent coverage/type)

This data was collected to validate the all-sky camera and to have a written back up for variables that were automatically recorded. During Leg 3b, no observations were taken during the night because only one observer was on duty.

5.3.2 All-sky camera

The all-sky camera system was used throughout the cruise to take pictures of the sky in order to determine the percentage and type of cloud cover. The system consisted of a Nikon D-90 camera outfitted with fish-eye lenses, mounted in a weather-proof enclosure. The camera was programmed to take pictures using an external intervalometer set at 15-minute intervals. The system was mounted in a small 'crow's nest' immediately above the ship's wheelhouse (Figure 5.5). Images will be post-processed into a tabular format describing cloud fractional coverage, cloud type, UTC date and time, and coordinates.

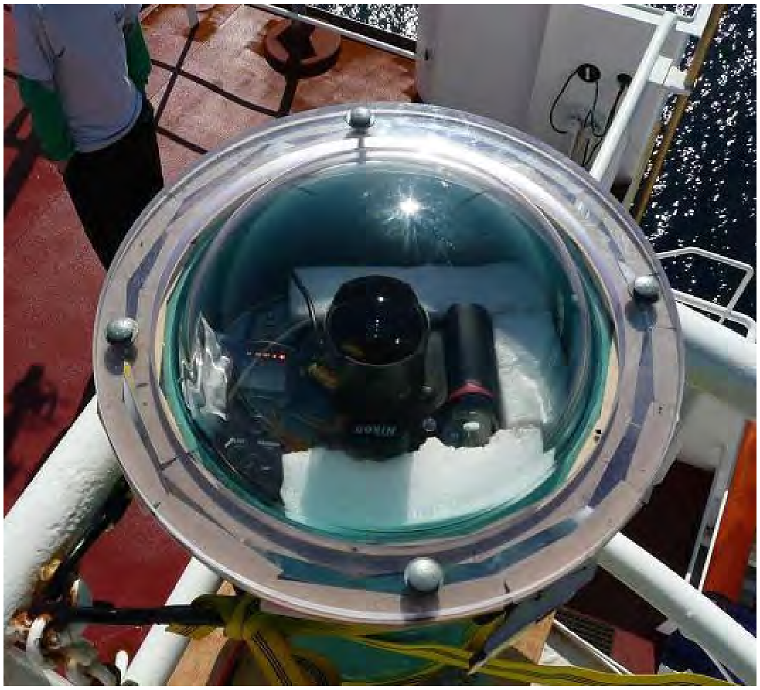

Figure 5.5. The all-sky Nikon D-90 Camera with fisheye lens attached in a weatherproof enclosure.

<u>Leg 1b – 30 June to 16 July 2009 – Victoria to Sachs Harbour</u>

The All Sky camera was not running as the intervalometer was broken; a replacement was brought onboard on16 July for Leg 2a.

<u>Leg 2a – 16 July to 30 July 2009 – Beaufort Sea</u>
<u>Leg 3a – 27 August to 12 September 2009 – Beaufort Sea</u>

The all-sky camera was non-functional during Leg 1b due to damage to the intervalometer and two replacements were brought to the ship on Leg 2a. Initially, the camera was initially producing white images (over-exposure), but this problem was quickly corrected.

Imagery collection started on 20 July and the camera-system was then fully functional through Legs 2 and 3, and only required regular maintenance and data backup.

<u>Leg 3b – 12 September to 8 October 2009 – Beaufort Sea</u>

At the start of Leg 3b, the all-sky camera needed calibrating as the system was not set up to work in all light levels. To account for the diminishing daylight, the system was set to

have an F-stop of 10 and a variable shutter speed. This allows for night sky pictures which could be processed based on how many stars were visible.

Figure 5.6. An All-Sky image taken on 02 October 2009 at 01:29 UTC during Leg 3b.

<u>Leg 4a – 8 October to 6 November – Beaufort Sea, NW Passage, Baffin Bay</u>

The all-sky camera was fully functional at the start of Leg 4a and only required regular maintenance and data backup.

5.3.3 Ceilometer

The Vaisala CT25K ceilometer was used to measure the height of up to three separate cloud layers above the ship (Figure 5.7). The instrument measured backscatter from an active laser pulse to identify cloud heights, sampling at a frequency of approximately once every 30 seconds. Routine maintenance and data backup were performed at regular intervals. All data files were raw text format, and required post-processing. The end data product will have UTC date and time, coordinates, and the height of each cloud layer detected.

Figure 5.7. The Vaisala CT25K ceilometer.

<u>Leg 1b – 30 June to 16 July 2009 – Victoria to Sachs Harbour</u>

The ceilometer continuously recorded the cloud base height in feet for up to 3 levels and ran throughout the leg except for a data gap due the port being set to data rather than maintenance.

Leg 2a – 16 July to 30 July 2009 – Beaufort Sea

The ceilometer was fully functional throughout Leg 2a and collected data continuously from 16 July to 30 July.

Leg 3a – 27 August to 12 September 2009 – Beaufort Sea
Leg 3b – 12 September to 8 October 2009 – Beaufort Sea

The ceilometer was fully functional throughout all of Legs 3a and 3b, with the exception of 4 September (Leg 3a) when power was lost to the "met shack" lab.

Leg 4a – 8 October to 6 November – Beaufort Sea, NW Passage, Baffin Bay

The ceilometer was fully functional throughout all of Leg 4a. Routine maintenance and data backup was performed at regular intervals.

5.3.4 Temperature and water vapour profiling radiometer

A Radiometrics temperature and water vapour 3000A profiling radiometer (TP/WVP3000A) was used to measure the temperature, relative humidity, and pressure in the atmosphere using passive microwave radiometry at 22 – 29GHz, and 51 – 59GHz. The TP/WVP3000A was installed on a mount attached to the white container laboratory located directly behind the ship's wheelhouse (Figure 5.8). The instrument was suspended away from the roof of the shed to ensure that the field-of-view (approximately 15° above the horizon to the left and right to the zenith) was clear of any obfuscation.

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igure 5.8. Radiometrics temperature and water vapour 3000A profiling radiometer (TP/WVP3000A).

The instrument generated vertical profiles of upper-level air variables including temperature, water vapour density, relative humidity, and liquid water from the surface to an altitude of 10 km. The resolution of the measurements varied with height: 50 m from the surface to an altitude of 500 m, then 100 m from 500 m to 2000 m altitude, and finally 250 m for measurements ranging from 2 km to 10 km. In addition, the instrument measured concurrent basic surface meteorology variables, including pressure, relative humidity, and ambient temperature. A skyward-looking infrared sensor measured the temperature of the sky and a rain-sensor detected the presence of any precipitation. The instrument also calculated integrated column water vapour, and liquid water content. The sampling frequency for all data was approximately one complete profile per minute. All data files are raw text format, and will require post-processing. The end data product will have UTC date and time, and coordinates attached to surface and upper-level data values, and integrated liquid and water vapour.

<u>Leg 1b – 30 June to 16 July 2009 – Victoria to Sachs Harbour</u>

The MW Profiler was not operational during Leg 1b because liquid nitrogen is required to calibrate the instrument and the liquid nitrogen plant was not yet running.

<u>Leg 2a – 16 July to 30 July 2009 – Beaufort Sea</u>

The TP/WVP 3000A was fully operational throughout Leg 2a, although fog registered as precipitation during much of Leg 2a. Due to the untimely breakdown of the ship's liquid nitrogen plant, liquid nitrogen calibration was not performed on the 51 – 59 GHz channels. The plant is expected to be operational again sometime during Leg 2b and the TP/WVP 3000A will be calibrated as soon as possible thereafter.

<u>Leg 3a – 27 August to 12 September 2009 – Beaufort Sea</u>

The TP/WVP 3000A was fully operational throughout Leg 3a, with the exception of 4 September when power was lost to the "met shack" lab. A liquid nitrogen calibration was performed on 28 August.

<u>Leg 3b – 12 September to 8 October 2009 – Beaufort Sea</u>

The TP/WVP 3000A was fully operational throughout Leg 3b, with the exception of the Radome filter change on 25 September and the liquid nitrogen calibration on 30 October.

<u>Leg 4a – 8 October to 6 November – Beaufort Sea, NW Passage, Baffin Bay</u>

The TP/WVP 3000A was fully operational throughout Leg 4a and was decommissioned on 03 November at the end of the leg.

5.3.5 Radiosondes (weather balloons)

Balloon launches were coordinated to correspond with the overflights of the earth-orbiting satellites CLOUDSAT and CALIPSO (at approximately 1130Z and 2100Z daily) for an Arctic validation study. Balloon launches were used to profile low-pressure systems, cyclones, and periods of significant warm or cold-air advection aloft. If a significant cyclone was affecting the region, the sampling interval was increased to 3-hourly.

Before launch, the radiosonde's temperature, pressure and humidity sensors were calibrated using the Vaisala ground station calibration unit. Surface meteorological observations were also noted and recorded for each launch. Starting meteorological conditions were input into the sounding including: sea level pressure, air temperature, relative humidity, and wind speed and direction. Data was transmitted at a rate of one message per second via VHF radio (~400.00 MHz). Each data message reported a value for pressure, temperature and humidity data (raw PTU data). GPS strings were also transmitted, and were used to calculate upper-level wind speed and direction. All raw PTU and GPS data is used to generate an ensemble of time series data. All radiosonde data files are exported as a raw time series, and will require quality assurance, and post-processing.

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igure 5.9. Launch of a radiosonde (weather balloon) during Leg 2a.

<u>Leg 2a – 16 July to 30 July 2009 – Beaufort Sea</u>

Fourteen balloons were launched during Leg 2a (Table 5.7). Weather balloon launches did not occur during Leg 2b and will resume following a similar sampling plan throughout Legs 3 and 4a.

Table 5.7. Summary of radiosonde launches conducted during Leg 2a.

Date in 2009 (GMT)	Time (GMT)	Latitude N	Longitude W	T_{air} (°C)	Relative humidity (%)	Pressure (mb)	Wind Speed (kts)	Wind direction (°true)
15 July	0305	70°37.620	136°02.880	1.3	92	1021.30	20	035
19 July	1825	70°39.600	135°37.740	0.1	98	1013.32	2	308
20 July	1045	70°36.600	135°57.300	-1.9	99	1018.05	5	135
21 July	0300	70°45.720	136°01.560	1.5	97	1018.42	6	055
21 July	1158	70°48.300	135°32.580	0.4	99	1017.43	5	034
21 July	2124	80°48.900	134°32.640	0.7	98	1013.44	7	034
23 July	2110	71°00.000	135°26.160	1.8	94	1009.33	13	048
24 July	1240	70°47.340	136°34.320	0.2	99	1009.54	7	030
25 July	0300	70°55.860	136°24.300	1.5	93	1012.72	4	040
25 July	1205	70°55.860	136°16.320	0.6	98	1014.56	8	082
25 July	2103	70°57.600	136°16.320	1.3	94	1016.86	9	120
26 July	1200	70°50.040	136°05.280	2.6	92	1019.48	4	160
26 July	2100	70°39.060	136°27.840	5.2	81	1017.86	16	110

Date in 2009 (GMT)	Time (GMT)	Latitude N	Longitude W	T_{air} (°C)	Relative humidity (%)	Pressure (mb)	Wind Speed (kts)	Wind direction (°true)
27 July	1204	70°38.340	135°06.060	3.8	93	1016.26	17	102

Leg 3a – 27 August to 12 September 2009 – Beaufort Sea

There were 14 balloon launches during Leg 3a (Table 5.8).

Table 5.8. Summary of weather balloon launches during Leg 3a.

Date (GMT)	Time (GMT)	Tair °C	RH (%)	P (mb)	Wind speed (kts)	Wind dir. (°true)
20090829	0250	7.2	97	1003.16	22	90
20090830	2043	0.5	99	1005.55	6	2
20090831	2014	0.2	79	1010.17	7	126
20090902	2144	1.9	95	1010.68	10	111
20090904	0408	0	99	1002.34	16	227
20090904	0623	-0.1	99	1001.27	11	232
20090904	1404	-1.4	93	1001.80	17	273
20090905	1903	-0.3	95	1006.15	17	175
20090906	0017	1.1	99	999.84	19	254
20090907	0607	-0.5	85	1001.82	30	258
20090907	2030	-1	86	1010.22	19	291
20090909	2035	-3.4	93	1018.00	15	66
20090910	2036	-0.5	99	1013.6	20	100

Leg 3b – 12 September to 08 October 2009 – Beaufort Sea

There were 13 balloon launches during Leg 3b, which took place only if winds were less than 25 knots and a helicopter flight was not scheduled at the same time.

Table 5.9. Summary of weather balloon launches during Leg 3b.

Date (UTC)	Time (UTC)	Tair (°C)	RH (%)	P (mb)	Wind speed (kts)	Wind direction (°true)
2009/09/20	20:30	-2.6	85	1018.55	10	052
2009/09/23	20:32	0.6	98	1008.69	18	117
2009/09/24	12:00	2.6	88	1001.45	18	050
2009/09/25	18:40	-2.3	87	1009.58	12	016
2009/09/28	12:00	-4.0	81	1022.26	14	302
2009/09/30	20:37	-3.4	69	1014.51	3	315
2009/10/01	12:00	-6.7	88	1016.78	12	299
2009/10/02	20:30	-3.8	73	1034.23	6	270
2009/10/05	12:00	-1.7	94	1018.56	16	037
2009/10/06	12:50					
2009/10/06	20:55					
2009/10/07	11:55					

Note: The last 3 launches are upcoming launches at the time of the writing of the report.

Leg 4a – 8 October to 6 November – Beaufort Sea, NW Passage, Baffin Bay

There were 11 weather balloon launches during Leg 4a, with no launches after 04 November.

5.3.6 Laser precipitation gauge

A Theis Clima Laser precipitation gauge was mounted approximately 3 m above the foredeck of the ship on the CEOS meteorological tower (Figure 5.10). The instrument analysed precipitation droplets that were intercepted by the laser, and estimated precipitation intensity. All data files were raw text format, and will require post-processing. The end data product will be processed to include UTC date and time, and geographical coordinates.

Figure 5.10. Theis Clima Laser precipitation gauge.

Leg 1b – 30 June to 16 July 2009 – Victoria to Sachs Harbour

The laser precipitation gauge was mounted and running on the micro-meteorological tower at the bow of the ship.

Leg 2a – 16 July to 30 July 2009 – Beaufort Sea
Leg 3a – 27 August to 12 September 2009 – Beaufort Sea

This instrument was fully functional throughout Leg 2a, ran as per normal, and all data was downloaded and backed up.

Leg 3b – 12 September to 8 October 2009 – Beaufort Sea

The laser precipitation gauge was fully functional throughout Leg 3b, with the exception of 02 October 16:00 UTC till 03 October 16:42 UTC when a corrupt data card resulted in the data not being recorded. The instrument was recording the wrong date and time, thus every time the data card was swapped the date and time needed to be recorded in order to manually input the correct date and time during the post-processing. Otherwise the instrument continued to run as per normal, and all data was downloaded and backed up.

Leg 4a – 8 October to 6 November – Beaufort Sea, NW Passage, Baffin Bay

This instrument was fully functional throughout Leg 4a and all data was downloaded and backed up.

5.4 Ocean methodology

5.4.1 Hyperspectral ocean surface reflectance (BaySys only)

Hyperspectral surface measurements for ocean color were conducted at various stations throughout Hudson Bay during the BaySys cruise on the CCGS *Pierre Radisson* (Table 5.10) using a HyperSAS instrument that records 256 channels from 300-800 nm (Figure 5.11).

Figure 5.11. The HyperSAS instrument mounted on the bow of the CCGS *Pierre Radisson* during the BaySys cruise in Hudson Bay in July and August 2009.

During most of the Hudson Bay cruise, conditions were poor for hyperspectral work (cloud cover, fog and ice) limiting data collection. Hyperspectral observations were generally accompanied by surface water samples. True orientation of the ship and geometry of the instrument was recorded for each data acquisition point. Times are given in local ship time (EDT), that was a 4 hour offset with UTC time. Photos of sky and target conditions were also taken at each site.

Table 5.10. HyperSAS log of hyperspectral ocean surface measurements conducted during the BaySys cruise in Hudson Bay onboard the CCGS *Pierre Radisson* in July and August 2009.

Sta tion	Date	time (start)	time (end)	Duration (m:s)	Filename	Instr Ort	Inc Ang	Ship Ort	Comments
PT10	7/28/2009	09:59:37		02:31	Station_PT10_ July2809AA	photo	35	?	cloud 75%, sea state calm
PT10	7/28/2009	10:03:25		03:15	Station_PT10_ July2809AB	photo	35	?	
PT5	7/28/2009	10:34:35		00:42	Station_PT05_ July2809AC	photo	35	70	cloud 60%, sea state calm
PT5	7/28/2009	10:35:08		01:25	Station_PT05_ July2809AD	photo	35	70	cloud 60%, sea state calm
PT5	7/28/2009	10:37:05		03:26	Station_PT05_ July2809AE	photo	35	87	cloud 60%, sea state calm
709	7/29/2009	10:01:00		02:00	Station_709_AA	300	40	335	James Bay, 2nd CTD station, computer time one hour earlier (CDT). 100% cloud, foggy, visibility 300m scattered ice (see photos). ES sensor drops occasionally
709	7/29/2009	10:03:19		02:44	Station_709_AB	300	40	326	
HB01	7/30/2009	12:57:35	13:02:45	05:10	Station_HB01_AA	0	40	0	north of JB, heavy ice,

Sta tion	Date	time (start)	time (end)	Duration (m:s)	Filename	Instr Ort	Inc Ang	Ship Ort	Comments
									good vis, 100 overcast
HB01	7/30/2009	13:03:13	13:05:55		Station_HB01_AB	0	40	4	2 w ater bottles collected
HB01	7/30/2009		13:10:20		Station_HB01_AB	0	40	320	UTC 17:10:20
HB01	7/30/2009		13:10:42	07:27	Station_HB01_AB	0	40	320	
HB01	7/30/2009	13:11:51			Station_HB01_AC	0	40	320	
HB01	7/30/2009		13:15:01		Station_HB01_AC	0	40	319	
HB01	7/30/2009		13:15:21		Station_HB01_AC	0	40	316	
HB01	7/30/2009		13:15:49		Station_HB01_AC	0	40	310	
HB01	7/30/2009		13:16:10		Station_HB01_AC	0	40	305	
HB01	7/30/2009		13:16:27		Station_HB01_AC	0	40	300	
HB01	7/30/2009		13:17:03		Station_HB01_AC	0	40	296	
HB01	7/30/2009		13:18:14		Station_HB01_AC	0	40	296	57 05.522N; 81 55.549W
HB01	7/30/2009		13:18:55		Station_HB01_AC	0	40	296	
HB01	7/30/2009		13:19:28	08:28	Station_HB01_AC	0	40	296	stop
HB01	7/30/2009	13:23:44			Station_HB01_AD		40	348	continuous overcast, vis 24k, starting to breakup to east, very occasion w hit caps
HB01	7/30/2009		13:31:05	07:19	Station_HB01_AD				
705	08/02/2009	08:51:40		03:52	Station_705_AA	45	40	184	100% overcast, foogy
715	08/02/2009	11:11:54		02:38	Station_715_AA	340	40	287	near nelson, overcast, patchy fog winds low, rippled surf ace, wavelets
715	08/02/2009	11:02:23		00:51	Station_715_AB	340	40	295	bottles (5,3)
715a	08/02/2009	14:11:05	14:20:15	09:13	Station_715a_AA	57.25	40	285	57 21.519N; 92 01.497W; helicopter launch in progress; overcast isolated ice, fog cleared
715a	08/02/2009	15:10:30			Station_715a_AB	22.5	40	56	57 21.482N, 92 01.566W, continuous cloud cover
715a	08/02/2009		15:12:25		Station_715a_AB			49	
715a	08/02/2009		15:14:15		Station_715a_AB	310	40	52	changed instrument orientation, ice moving in
715a	08/02/2009		15:19:10		Station_715a_AB	310	40	55	
715a	08/02/2009		15:21:26		Station_715a_AB	310	40	61	
715a	08/02/2009		15:23:15		Station_715a_AB	310	40	56	
715a	08/02/2009		15:24:30	14:00	Station_715a_AB		40		end
715a	08/02/2009	15:27:04			Station_715a_AC	25	40	50	
715a	08/02/2009		15:29:00		Station_715a_AC	40	40	330	
715a	08/02/2009		15:31:25	04:29	Station_715a_AC	45	40	330	stopped logging, ice moving in
713	08/03/2009	09:00:53	09:06:00	05:00	Station_713_AB	30	40	333	overcast, foggy, windy, small waves, vis 400-600m
713	08/03/2009	09:06:01	09:09:00	03:00	Station_713_AC	30	40	333	
713	08/03/2009	09:10:02	09:11:02	01:00	Station_713_AD	310	40	333	terminated, ice
713	08/03/2009	09:14:15	09:19:15	05:00	Station_713_AE	310	40	325	
705	08/03/2009	17:13:27	17:15:13	01:56	Station_705_AA	55	40	122	overcast, foggy, windy, small waves, vis 400-600m
705	08/03/2009	17:18:18	17:20:40	02:16	Station_705_AB	55	40	75	
705	08/03/2009	17:21:30	17:23:13	01:41	Station_705_AC	2	40	82	
714	08/03/2009	18:56:30	18:57:30	01:00	Station_714_AA	42	40	105	cloudy, fog, wind
714	08/03/2009	18:57:50	18:58:38	00:52	Station_714_AB	42	40	105	

5.4.2 HyperOCR and CTD Profiling

The Hyperspectral Ocean Colour Radiometer (HyperOCR) is the first of Satlantic's new line of precision optical sensors which provide 136 channels of factory-calibrated optical data in the spectrum of 350 to 800 nm. These sensors were deployed into seawater in the marginal ice zone with Profiler 2, the design of which builds on Satlantic's previous generations of profiling instrumentation. It recorded vertical profiles of downwelling irradiance, upwelling radiance in water as well as reference irradiance in air.

CTD profiles of the water column were conducted using an Ocean Seven 304 CTD that measured conductivity, temperature and density of the ocean surface-mixed layer (0–50 m).

<u>Leg 2a – 16 July to 30 July 2009 – Beaufort Sea</u>

The profiler was deployed at 9 stations during Leg 2a, for a total of 26 profiles of downwelling irradiance, upwelling radiance in water as well as reference irradiance in air (Table 5.11). The Ocean Seven 304 CTD was deployed once with an Alec PAR sensor, an ultra-miniature light intensity recorder, immediately following HyperOCR deployments. No PAR sensor data was collected at Stations 7, 20, or 21.

Table 5.11. Summary of CTD, PAR and HyperOCR measurements conducted during Leg 2a.

Station ID	Cast #	Date in 2009 (UTC)	Time (UTC)	Latitude N	Longitude W
01	01	07-08	1630	70°29.030	135°11.214
14	02	07-09	0000	70°34.825	135°57.278
17	03	07-20	1400	70°37.170	136°32.390
10	04	07-21	1430	70°47.310	135°33.300
21	05	07-22	1522	71°01.221	134°37.336
20	06	07-23	1548	71°00.941	135°20.775
16	07	07-24	1530	70°47.246	136°40.564
07	08	07-25	1600	70°59.270	136°08.333
12	09	07-27	1554	70°38.196	135°05.173

<u>Leg 3a – 27 August to 12 September 2009 – Beaufort Sea</u>

The hyperOCR was not deployed during Leg 3a. Five CTD casts were performed at Station L2, in an area of rotten first-year ice.

<u>Leg 3b – 12 September to 8 October 2009 – Beaufort Sea</u>

The profiling Hyperspectral Ocean Colour Radiometer (HyperOCR) was deployed at 3 stations in Leg 3b for a total of 17 casts (Table 5.12). This optical ocean profiler collected spectra over 350-800 nm using 256 channels. The casts were done from the Zodiac and the profiles extended to 60 m depths. Besides the hyperspectral data, the instrument also collected fluorescence and CTD data.

Table 5.12. List of HyperOCR casts performed during Leg 3b.

Site	Date in 2009 (UTC)	Time (UTC)	Latitude N	Longitude W	Data files
01	09-25	15:00	70°41.0	136°10.1	0925AA.raw; 0925AB.raw; 0925.txt
02	09-26	14:00	70°39.5	136°05.6	0926AA.raw; 0926AB.raw; 0926AC.raw; 0926AD.raw; 0926AE.raw; 0926AF.raw; 092602AA.raw; 092602AC.raw; 092602AD.raw
03	09-29	14:30	70°37.60	136°00.75	0929AB.raw; 0929AC.raw; 0929AD.raw; 0929AE.raw; 0929AF.raw; 0929AG.raw; 0929.txt

5.4.3 Meteorological-ocean buoys (MOBS)

The MOBS buoys measured the 3-dimensional wave-spectrum via accelerometers, and surface winds through a sonic anemometer.

Leg 2a – 16 July to 30 July 2009 – Beaufort Sea

Five buoy deployments were performed using the Zodiac, away from the influence of the ship (Figure 5.12). Deployment opportunities were limited to short periods (1.5 to 2 hours) during the optics program sampling. As a result, the data sets available from these deployments are very limited, but are representative of the relatively small sea surface roughness encountered in the Ajurak block arising from high sea ice concentrations, and predominantly light winds. Future MOBS buoy deployments are planned to be for longer durations during full-stations with open water (Legs 3b and 4a).

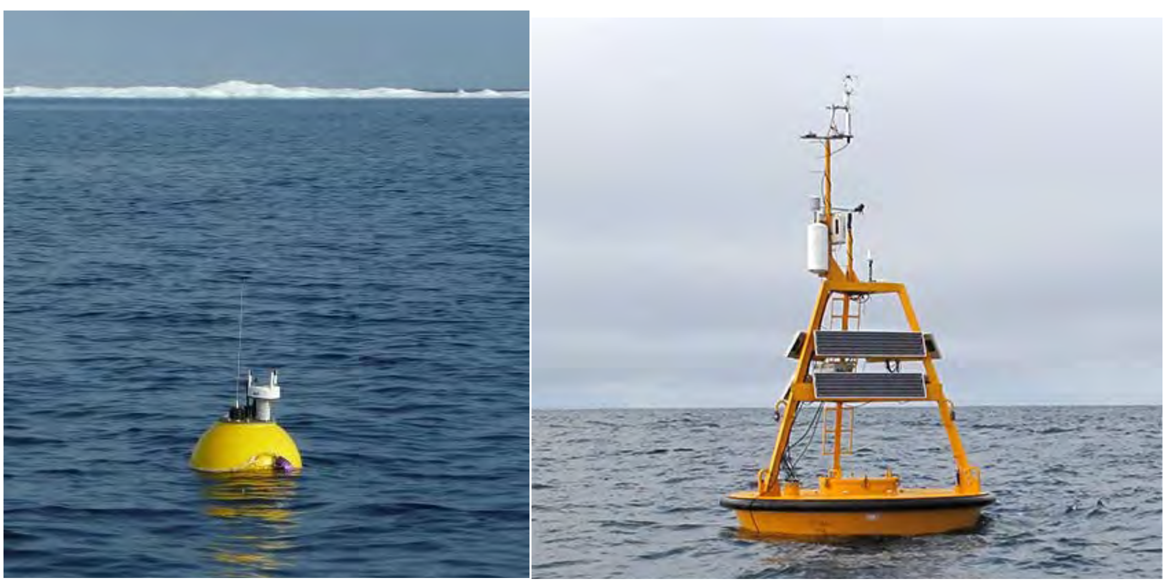

Figure 5.12. Left: Meteorological-ocean buoys (Datawell Meteorological Ocean Buoy, MOB) deployed during Legs 2a and 3b. Right: Met/Ocean 3 m discus buoy with AXYS©, TriAXYS OEM motion sensor deployed during Leg 3b.

Table 5.13. Summary of MOBS buoy deployments during Leg 2a.

Station ID	Cast #	Date in 2009 (UTC)	Time (UTC)	Latitude N	Longitude W
17	03	07-20	1400	70°37.170	136°32.390
10	04	07-21	1430	70°47.310	135°33.300
21	05	07-22	1522	71°01.221	134°37.336
20	06	07-23	1548	71°00.941	135°20.775
16	07	07-24	1530	70°47.246	136°40.564
12	09	07-27	1554	70°38.196	135°05.173

<u>Leg 3a – 27 August to 12 September 2009 – Beaufort Sea</u>

One MOB buoy was deployed 4 times during Leg 3a, either from the Zodiac or from the ice cage on the ship. Deployment opportunities were limited, but occurred for extended periods (4 to 10 hours) during the optics sampling program. Deployments of the MOBS buoy are summarized in Table 5.14.

Table 5.14. Summary of MOBS buoy deployments during Leg 3a.

Date	Station	Latitude N	Longitude W
Aug 29, 2009	-	69° 29.823	137° 58.589
Aug 30, 2009	S2	69° 58.877	138° 27.500
September 5, 2009	L2	74° 23.994	136° 25.605
September 9, 2009	L11	72° 30.816	136° 44.479

<u>Leg 3b – 12 September to 8 October 2009 – Beaufort Sea</u>

Ocean surface roughness measurements (sea state) were made using the MOB from Datawell (Figure 5.12). This data was intended to supplement the sea state data collected using AXYS®, TriAXYS OEM motion sensor located on the Met/Ocean 3 m discus buoy (Figure 5.12) (see Sections 3 and 6 for more details on the Met/Ocean buoys program). The MOB was deployed only once (Table 5.15) because of the operational constraints of this leg.

Table 5.15. MOB deployment during Leg 3b.

Ship date	Average $H_{1/3}$ (cm)	Latitude N	Longitude W
September 29, 2009	30.7	70° 37.359	136° 01.086

5.5 Preliminary results

5.5.1 Helicopter EMI surveys

<u>Leg 2a – 16 July to 30 July 2009 – Beaufort Sea</u>

Helicopter EMI survey was conducted at Station 5 in the morning of 28 July, starting at 8:46 local time (14:46 UTC) and ending at 10:48 local time (16:48 UTC). A total of seven floes were sampled with a total of 40 separate sampling transects. Data for two of the seven floes are presented in Table 5.16 and Figure 5.13 and 4.14 with photos along taken while surveying which will be used to characterize the ice conditions along each transect.

Table 5.16. EMI surveys at Floes 2-05 and 6-05 with the six transects sampled at each floe during Leg 2a.

Transect #	Start location		End location		Mean ice thickness (m)
	Latitude N	Longitude W	Latitude N	Longitude W	
Floe 2-05					
1	70°51.960	135°21.600	70°53.160	135°18.000	1.849
2	70°53.220	135°18.000	70°51.840	135°22.800	1.593
3	70°51.900	135°22.800	70°53.340	135°18.600	1.396
4	70°53.580	135°18.600	70°52.020	135°23.400	1.746
5	70°52.020	135°23.400	70°53.820	135°19.200	1.861
6	70°53.820	135°19.200	70°52.320	135°24.600	1.778
Floe 6-05					
1	70°55.380	135°43.200	70°53.340	135°43.200	2.704
2	70°54.900	135°42.600	70°55.620	135°42.600	2.135
3	70°55.500	135°42.300	70°53.700	135°42.300	2.822
4	70°54.000	135°41.700	70°55.500	135°41.400	2.545
5	70°55.500	135°41.100	70°53.700	135°41.100	2.802
6	70°54.000	135°40.800	70°55.500	135°39.900	3.254

Ice thickness values in Table 4.16 are approximations based on the data collected. Ice roughness values were not available due to the number of transects acquired and will be processed at a later date.

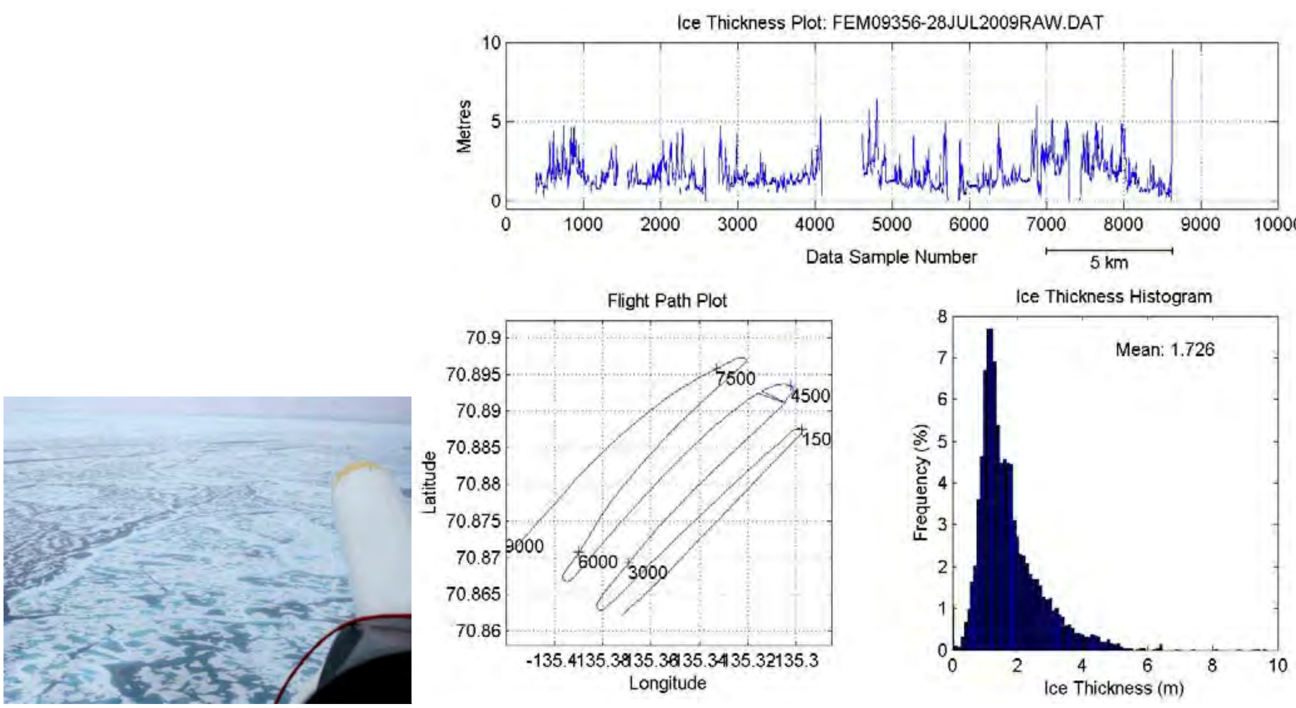

Figure 5.13. Photo of Floe 2-05 sampled on 28 July during Leg 2a and output showing the helicopter flight path over the six transect lines for Floe 2-05 with the raw ice thickness data.

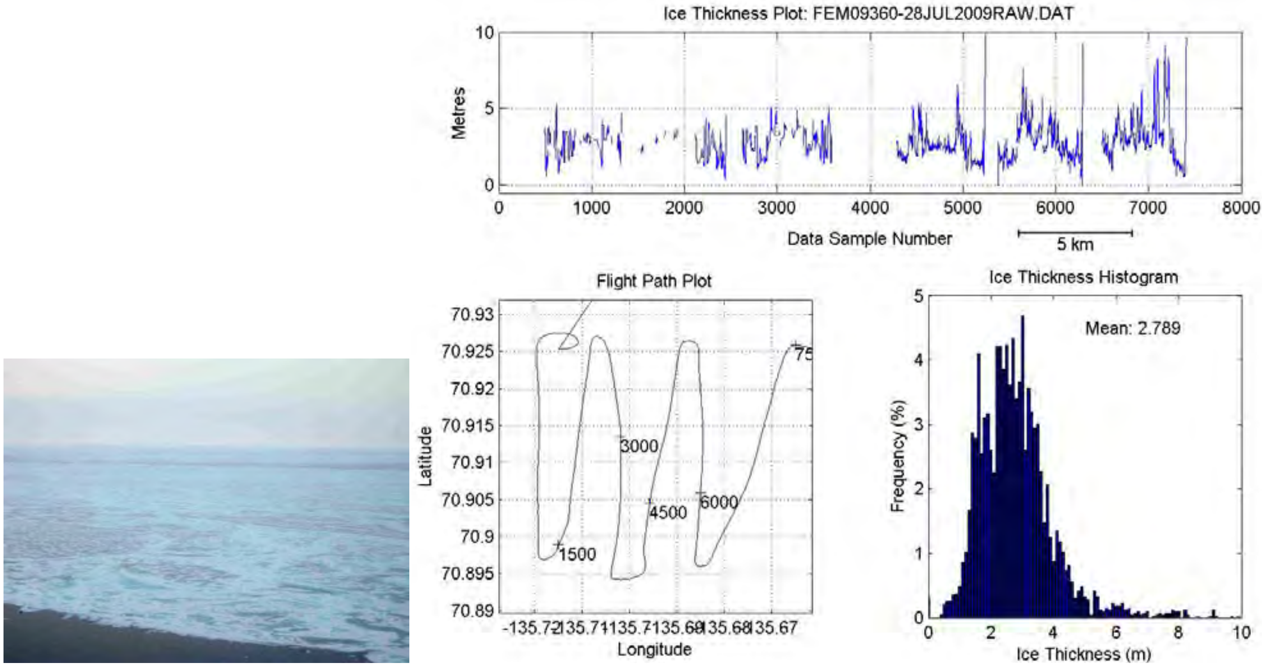

Figure 5.14. Photo of Floe 6-05 sampled on 28 July during Leg 2a and output showing the helicopter flight path over the six transect lines for Floe 6-05 with the raw ice thickness data.

Leg 3a – 27 August to 12 September 2009 – Beaufort Sea

A before and after comparison of ice conditions following the cyclone-induced swells in the Beaufort Sea during Leg 3a is presented in **Error! Reference source not found.**.

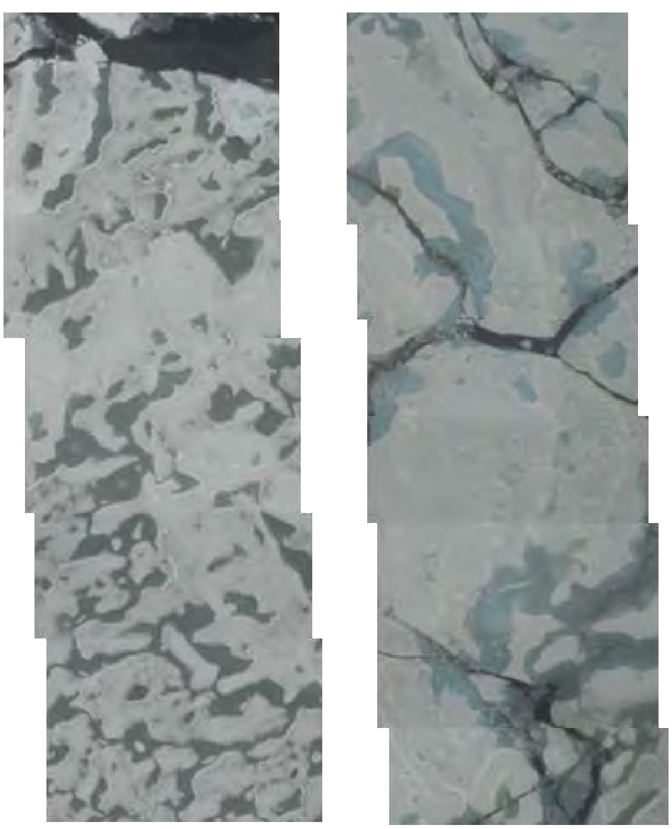

Figure 5.15. Left: Mosaic-video frame 59360 from F121 6 September at 11:02 (Leg 3a). Video and Mosaic width are140 m and direction flown was from North to South. No cracks in this old ice floe which flat ice section was 2 m thick.   Right: Mosaic-Video frame starting 59638 from file F123 of 6 September at 13:00. The video frame and Mosaic width is 110 m. The thick ice (2 m in flat sections) now has cracks that aligned perpendicularly to swell direction running from NW to SE. Cracks (max) spacing is around width of video frame or 110 m.

The left panel shows a large floe section from Mosaic-video frame **59360** from file F121 taken on 6 September at 11:02 (74°28.35' N, 133°28.332' W) while flying at 130 m height so that Video and Mosaic width shown are 140 m. At the time the video was taken while flying N to South and with NW wind that caused the video frame offset. The second Mosaic (right panel) 2 hours later shows cracks even in the thicker ice. This Mosaic-Video frame **59638** from file F123 was taken on 6 September at 13:00 (74°26.64' N, 133°20.020' W) at a flying height of 100 m and Video and Mosaic width 110 m while flying to NE.

Below are presented preliminary results of the ice beacon deployments and HEMI sampling that took place on 4 September and 8 September during Leg 3a.

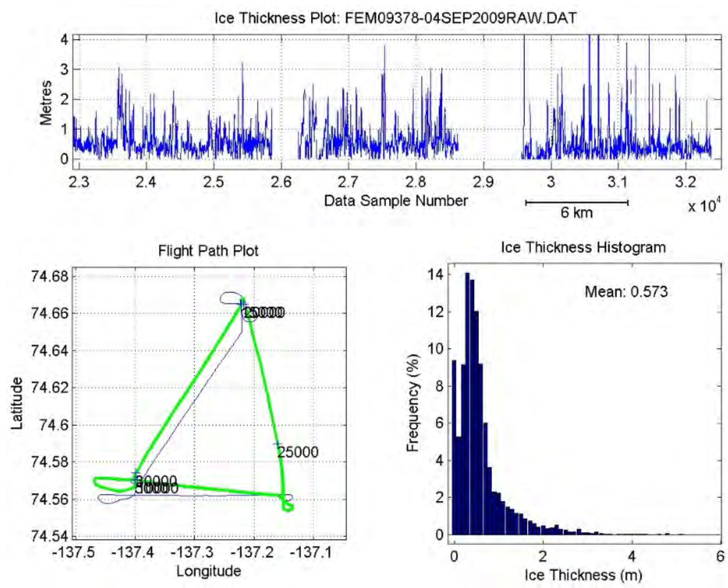

Figure 5.16. Triangular beacon deployment for 4 September showing transect thickness, coordinates, and thickness histogram.

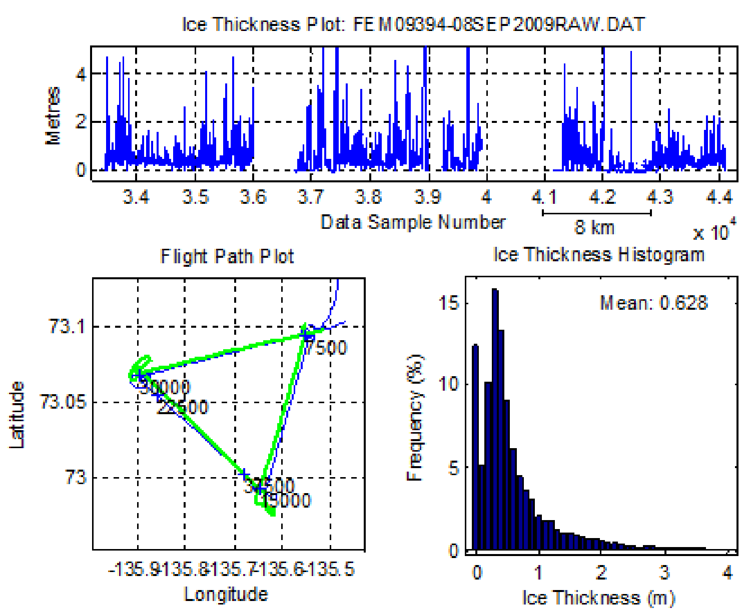

Figure 5.17. Triangular beacon deployment for 8 September (morning) showing transect thickness, coordinates, and thickness histogram.

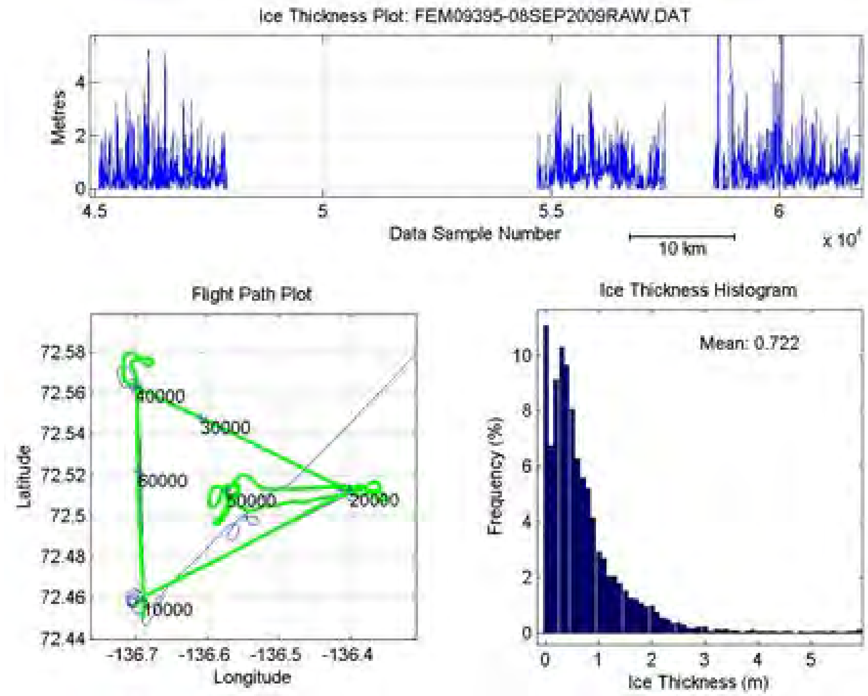

Figure 5.18. Triangular beacon deployment for 8 September (afternoon) showing transect thickness, coordinates, and thickness histogram.

Leg 3b – 12 September to 08 October 2009 – Beaufort Sea

Helicopter EMI transect results obtained during leg 3b are shown in Figure 5.19 to 4.21.

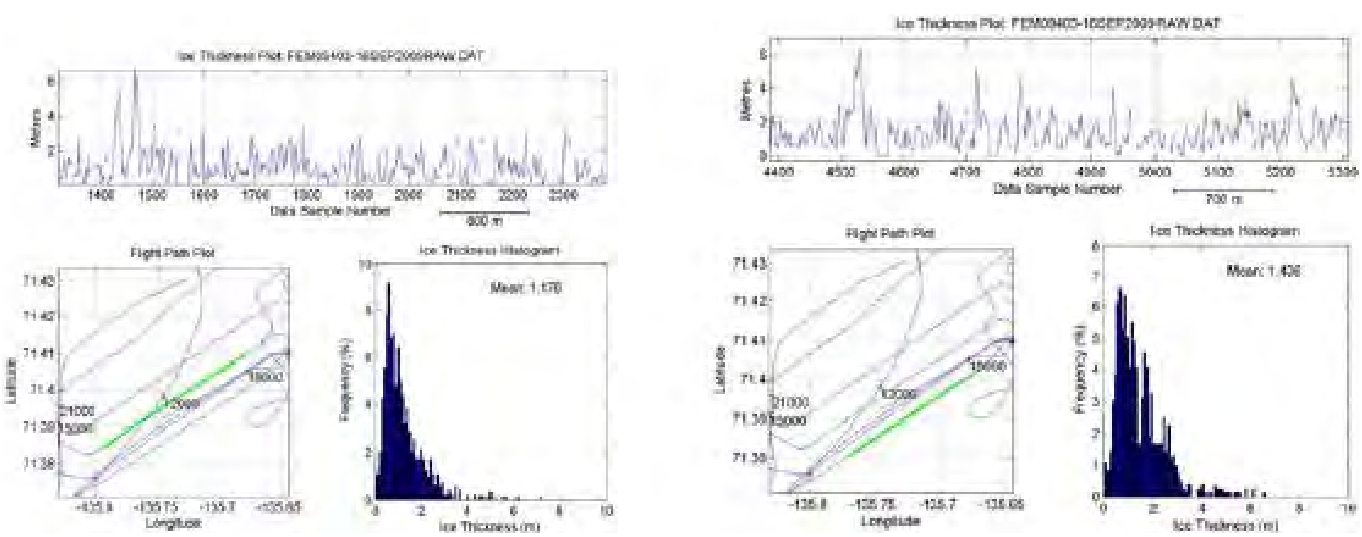

Figure 5.19. Unconsolidated first year ice, ice thickness profile and frequency distribution for the EMI flight of 16 September on Leg 3b. Left: Floe 1, Transect 1, Right: Floe 1, Transect 2.

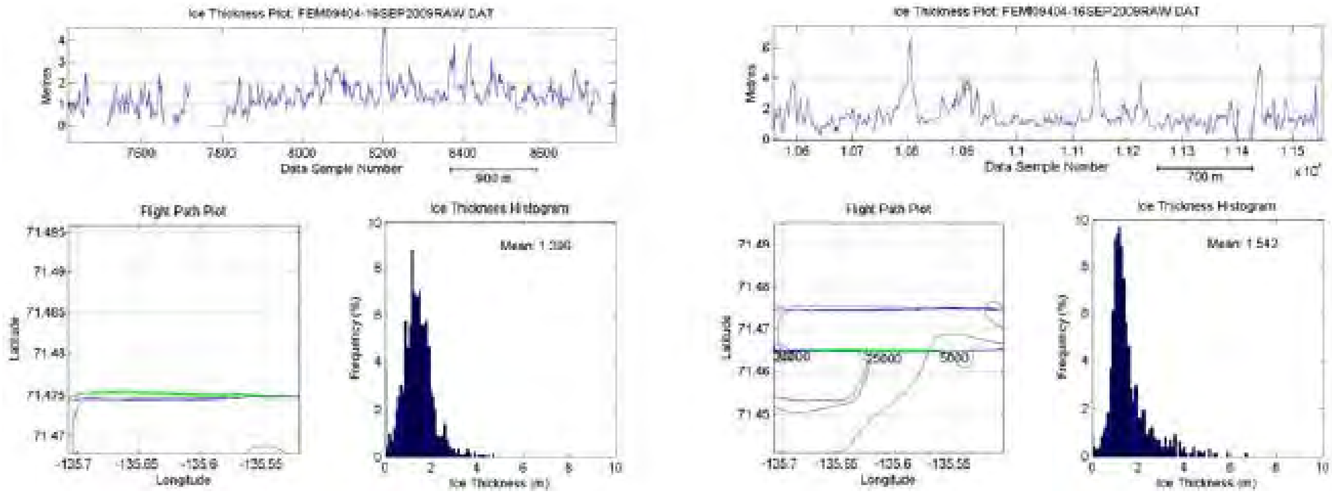

Figure 5.20. Consolidated first year ice, ice thickness profile and frequency distribution for the EMI flight of 16 September on Leg 3b. Left: Floe 2, Transect 1, Right: Floe 2 Transect 2.

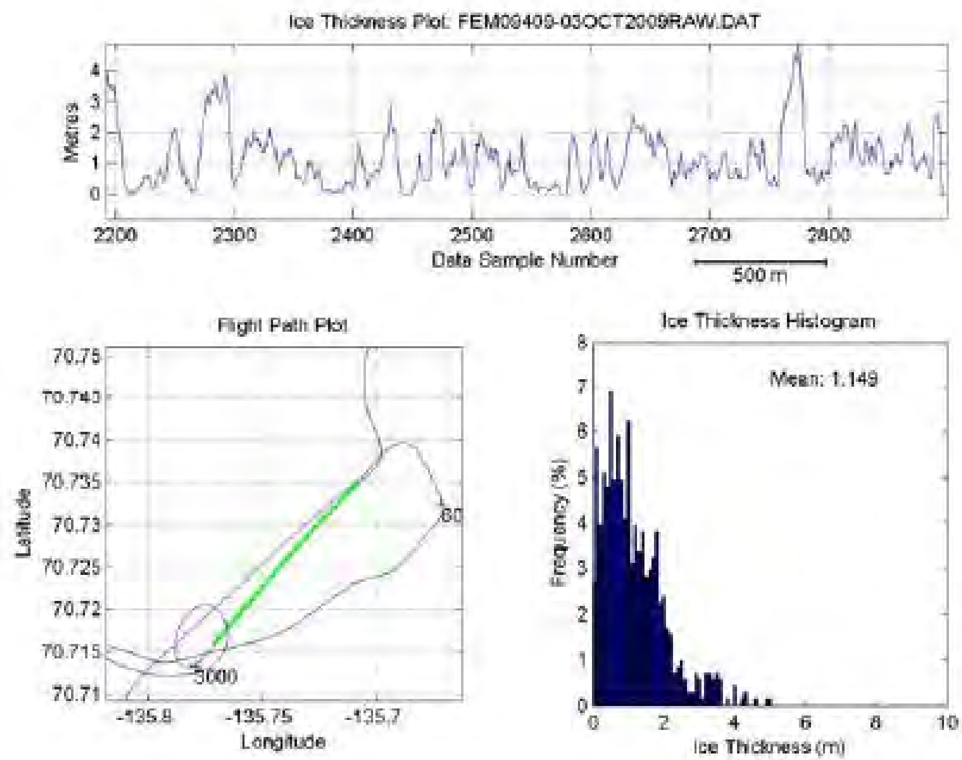

Figure 5.21. Second-year floe ice thickness profile and frequency distribution for the EMI flight of 2 October on Leg 3b.

5.5.2 Ship-based EM measurements

Examples of VV and HH polarization for first-year ice, and old ice collected during Leg 3a are shown in Figure 5.22.

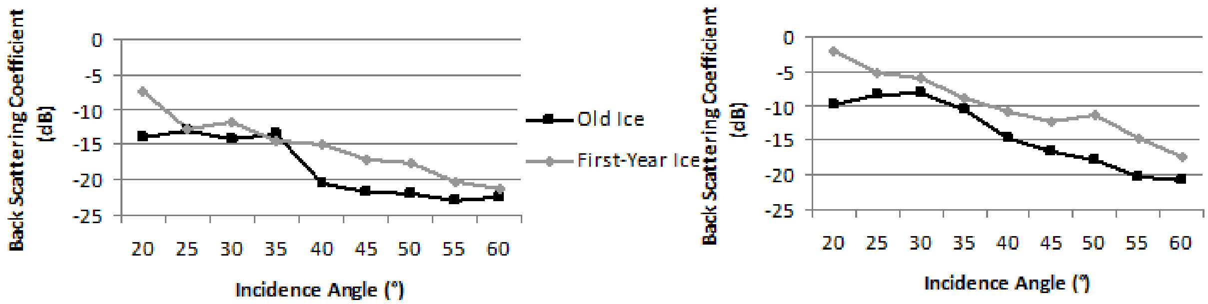

Figure 5.22. VV polarization (left) and HH polarization (right) comparison of first-year ice to old ice from data collected during Leg 3a.

5.5.3 Microwave profiler data

Results from the microwave profiler over a period of 3 days, from 27 to 29 July (Leg 2a), at altitude ranging from 0 to 2 km (Figure 5.23), show a prominent temperature inversions aloft, and corresponding increases in water vapour content. Liquid water signatures were weak, but visible at this scale.

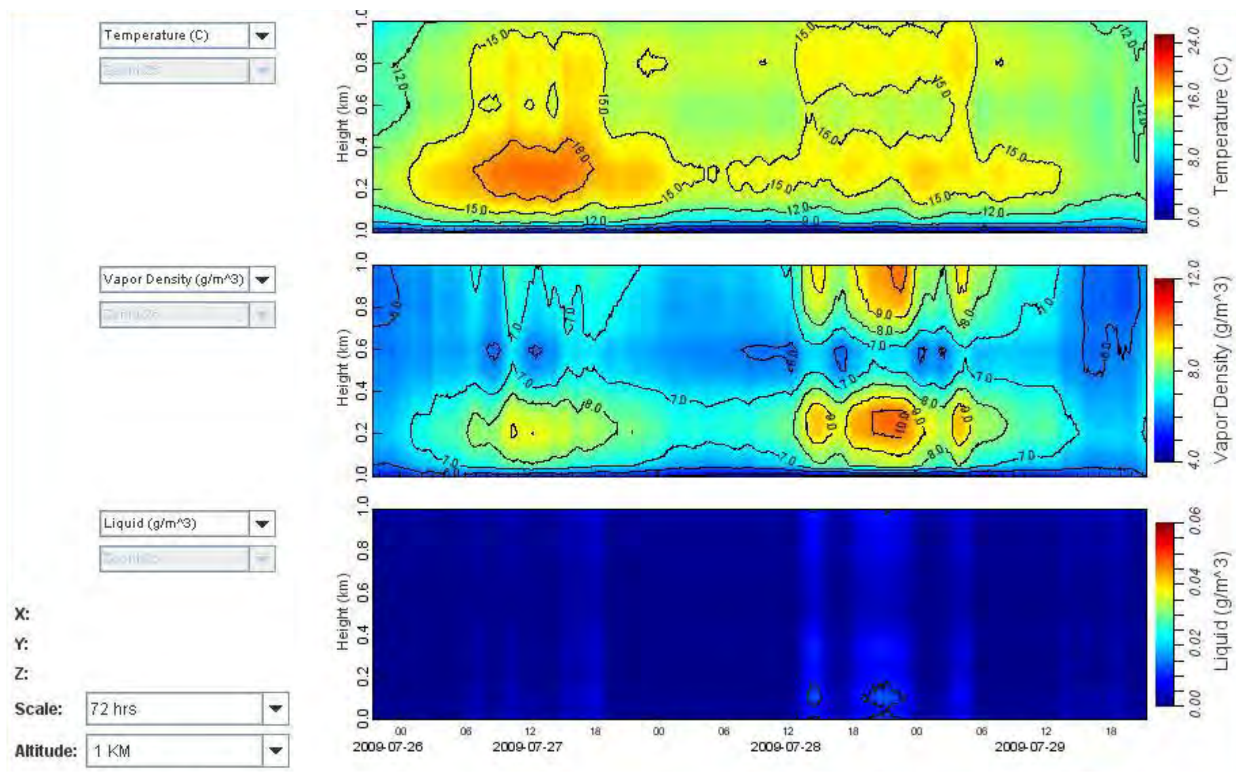

Figure 5.23. Microwave profiler control and monitoring software showing 3 days (27 to 29 July in Leg 2a) of temperature (top), water vapour (middle) and liquid water content (bottom) data at altitude from 0 to 2 km.

5.5.4 Water column profiles

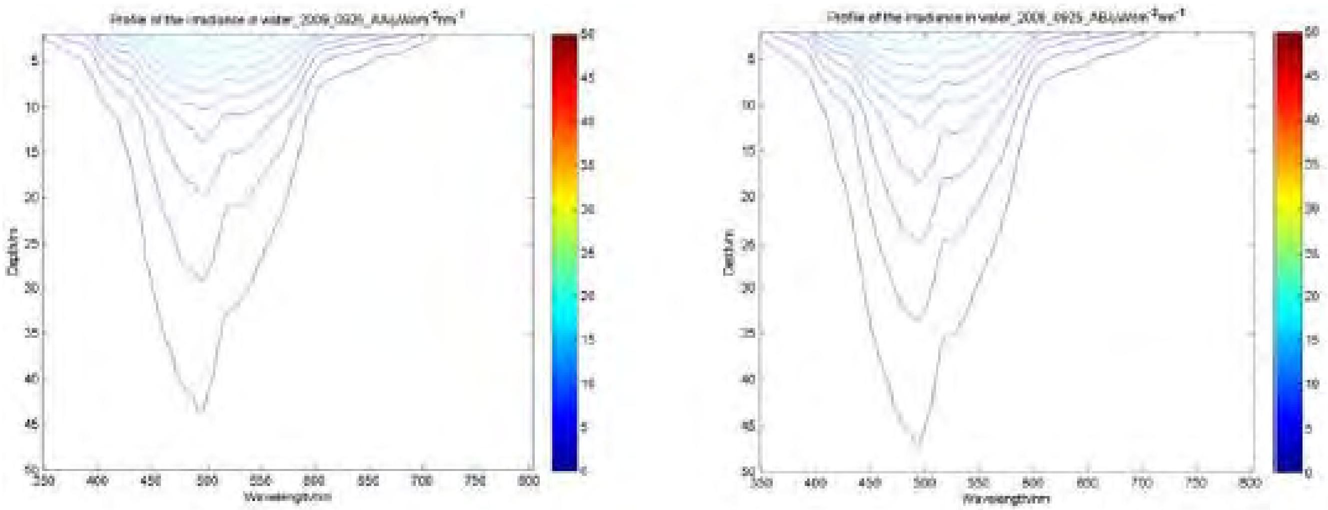

Figure 5.24. HyperOCR vertical profiles of irradiance spectra obtained during Leg 3b.

5.6 Comments and recommendations

Data collection was proceeding as planned with no major unresolved issues during Leg 2a. Unfortunately, due to a lack of available berths, ice monitoring program and balloon launches were suspended during Leg 2b and sampling activities resumed on Leg 3a and continued until the end of Leg 4a.

6 Sea ice sampling for chemical parameters (GEOTRACES) – Leg 3a

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6.1 Methodology

Sampling for inorganic and organic carbon parameters from sea ice was conducted opportunistically as part of a joint Geotraces & ArcticNet effort. When possible, cores of multi-year and 1st year ice were obtained and sectioned for the analyses of chemical tracer concentrations (DIC/TALK, ^{13}C-DIC, ^{13}C-POC, ^{18}O, ^{13}C-TOC, Salinity & NH_4) as per Table 6.1. Once cores were removed from the ice floe, they were cut with a hand saw into 2x10 cm sections and placed in gas tight Tedlar bags. Once bags were sealed the head space was carefully removed using a Nalgene hand pump. Core sections were left to melt in the dark at room temperature in the Paleolab (~24 hours) and were then sampled through the use of a drawing tube off the side of the Tedlar bag.

In addition to the bulk sea ice property samples, a small 230 volt Quiet One 800 aquarium pump was used to draw seawater from under the ice through the core hole at a depth of 150 cm. This water was collected in a clean (3x rinsed) 10 L cubetainer and sampled for various chemical parameters once back on the ship (DIC/TALK, ^{13}C-DIC, ^{13}C-POC, ^{18}O, ^{13}C-TOC, Salinity & NH_4) as per Table 6.1. Stations for chemical analyses within multi-year and 1st year ice were occupied adjacent to Stations L1, L2 & L1.1 visited during the GEOTRACES campaign in Leg 3a.

6.1.1 Ikaite ($CaCO_3 \cdot 6H_2O$) precipitation in multi-year sea ice

The temperature core from L1 (1 September) was saved in the -10°C cooler to sample for the presence of Ikaite mineral precipitates ($CaCO_3 \cdot 6H_2O$) in the multi-year pack ice. Looking at the temperature/salinity profile from the core, it was expected that the ice was too warm to have retained enough brine or even maintain a stable precipitate; however the core was processed anyway to practice the method. Since the core was so warm, it was thought that any dissolved $CaCO_3 \cdot 6H_2O$ still in the brine (if any brine was left) might re-crystallize at low temperature. The core was therefore left in the -10°C lab for 2.5 days before processing. Seven 10-cm sections of the core with highest salinity were chosen and cut from Core 3 in the -10°C cold room and placed in clean (new) 1-L plastic beakers and covered in Parafilm for melting. The seven selected sections were then taken to the 4°C container on the helideck (actual temperature was maintained between 6.5-8°C) and slowly melted in an open Coleman cooler. After 11 hours of melting, samples were checked for melt progress every 5 hours and then more frequently once melt had progressed to ~90%;

temperature in the container and in the cooler were both recorded on each check of melt progress. Once samples were virtually completely melted, they were taken down to the filtration set up in the aft labs and evaluated for the presence of Ikaite crystals following Dieckmann et al. (2008). Although no Ikaite crystals are presumed to have been successfully isolated, samples of the collected particulates from the melts were saved on pre-weighted pre-combusted GF/F filters (ethanol washed) or preserved in 75% ethanol in cryovials in the -80°C freezer for possible analysis (or method tests) later in the lab.

Table 6.1. Sea ice cores and under-ice pumping samples collected in multiyear ice floes during Leg 3a.

Station	Lat	Lon	Date	Time	Sample	Depth of Sample	13C-POC	DIC/TALK	13C-DIC	13C-TOC	18O	salinity	NH4
L1	71.019	139.00458	31-Aug-09	14:00	T & S Cores	Full Cores						x	
L1	71.12749	139.20603	01-Sep-09	7:45	Core Section 1	37-59cm		x	xx	x	x	x	x
L1	71.12749	139.20603	01-Sep-09	7:45	Core Section 2	115-135cm		x	xx	x	x	x	xx
L1	71.12749	139.20603	01-Sep-09	7:45	Core Section 3	172-192cm		x	xx	x	x	x	xx
L1	71.12749	139.20603	01-Sep-09	7:45	Core Section 4	240-260cm		x	xx	x	x	x	x
L1	71.12749	139.20603	01-Sep-09	7:45	Core Section 5	337-357cm		x	xx	x	x	x	x
L1	71.12749	139.20603	01-Sep-09	7:45	Core Section 6	403-423cm		x	xx	x	x	x	xx
L1	71.12749	139.20603	01-Sep-09	7:45	Core Section 7	bottom 20		x	xx	x	x	x	x
L1	71.019	139.00458	31-Aug-09	14:00	PUMP 1	130cm	x	xx	xx		xx	xx	
L1	71.019	139.00458	31-Aug-09	14:00	PUMP 2	130cm	xx	xx	xx		xx	xx	
L1	71.12749	139.20603	01-Sep-09	7:45	PUMP 3	150cm	xx	xx	xx		xx	xx	
L2	74 38.793	137 21.128	03-Sep-09	19:15	Hand picked	surface		x	xx	xx	x	x	xx
L2	74 38.793	137 21.128	03-Sep-09	19:15	Hand picked	surface		x	xx	xx	x	x	xx
L2	74 38.793	137 21.128	03-Sep-09	19:15	Hand picked	surface	x						
L2	74 38.793	137 21.128	03-Sep-09	19:15	Hand picked	surface	x						
L2	74 34.87	137 04.88	04-Sep-09	11:50	Core Section 1	20-40cm		x	xx	xx		x	x
L2	74 34.87	137 04.88	04-Sep-09	11:50	Core Section 2	40-60cm		x	xx	xx	x	x	x
L2	74 34.87	137 04.88	04-Sep-09	11:50	Core Section 3	60-80cm		x	xx	x		x	x
L2	74 34.87	137 04.88	04-Sep-09	11:50	Core Section 4	80-97cm		x	xx	xx		x	x
L2	74 34.87	137 04.88	04-Sep-09	11:50	Core Section 5	100-120cm		x	xx	xx	x	x	x
L2	74 34.87	137 04.88	04-Sep-09	11:50	Core Section 6	bottom 15cm		x	xx	x	x	x	x
L2	74 31.6	135 45.5	04-Sep-09	18:30	Core Section 1	bottom 60cm	x				x		
L2	74 31.6	135 45.5	04-Sep-09	18:30	PUMP 1	105cm	x	x	xx	xx	x	x	xx
L11			10-Sep-09		Core Bottom	bottom 60cm	x				x		
L11			10-Sep-09		PUMP 3	150cm	x	x	xx	xx	x	x	xx
L11			10-Sep-09		Core Section 1	20-40cm		x	xx	xx	x	x	x
L11			10-Sep-09		Core Section 2	51-71cm		x	xx	xx	x	x	x
L11			10-Sep-09		Core Section 3	96-116cm		x	xx	xx	x	x	xx
L11			10-Sep-09		Core Section 4	138-158cm		x	xx	xx	x	x	xx
L11			10-Sep-09		Core Section 5	172-192cm		x	xx	xx	x	x	xx
L11			10-Sep-09		Core Section 6	bottom 20		x	xx	xx	x	x	x
L11			10-Sep-09		PUMP 2	150cm	x	xx	xx		xx	x	x
L11			10-Sep-09		Core Bottom	bottom 60cm	x				x		

7 Mooring program – Legs 2a and 3b, BaySys and Hudson Strait

ArcticNet Phase 2 – Project titled *Long-Term Observatories in Canadian Arctic Waters*.
ArcticNet/Phase2/Gratton_Marine_observatories

Project leaders: Yves Gratton[1] (yves_gratton@ete.inrs.ca) and Imperial Oil (Legs 2a and 3b)
***CCGS Amundsen* operations participants Legs 2a and 3b**: Imperial Oil, Luc Michaud[2], Pascal Massot[2], Frédéric St-Germain[2], Sylvain Blondeau[2], Jean Ouellet[2], Steeve Gagné[2] and Vincent Dupuis[2]
CCGS *Pierre Radisson* operations participants BaySys: Steeve Gagné[2] and Vincent Dupuis[2]
***R/V Knorr* operations participants (Hudson Strait)**: John Kemp[4] and Fiammetta Straneo[4]
2009 ArcticNet Mooring Report author: Shawn Meredyk[3]

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[3] *ArcticNet, Pavillon Alexandre-Vachon local 4081, 1045 avenue de la Médecine, Université Laval, Québec, QC, Canada, G1V 0A6, Canada.*
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7.1 Introduction

2009 is the sixth year of ArcticNet, a Network of Centres of Excellence of Canada that brings together scientists and managers in the natural, human health and social sciences with their partners from Inuit organizations, northern communities, federal and provincial agencies and the private sector to study the impacts of climate change in the coastal Canadian Arctic. The ArcticNet program was created in 2004 to assess the effects of ongoing warming and modernization on Canadian Arctic ecosystems, economies and societies. An important part of the ArcticNet program includes the monitoring and study of biological, chemical and physical components of the coastal Canadian Arctic seas.

ArcticNet's 2009 mooring operations were carried out from the CCGS *Amundsen* from 17 to 30 July (Leg 2a; 0902) and from 12 September to 8 October (Leg 3b; 0903). ArcticNet mooring operations were also conducted in Hudson Bay within the framework of the BaySys program aboard the CCGS *Pierre Radisson* from 27 July to 5 August.

7.1.1 Beaufort Sea mooring program

The mooring operations in the Beaufort Sea during Legs 2a and 3b were a partnership between several interested parties. The two petroleum giants Imperial Oil Limited (IOL/ESSO) and British Petroleum (BP) were awarded exploration leases in the Beaufort Sea by the Canadian government and contracted ASL to design and deploy two mooring arrays in their two respective Exploration Lease Blocks. ArcticNet mooring personnel were also involved in these mooring operations.

In addition to the lease block moorings, the petroleum companies, environmental consultants (ASL), DFO, NRCan, ArcticNet and others collaborated to deploy two more moorings (D-09 and E-09) for the *Nahidik* Program, carried out from the CCGS *Nahidik*. The program was initiated and supervised by the Department of Fisheries and Oceans (DFO), Winnipeg. Primary goal of the *Nahidik* program was to study shallow marine ecosystems particularly in the Canadian Beaufort Sea. Each summer (2005-2009), sets of samples were collected along the environmental gradients in order to reveal spatial and temporal variability of both oceanographic and biological phenomena. The outcome of this work will serve to better understand the biodiversity, taxonomical composition and abundance of zooplankton and the complex Beaufort Sea ecosystem in terms of relationships between fish occurrence/densities and zooplankton ecology, benthic ecosystem, physical oceanography, etc. These results will provide the necessary components for the environmental impact assessment concerning pipeline and drilling operations.

Another ancillary program that involved the deployment and recovery of moorings (floating buoys) was the France-Canada program Malina conducted in the Beaufort Sea in Leg 2b. Malina scientists deployed three floating moorings each for 24-hour sampling periods. There are no documented reports concerning these deployments on the *Amundsen* but the operations were reported to have been successful, the buoys were retrieved, and the sediment trap data, current profilers and ARGOs (GPS) data were collected and recovered. This report will not discuss the Malina program, but figure of the deployed floating mooring can be found in ArcticNet mooring report (Meredyk 2014) along with the other mooring designs employed in 2009.

The primary objective of the ArcticNet Beaufort Sea moorings deployed in 2009 was towards an improved understanding of the character and causes of variability and change in the Canada Basin. The secondary objective was to improve understanding of the influence of topography on the exchange of waters between the continental shelf and the ocean basin. Beaufort Sea moorings also carried sediment traps to measure the carbon flux and associated oceanographic conditions along with ADCP and CTD sensors to investigate the fluid dynamics in relation to detrital transport.

7.1.2 International research partnerships

Université du Québec à Rimouski (UQAR) and ArcticNet worked with scientists at Woods Hole Oceanographic Institute (WHOI, USA) to recover an array of four mooring deployed across Hudson Strait from onboard the *R/V Knorr* (17 September – 2 October; cruise #2009-055). The goal of this project is to observe and quantify the water exchange across the Hudson Strait and in particular, the inflow of the Arctic freshwater along the northern side of the strait. This is an important question to address because exchanges through the strait have an impact on Hudson Bay and the Labrador Sea, and even more so in light of the dramatic changes occurring all over the Arctic. This project follows a three-year program carried out in collaboration with Canadian researchers (Y. Gratton, UQAR and ArcticNet) as part of the Canadian MERICA-Nord project to observe the current flowing out of Hudson Strait along its northern boundary.

Supplemental to the Beaufort Sea, Hudson Bay and Hudson Strait moorings were mooring recovery attempts from the Laptev and East-Siberian Seas, with the Nansen Amundsen Basin Observations System (NABOS) program. The main goal of the NABOS project is to provide a quantitative assessment of circulation and water mass transformation along the principal pathways transporting water from the Nordic Seas to the Arctic Basin. ArcticNet's close partner, Québec-Ocean, had deployed these moorings in 2007 and attempted to recover these moorings in 2008. Unfortunately, only two moorings M01-07 and M09-07 were recovered in 2008 (due to extensive ice cover). In 2008, NABOS re-deployed mooring M09, but the heavy ice conditions were again problematic in 2009 and M09-08 was not recovered. For more information on these mooring operations, see the NABOS 2009 cruise report (nabos.iarc.uaf.edu/NABOS-2009-report), as these operations will not be covered in this report.

7.1.3 ArcticNet mooring program objectives

The primary ArcticNet objectives for the 2009 Expedition were to:

- Recover the six ArcticNet moorings that were deployed in the Beaufort Sea in 2008 (CA04-08, CA05-08, CA05-MMP-08, CA16-08, CA16-MMP-08 and CA18-08)
- Re-deploy six of these Beaufort Sea moorings (CA04-09, CA05-09, CA05-MMP-09, CA16-09, CA16-MMP-09 and CA18-09)
- Recover (and re-deploy) four moorings deployed in Hudson Bay in 2007 (AN01-07, AN02-07, AN03-07 and AN04/MH01-07).

7.2 Methodology

7.2.1 Overview of 2009 mooring operations

In 2009, ArcticNet mooring operations took place in the Beaufort Sea and in Hudson Bay (Figure 7.1). A summary of all ArcticNet mooring operations performed in 2009, including the recovery results for the 2009 deployments, are presented in Table 7.1. Further information on instruments specifications, deployment and recovery statistics and data status for all equipment retrieved can be found in the 2009 ArcticNet mooring report (Meredyk 2014).

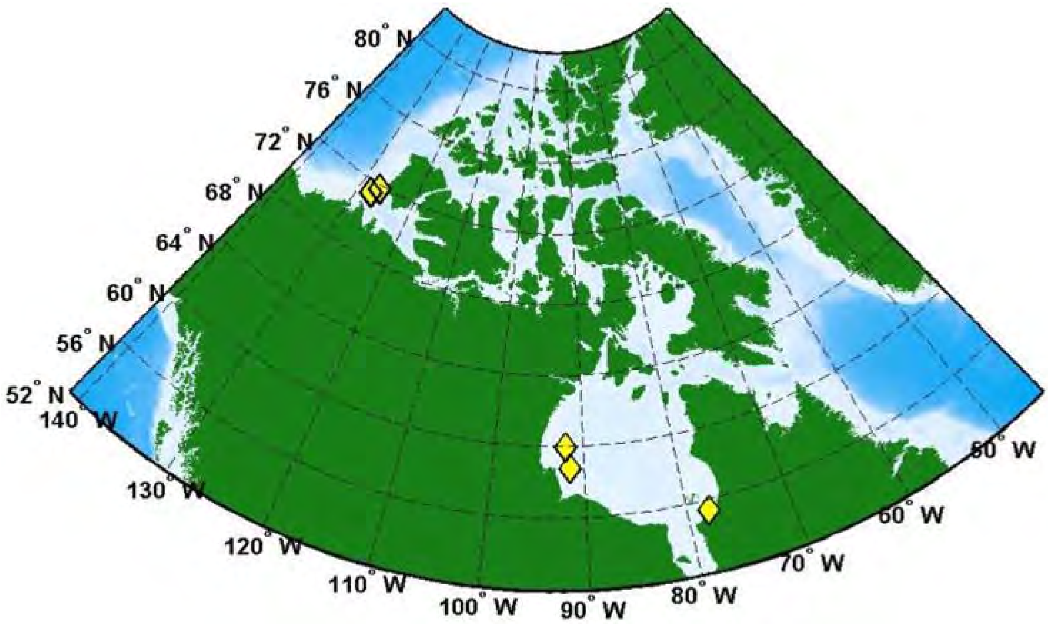


Figure 7.1. Location of ArcticNet mooring operations in the Beaufort Sea and Hudson Bay in 2009.

Table 7.1. Summary of ArcticNet mooring operations conducted in 2009, including recoveries performed in 2010 for moorings deployed in 2009.

Mooring ID	Program	Deployment year	Recovery year	Latitude N	Longitude W	Depth (m)
CA04-08	ArcticNet	2008	LOST	71°04.884	133°37.776	307
CA05-08	ArcticNet	2008	2009	71°18.744	127°34.944	204
CA05-MMP-08	ArcticNet	2008	2009	71°24.696	127°38.676	235
CA16-08	ArcticNet	2008	2009	71°47.208	126°29.814	314
CA16-MMP-08	ArcticNet	2008	2009	71°45.150	126°30.486	353
CA18-08	ArcticNet	2008	LOST	70°39.894	122°59.652	540
M9-08	NABOS-ArcticNet	2008	LOST	80°23.214	161°34.080	2718
HS_A-08	ArcticNet- MERICA- WHOI	2008	2009	61°58.740	071°39.410	190
HS_E-08	ArcticNet- MERICA- WHOI	2008	2009	62°19.420	071°00.000	345
HS_F-08	ArcticNet- MERICA- WHOI	2008	2009	62°24.620	070°49.410	360
HS_G-08	ArcticNet- MERICA- WHOI	2008	2009	62°29.450	070°40.240	340
A1-09	ArcticNet-Industry	2009	2010	70°45.684	136°00.384	688
A2-09	ArcticNet-Industry	2009	2010	70°44.784	135°55.212	615
AN01-09	ArcticNet	2009	2010	59°58.164	091°57.054	104
AN02-09	ArcticNet	2009	LOST	58°46.686	091°32.094	76
AN03-09	ArcticNet	2009	LOST	55°24.534	077°55.860	136
AN04/MH01-09	ArcticNet-ManitobaHydro	2009	2010	57°40.212	091°36.192	54
B-09	ArcticNet-Industry	2009	2010	70°39.990	135°35.862	154
C-09	ArcticNet-Industry	2009	2009	70°29.724	135°8.028	61
CA05-09	ArcticNet	2009	2010 (partly lost)	71°19.050	127°35.514	204
CA05-MMP-09	ArcticNet	2009	2010	71°25.026	127°39.684	235
CA16-09	ArcticNet	2009	2010	71°48.090	126°31.020	314
CA16-MMP-09	ArcticNet	2009	2010	71°45.270	126°30.564	353
F-09	ArcticNet-Industry	2009	2010	70°55.818	136°24.642	1010
G-09	ArcticNet-Industry	2009	2010	71°00.126	135°28.770	702

Mooring ID	Program	Deployment year	Recovery year	Latitude N	Longitude W	Depth (m)
H-09	ArcticNet-Industry	2009	2010	71°01.248	134°41.226	367
I-09	ArcticNet-Industry	2009	2010	70°48.870	134°32.724	75
J-09	ArcticNet-Industry	2009	2010	70°53.880	134°15.612	83

7.2.2 Mooring design and instrumentation

ArcticNet moorings were generally designed to be of taut-line configuration (Figure 7.2). The first instrument deployed close to the surface was a conductivity-temperature probe, with different models from RBR, Sea-Bird, Alec or Nortek companies. Sediment traps were always attached 5 to 10 meters below a current meter. Acoustic Doppler Current Profilers (ADCPs) were deployed at 100 m so they could provide current data from 100 m and upwards and simpler Current Meters (CMs) were used at 200 m and 400 m.

The McLane Moored Profiler (MMP) is a moving profiler that slides up and down along the mooring line recording temperature, salinity, pressure and fluorescence data (Figure 7.2). 2009 was the third year for the Beaufort Sea MMP moorings and they were paired with other moorings that contained a full suite of oceanographic equipment (Sediment traps, current meters, CTDs) so that the CTD data on the MMP moorings could be verified with the adjoining mooring and increase the resolution of the water column data. Two MMP moorings were deployed next to moorings CA05 and CA16 and were named accordingly CA05-MMP and CA16-MMP.

The moorings generally consisted of the following oceanographic equipment (see also Table 7.2).

- Top float with ice profiler (IPS).
- JFE-ALEC CT or SBE37 Conductivity, Temperature and Depth (CTD) probe to record water characteristics.
- Hydrophone (AURAL) – bioacoustics.
- RCM 11/ RBR with Aquadopp or AquaPro Conductivity, Temperature and Depth (CTD) probe with single-point current meter.
- ISUS V3 Nitrate sensor.
- Technicap sediment traps (24cups – bi-weekly sampling rate) to trap descending sediment for particle flux analysis and accumulation rates.
- RDI or Nortek Continental current profilers.
- 30” ORE float and/or 17” BENTHOS floats in-line floatation to balance the weight and float throughout the mooring line.
- Technicap sediment traps (24 cups – bi-weekly sampling rate) to trap descending sediment for particle flux analysis and accumulation rates, (deeper water moorings).
- RCM 11 / Aquadopp or AquaPro with RBR Conductivity, Temperature and Depth (CTD) probe with single-point current meter.
- 17” BENTHOS floats in-line floatation to balance the weight and float throughout the mooring line.
- Tandem mooring releases (Oceano 861AR and BENTHOS 865A).
- Anchor (one to four train wheels).

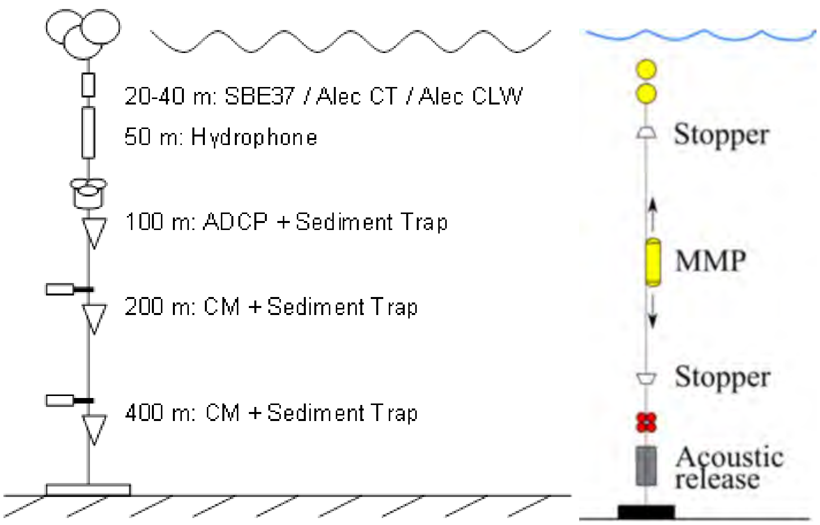
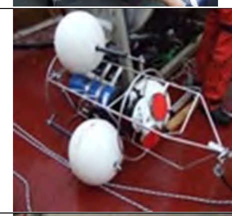
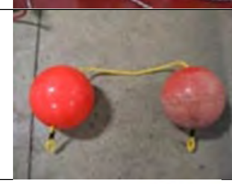


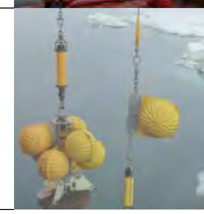
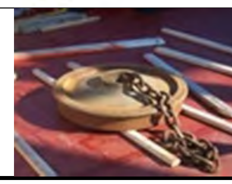
Figure 7.2. Illustration of typical ArcticNet mooring designs. Left: Taut-line configuration and Right: MMP mooring setup.

More details on equipment's manufacturers and specifications can be found in the 2009 ArcticNet mooring Report (Meredyk 2014).

Table 7.2. Instruments typically deployed on moorings during the 2009 ArcticNet Expedition.

Instrument	Description	Image
Ice Profiling Sonar (IPS)	ASL Environmental Sciences IPS (model 4/5) to measure size and thickness of ice keels and ice velocities. Deployment depth 50-60 m with synthetic buoy.	
SBE37 Conductivity Temperature and Depth (CTD) Data Logger	RBR duo/concerto data loggers to record conductivity, temperature and depth information.	
Nortek Aquadopp® Acoustic Doppler Current Profiler (ADCP)	Nortek Aquadopp® current profilers to measure the surrounding water current velocity in a single volume. Deployed at various depths, accompanied by RBR duo/concerto (multi-channel/sensor) CTD data logger.	
RBR duo/concerto Conductivity Temperature and Depth (CTD) Data Logger	RBR duo/concerto data loggers to record conductivity, temperature and depth information, which was then used to compute the speed of sound for a specific position (required for IPS data processing). The multi-channel data loggers contained additional turbidity (Tu) and dissolved oxygen (DO) sensors.	
AURAL-M2 Sound Recorder	The AURAL-M2 (Autonomous Underwater Recorder for Acoustic Listening-Model 2) is a continuous underwater sound	

Instrument	Description	Image
	recording device with one-year data storage. Deployment depth 60-70 m.	
Satlantic *In situ* ultraviolet spectrophotometric (ISUS) V2/3 Nitrate Sensor	ISUS deployed to collect an annual time-series of high-resolution (0.5 – 2000 µM) nitrate concentration data. Deployment depths 60 m and 80 m.	
Nortek Continental® 470 kHz Current Profiler	Nortek Continental® current profilers to measure the water current velocity towards the surface with an increased range (100 m) and a 1-m resolution Accompanied by a RBR duo/concerto (multi-channel sensor) CTD data logger. Deployment depth 90 m.	
Marine Subsea Float	13” Vinyl Floats attached to the JFE_ALEC Infinity-CLW.	
JFE_ALEC Infinity-CLW ACLW2-USB	The Infinity-CLW is an autonomously deployable data logger for long-term chlorophyll and turbidity measurements.	
JFE_ALEC Compact-LW ALW-CMP	The COMPACT-LW is an autonomous deployable data logger for PAR (Photosynthetic Available Radiation: 400 to 700 nm) measurements.	
Technicap Sediment Trap PPS 3/3-24s	Model PPS 3/3-24s is a cylindro-conical trap used to sequentially collect 24 sediment samples to record the annual cycle in vertical carbon flux. Deployment depths 100 m and 200 m.	
SeaBird SBE26plus Wave and Tide Recorder	The SBE26plus to record the wave and tide cycles, temperature and conductivity for this mooring location. Deployed with the Benthos acoustic release device. Deployment depth 200 m.	

Instrument	Description	Image
Benthos 17” Floats	204-SRM-17 Super ribbed mooring flange hard hat housing and 17” glass spheres used as flotation along the mooring line.	
EdgeTech / ORE Offshore 30” Float	EdgeTech/ORE Offshore 30” Float was installed along the mooring line to increase floatation.	
Teledyne - Benthos Acoustic Release Device	Tandem (875-A-TR) Teledyne-Benthos model 866-A transponding acoustic releases used as the primary recovery device.	
Train Wheels	Two or four (large mooring payload) 800 lbs steel train wheels used as mooring weights.	

In 2009, the only mooring not of a taut-line configuration was industry mooring C-09 deployed during Leg 2a in IOL’s Ajurak exploration lease (Figure 7.3). Mooring C-09 was a bottom frame mooring meant for deployments in shallow shelf waters. At the shallowest site (C) in the southeastern corner of IOL’s Ajurak lease area, an Acoustic Doppler Current Profiler (ADCP) was deployed to measure current profiles as well as directional wave data. In order to measure wave height, period and direction accurately, the ADCP must be stable and a bottom frame was used instead of a taut-line mooring.

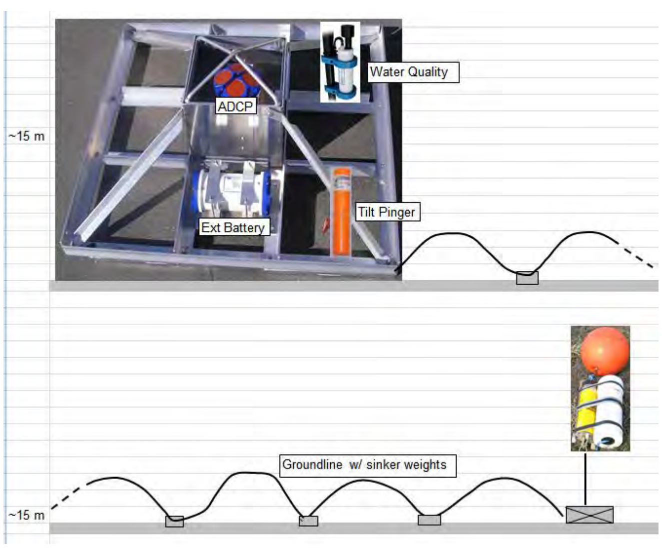


Figure 7.3. Bottom frame design of mooring C-09 deployed in the IOL Ajurak lease block during Leg 2a.

Current profile data were recorded in XYZ coordinates, while wave data were recorded in beam coordinates. Even after the compass calibration, errors may occur in the ADCP heading due to fluctuations in the earth's magnetic field caused by the reduced horizontal component this close to the magnetic pole. ADCP heading data were recorded, and since the frame did not move, an average heading could be determined and applied during data processing.

Along with the current/wave measurements, water parameters were obtained using an RBRXR420 CTD (plus Dissolved Oxygen), and an Alec CLW (Fluorescence plus Chlorophyll). An acoustic tilt-pinger was used to monitor the verticality of the frame and thus ensure that the bottom frame was deployed upright. The primary recovery mechanism (planned for Leg 3b in Sep-Oct 2009) was a release activated pop-up buoy, while the groundline could be dragged up if necessary. The groundline was 1" buoyant polysteel rope with small weights every 10-20 m.

The design and oceanographic instrumentation of other moorings deployed during the 2009 Expedition, including ASL/IOL-BP moorings, ArcticNet MetOcean buoys and Malina floats/moorings, can be found in the 2009 ArcticNet Mooring Report (Meredyk 2014).

7.2.3 Mooring equipment calibration and verification

Sensors calibration and validation

The sensors on Aanderaa RCM, SeaBird and JFE-ALEC instruments were calibrated by the manufacturers and were validated by the Université Laval and/or ArcticNet technical team (details on the source and status of calibrations & verifications for all instruments are provided in Boisvert et al. 2010 and Meredyk 2014).

Field verifications of internal compasses

Compass accuracy is essential for current meters deployed near or above the Arctic Circle due to the reduced magnitude of the horizontal component of the earth's magnetic field. It was therefore important to verify internal compasses near the approximate latitude where they were deployed. Care was taken to eliminate all ferrous material in the mooring cages and in the environment when conducting these verifications.

The internal compasses of all ADCPs and current meters needed for the moorings deployed in each of the three regions were verified on shore close to their respective deployment sites (Table 72 and 7.3). In addition, the compasses of 2005 mooring equipment recovered in 2006 needed in many cases to be verified again and they were re-tested along with the 2006 instruments.

The compass verification procedure followed standard manufacturer protocols and were conducted with a tilt and rotate jig using a tripod with a spinning top fixture, where the instrument was installed (Meredyk 2014). A Garmin hand-held GPS unit was used to establish a distinct true North sight line from the tripod to a landmark, and the successive instrument direction readings were obtained by rotating the unit relative to this true North direction, in 10-degree increments.

Compass calibration information is not available for the BaySys and NABOS mooring programs. More information on the MERICA-Nord calibrations can be obtained by contacting the project leader (Y. Gratton, INRS-ETE).

All mooring instruments deployed in the Beaufort Sea in 2009 were calibrated by their respective manufacturers prior to the expeditions, except the ADCPs (RDI, Nortek and Anderaa). The ASL/IOL-BP mooring equipment was calibrated in Inuvik, NWT, and then transferred to Sachs Harbour, NT for transfer onboard the *Amundsen.* The ArcticNet mooring equipment was calibrated in Paulatuk, NT (September 2009: 69°19.422' N, 124°05.603' W; Magnetic deviation 32.2°) and Sachs Harbour (October 2009: 71°55.572' N, 125°05.105' W; Magnetic deviation 28.18°) (Figure 7.4 and Table 7.3).

Table 7.3. ArcticNet mooring equipment compass calibration details for moorings deployed in the Beaufort Sea.

Instrument	SN	Region	Pre-Calibration site	Pre-calibration date	Pre-calibration status
AQD	2754	BS	Paulatuk, NT	Sep-09	Good?
AQD	2688	BS	Paulatuk, NT	Sep-09	Good?
AQD	2690	BS	Paulatuk, NT	Sep-09	Good?
AQD	2692	BS	Paulatuk, NT	Sep-09	Good?
AQD	2747	BS	Paulatuk, NT	Sep-09	Good?
AQD	2778	BS	Paulatuk, NT	Sep-09	Good?
CNL	6088	BS	Paulatuk, NT	Sep-09	Good?
CNL	6085	BS	Sachs Harbour, NT	Oct-09	Good?
RCM11	266	BS	Sachs Harbour, NT	Oct-09	Good?
RCM11	289	BS	Sachs Harbour, NT	Oct-09	Good?
CNL	6110	BS	Sachs Harbour, NT	Oct-09	Good?
CNL	6116	BS	Sachs Harbour, NT	Oct-09	Good?
WHS	6320	BS	Sachs Harbour, NT	Oct-09	Good?
WHS	8682	BS	Sachs Harbour, NT	Oct-09	Good?
AQD	2468	BS	Sachs Harbour, NT	Oct-09	Good?
AQD	2475	BS	Sachs Harbour, NT	Oct-09	Good?
AQD	2481	BS	Sachs Harbour, NT	Oct-09	Good?
LR	3883	BS	Not Calibrated	na	na

All of the instruments needed for the Beaufort Sea mooring sites were calibrated close to the respective deployment sites and were reported as having been properly calibrated (INRS Technical Report 2009-2010; Boisvert et al. 2010).

The current meter compasses (Aquadopp, Continental (CNL), WorkHorse – Sentinel (WHS) and RCM11) needed for the ASL/IOL-BP moorings were calibrated by ASL in Inuvik, NWT (July 2009) and then transferred to Sachs Harbor by ASL technical staff (contracted out by Imperial Oil Limited).

Figure 7.4. Locations of ArcticNet mooring equipment calibration sites in Paulatuk and Sachs Harbour in September and October 2009.

7.2.4 Mooring recovery and deployment operations

Hudson Bay

Four of the five moorings located in three sites deployed in 2007 were recovered in July-August 2009: AN01-07, AN03-07, AN04-07-A/B (Figure 7.5). AN02-07 was not recovered because the acoustic releases gave no response in spite of two separate attempts. A current meter (RCM4 – 4645) from AN01-06 was found in Kujjuarapik (other side of Hudson Bay from which it was deployed) by a local citizen and was returned to the ArcticNet-Québec-Ocean mooring inventory (data was not recoverable / downloaded). Four moorings (AN01-09, AN02-09, AN03-09 and AN04-09) were successfully deployed in 2009 (Figure 7.5).

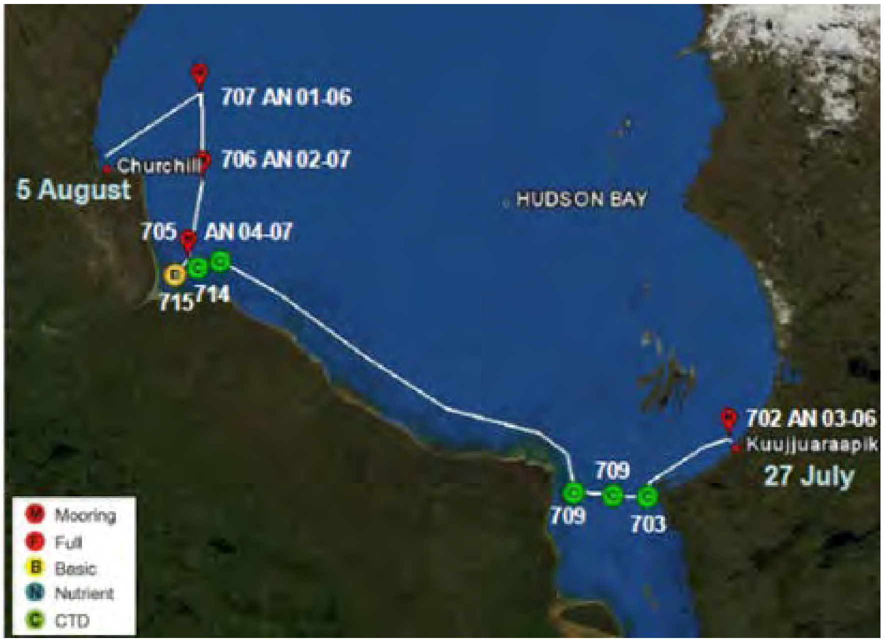


Figure 7.5. Moorings recovered and deployed in Hudson Bay from the CCGS *Pierre Radisson* between 27 July and 5 August 2009 as part of the BaySys cruise.

Beaufort Sea – ArcticNet moorings

The 2009 Expedition was relatively successful for mooring recoveries in the Beaufort Sea. Four of the six moorings deployed in 2008 in the southern Beaufort Sea were recovered and re-deployed in 2009, including two MMP moorings (CA05-, CA05-MMP-, CA16- and CA16-MMP-) (Figure 7.6). Moorings CA04-08 and CA18-08 were not recovered in 2009, due to the extensive ice cover and failure to communicate with releases (CA18-08), and were therefore not re-deployed in 2009.

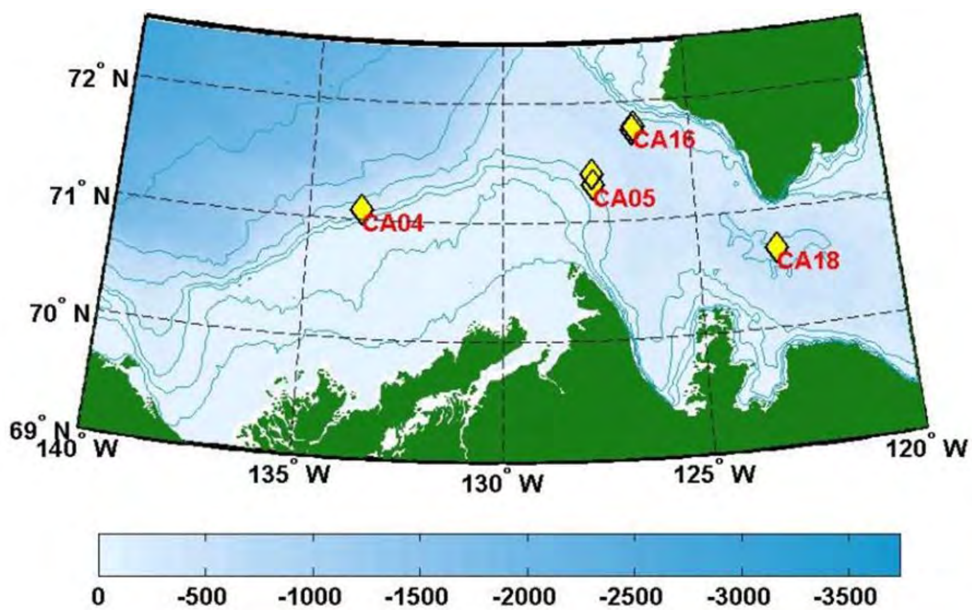


Figure 7.6. ArcticNet moorings deployed in the Beaufort Sea in 2008 and re-deployed in 2009: CA05-, CA05-MMP-, CA16- and CA16-MMP-. CA04-08 and CA18-08 were not recovered in 2009.

CA04-08: Due to bad weather conditions (Beaufort scale 7), the decision was taken to leave the mooring in its position for another year. The acoustics releasers battery life was estimated to be good for at least three years, so there was no need to pursue a dangerous mooring recovery if a safer day (potentially next season) was viable.

CA05-08 and CA05-MMP-08: These moorings were recovered on 9 October 2009 during Leg 4a. Weather conditions were good and the moorings were quickly recovered. The ISUS (nitrate sensor) and AURAL (hydrophone) did not record any data during the year-long deployment. The ULS (Ice profiler) stopped recording data after 11 October 2008. Data from the SBE 26 (CTDs) were not downloaded, as the battery was discharged due to a casing leak. The instrument (SBE26) was stored onboard until it was dried and cleaned but unfortunately, the data was not recoverable. The CA05-MMP data were downloaded and the instrument stored in the hold. The four acoustics releasers were cleaned and two releases were stored in the ArcticNet container. One of the releases was redeployed on mooring CA05-09 and another on CA05 MMP-09. The data from two RBR CTD+Tu+DO were recovered from these moorings, one unit (#10419) was redeployed on CA05-09. The Technicap sediment trap motor was cleaned and redeployed on CA16-09.

Mooring CA16-08: The mooring was recovered on 12 October at approximately 16:50 UTC, in strong winds (Beaufort scale 6). At the surface, the Benthos 17" buoys (installed on the line just above the releases) were not on the line anymore. A lack of buoyancy in the lower part of this mooring line explained why the mooring took a long time to surface. Water had infiltrated the recovered ULS (Ice profiler) (#51073) and thus, no data was recordered after 8 October 2008. All data of the other instruments were recovered, and the instruments were cleaned and stored accordingly. The RBR CTD+Tu+DO sensor serial #10422 had been redeployed on CA05-09. The acoustic release #41436 didn't respond at all and has to be checked before being re-used.

Mooring CA16-MMP-08: The mooring was recovered on 14 October at approximately 19:50 UTC in good weather conditions. The MMP data has been recovered and the instruments stored accordingly.

Mooring CA18-08: Recovery operations took place on 15 October at approximately 18:50 UTC, under good weather conditions, but it was impossible to recover this mooring. None of the two acoustic releases responded and the multibeam system (EM302) could not verify the location of any mooring instruments. On 16 October, following a south-east route, the *Amundsen* tried to communicate with the releases at a range of 2 nm without success. It is possible that this mooring may not be at this location anymore.

Mooring CA05-09: On 13 October at approximatively 00:50UTC, mooring CA05-09 was deployed with the following instruments: an ISUS nitrate sensor, an Aural Hydrophone, an ULS (ice profiler), a Nortek 470 khz ADCP, a Technicap sediment trap, two RBR CTD+Tu+DO sensors, an RCM 11 (CTD – Current meter), an ALEC CLW (Fluorometer), and an ALEC ALW (PAR sensor). The triangulated position of this mooring line was calculated to be 70°18.6902' N and 127°35.5996' W. A CTD profile was done after the deployment.

Mooring CA16-MMP-09: This mooring was deployed on 15 October in good weather conditions at approximately 02:10 UTC. Instruments on the mooring included an MMP and an RDI LongRanger. Despite the fact than the RDI LongRanger had not been calibrated, it was decided to deploy it on this mooring. The LongerRanger will need to be post-calibrated after the recovery, planned in 2010. The mooring position was triangulated and calculated to be 71°45.268' N and 126°30.6106' W. A CTD profile was done after deployment of the mooring.

Mooring CA16-09: This mooring was deployed on 12 October at approximately 03:20 UTC. Instruments on the mooring line included two Aquadopps, an Aural Hydrophone, an ULS (Ice profiler), a Nortek 470 khz ADCP, two Technicap sediment traps, an RBR CTD+Tu+DO, two additional RBR CTDs, and two ALEC CTW. The mooring position was triangulated and a CTD profile was done after the deployment of the mooring.

Mooring CA05-MMP-09: This mooring was deployed on 16 October at approximately 04:55 UTC. Instruments on the mooring included an MMP, a SBE 37 (CTD), and a Nortek 190 kHz ADCP. The mooring position was triangulated and a CTD profile was done after deployment of the mooring.

Mooring CA04-09: Due to bad weather conditions (Beaufort scale 7), it was decided not to attempt a deployment at this site.

Mooring CA18-09: Due to the loss of mooring equipment at this location in the last three years, the decision was made to cancel the deployment of CA18 for 2009.

More details on the ArcticNet instruments recovered from the 2008 moorings along with deployment field sheets for all moorings and deployed instruments in 2009 can be found in the 2009 ArcticNet mooring report (Meredyk 2014).

Beaufort Sea – ASL / IOL and BP moorings

All information regarding the IOL and BP mooring operations in the Beaufort Sea (plots and procedures mentioned) and preliminary results were documented in the ASL Leg 2a and Leg 3b Cruise Reports (Birch et al. 2009). Minor modifications have been made to the text from these ASL cruise reports to fit within the structure and formatting of this report.

Legs 2a (16-30 July) and 3b (12 September–8 October) of the 2009 Expedition were multi-faceted programs involving biology, ocean chemistry, marine mammal observations, meteorology and other oceanographic investigations. One of the primary objectives of ArcticNet's mooring program for Leg 2a was to assist the ASL technical staff deploy five oceanographic moorings in the Imperial Oil Limited (IOL) Ajurak lease area (sites A1, A2, B, C, F; Figure 7.8), and four in the British Petroleum (BP) lease area (sites G, H, I, J; Figure 7.8).

Nine industry (ASL/IOL-BP) moorings were deployed during Leg 2a in the Canadian Beaufort Sea. Industry moorings at sites A1, B and C were retrieved and redeployed during Leg 3b, two months later (Figure 7.7).

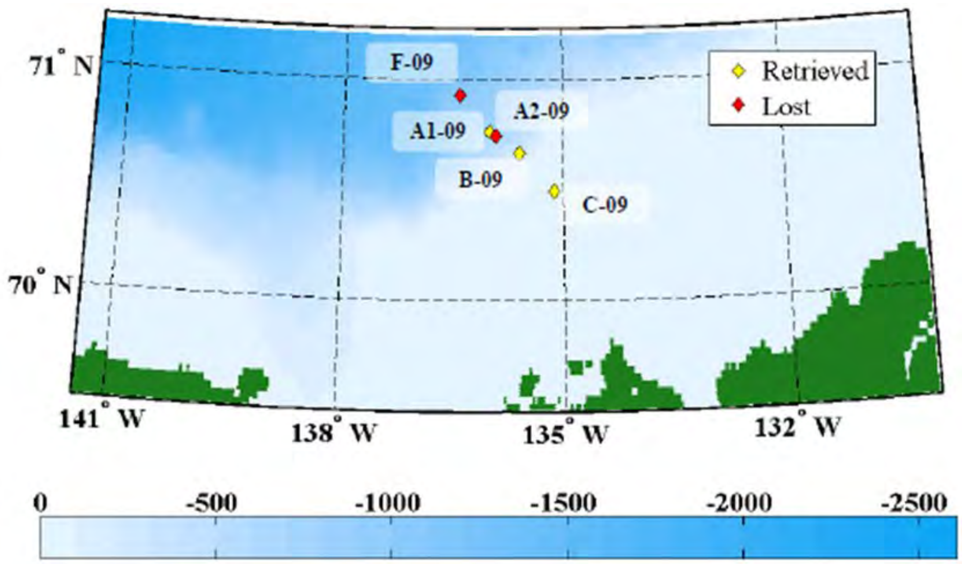


Figure 7.7. Locations of ASL/IOL-BP moorings deployed in 2009 in the Beaufort Sea, with 2010 recovery results.

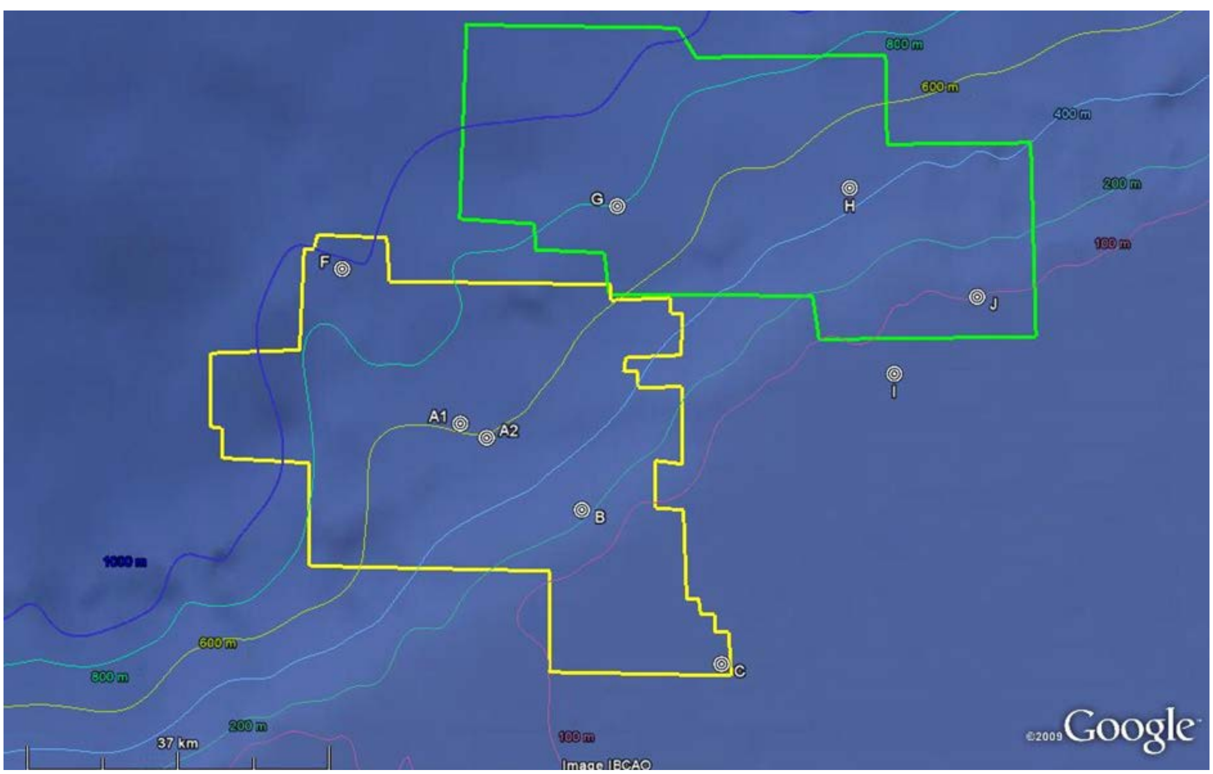


Figure 7.8. Locations of ASL / IOL-BP moorings (9) deployed in 2009 in the Beaufort Sea by ArcticNet – ASL / IOL-BP (ASL Cruise Report 2009).

Even though most of the license areas were covered by ice in July 2009, there was just enough open water to allow for top-first deployment of all the moorings. Further details about the deployment operations can be found in the 2009 ASL cruise report (Birch et al. 2009).

The sub-surface moored instrumentation were primarily intended to measure ice draft, water velocity profiles and waves, but also water parameters such as temperature, salinity, dissolved oxygen, chlorophyll and turbidity. All moorings were taut-line configuration except Site C which was a bottom frame (see Figure 7.3). All moorings except site C were to be in place until summer of 2010 (see summary in Table 7.1). However, in order to have some preliminary data available for the IOL Environmental Assessment Report, A1 and B were turned over during Leg 3b in September 2009, and C was to be recovered at that time.

Mooring C: During Leg 2a, an Acoustic Doppler Current Profiler (ADCP) was deployed to measure current profiles as well as directional wave data at the shallowest site (site C, 60 m depth) at the southeastern corner of the Ajurak lease area. Along with the current/wave measurements, water parameters were to be obtained using an RBRXR420 CTD (plus Dissolved Oxygen), and a JFE-Alec CLW (Fluorescence, Chlorophyll & Turbidity). The instrumentation was deployed on an ASL bottom frame because the ADCP must be stable to measure directional waves in shallow coastal waters.

An attempt was made to recover the bottom frame on 2 October by sending a release command to the pop-up. The release responded as having opened but the pop-up did not surface. The *Amundsen* tried dragging with a 100 pound Danforth anchor but did not snag the bottom frame. The next day the ROV was deployed and found that the acoustic release had opened and dropped the drop link, but that the ground line had tangled with the pop-up assembly (Figure 7.9). The ROV was able to free the pop-up buoy and it surfaced. The bottom frame was then recovered via the pop-up line and then the ground line (Figure 7.10).

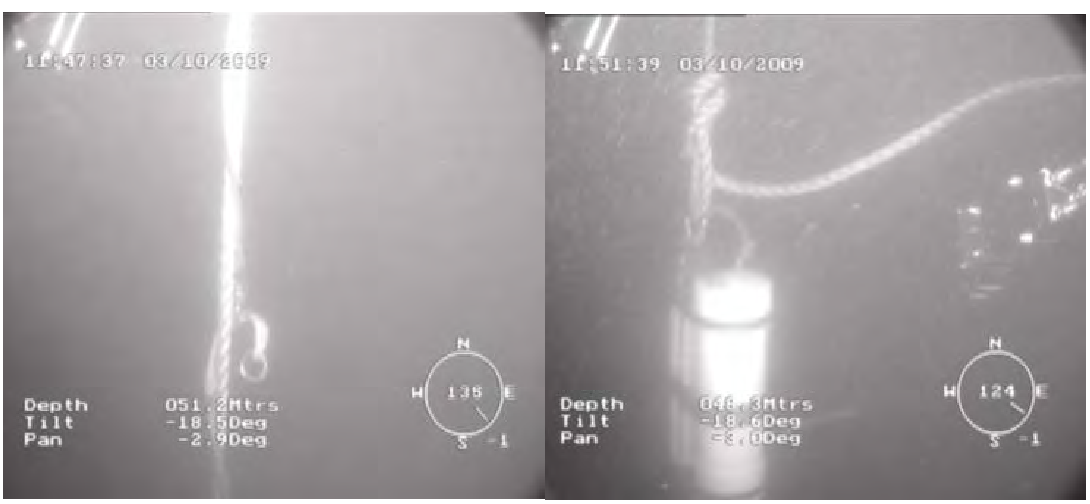


Figure 7.9. ROV mooring recovery operations images for Site C-09 in the Beaufort Sea.

Figure 7.10. Recovery of ASL/IOL-BP bottom frame mooring at site C (Photo: ASL Cruise Report 2009).

Mooring B: The site B mooring was deployed on 19 July during Leg 2a and recovered on 16 September. One CART acoustic release (#33747) was enabled and ranged to begin recovery of the mooring. Water depth was ~154 m and at slant ranges of about 200 m, the command to release was sent and the IPS floats/cage surfaced (16 September 12:53 UTC), followed closely by the ADCP in the M40 float. The Zodiac was used to pull the mooring alongside the ship where the mooring instruments were lifted onto the foredeck.

A time check on the IPS5 #51103 showed its clock to be 69 seconds slow. The pressure case was opened, the battery disconnected, and the flash card removed. The data (~1444 files; ~740 MB) were transferred to the laptop and backed up onto a USB drive. The program IPSLink was used to view a few of the hourly data files to verify that the IPS5 had operated properly. The memory card was then replaced, the battery reconnected and the pressure case closed up again. Using IPSLink, the flash card was formatted and about 2 hours of test data collected to confirm proper functioning of the flash card. The IPS was then restarted (start time 17 September 1:00 UTC) using the same configuration phases as before. The duration of the first phase had to be reduced so that phase 2 would start at the same date as originally intended.

The data from the ADCP current profiler (QM #12585) was downloaded using the program WinSC through the 25 m serial cable. There was one file of size 31,839,288 bytes and no errors occurred during download. A time check on the clock showed it to be 18 seconds slow. The data were viewed with the program WinADCP to verify that the ADCP had functioned properly. Then the ADCP was re-started (delay start 23:50 UTC on 16 September 2009) with the same configuration as used previously.

The data from the two RBR instruments (CT logger #15267 attached to ADCP; and XR420 logger #17112 attached to the IPS5) were downloaded via the serial cables without interrupting the data logging. The data files were plotted using the RBR software to confirm that the instruments had operated properly.

The mooring was then re-assembled and prepared for redeployment. It was redeployed the next day (17 September) at 15:20 UTC at position 70°39.960' N and 135°35.966' W, about 80 m to the southwest of the original deployment position in July. No triangulation was done because the mooring was relatively short and during freefall was not expected to be pulled very far where the anchor was dropped.

Mooring A1: A CTD cast was conducted prior to recovery of mooring A1-09, allowing comparison with the CT loggers on the mooring, particularly as to drift. The mooring at Site A1 was recovered on 1 October 2009 during Leg 3b. Cart #33748 was enabled, ranged on and released. The CART released the first time and instruments first appeared on surface at 16:52 local time. All instruments appear to have operated properly except for the lowermost RBR CT logger (~680 m depth) which leaked and did not provide any useful data. Timing checks on the various instruments were performed.

When the A1 mooring was deployed in July the water depth from the sounders (multi and single-beam) on the *Amundsen* gave a depth of 688 m. However, the data from the site A1 mooring indicated that the instruments were about 25 m shallower than expected. The mapping group on Leg 3b believed the proper depth was 665 m, a difference of 23 m. The difference probably stemmed from the sound speed used. The mapping group on Leg 3b felt they had a better handle on the sound speed and their revised depth agreed with the mooring instruments data. Therefore, for redeployment, adjustments (reduction of 25 m of Kevlar) were made to the mooring length to take into account the shallower depth at Site A1.

The instruments on the A1 mooring were re-initialized to sample using the same parameters as previously deployed in Leg 2a. A new RBR CT logger was deployed in place of the one that had leaked. The mooring was deployed at the same place as before but was modified (35 m length or rope beneath the IPS was replaced with a 10 m length), so that the IPS would end up closer to the targeted 60 m depth. The anchor was dropped at 19:26UTC on 2 October 2009 at 70°45.678' N and 136°00.519' W based on the hand-held Garmin on the foredeck. The coincident bridge position was 70°45.689' N and 136°00.497'W.

Beaufort Sea – MetOcean-AXYS buoys

Four MetOcean AXYS® buoys were planned to be deployed to obtain data on the surface meteorology, fluxes and characteristics of the water column's upper 50 m. Pairs of buoys were to be deployed at two locations each within the Ajurak Block at a shallow site (~150 m) and a deep site (~600 m). The buoy pairs consisted of a 3 m discuss buoy and a surface float suspending a 50 m string of sensor within the water column (Figure 7.11).

Figure 7.11. ArcticNet MetOcean-AXYS® oceanographic buoy (3m diameter) and surface buoy (red – right) deployed at mooring site A1-09 (size relative to each other).

However, because of space limitations on the *Amundsen*, only one of the four MetOcean AXYS® buoys was loaded onto the ship. The 3-m buoy was commissioned for deployment, but heavy ice conditions within the Ajurak block in Leg 2a prevented deployment, including the surface floats. The discus buoy and its associated surface buoy were deployed during Leg 3b at IOL-BP mooring site A1-09.

A Nortek Aquadopp Current Profiler (#3397) was attached to the yoke at the base of the 3-m discus buoy in order to obtain current profile data over the upper 50 m of the water column. Also attached to the yoke were a CTD and a pCO_2 (partial pressure CO_2) (Figure 7.12). ASL was responsible to post-process the data for only the Nortek Profiler.

F

igure 7.12. The three instruments mounted beneath the 3 m MetOcean AXYS® buoy deployed at Site A1: RBR CTD, Nortek Current Profiler & the Pro-Oceanus pCO_2.

Beaufort Sea – Secondary surface buoys at IOL-BP Sites A & B

Two single-point Alec EM current meters were mounted on the 0-50 m lines underneath each of the secondary buoys, at depths of 3 m and 20 m subsurface. ASL was responsible for programming these sensors. The Alec EM was a single point electromagnetic current meter and was mounted within a stainless steel cage, attached in-line beneath the secondary buoy (Figure 7.13).

Figure 7.13. Uppermost Alec EM current meter in-line beneath one of the secondary surface buoys accompanying the MetOcean AXYS® buoys (ASL Cruise Report Leg 3b, 2009).

Hudson Strait (WHOI partnership)

In 2009, a set of four moorings were recovered across Hudson Strait in collaboration with Woods Hole Oceanographic Institute (WHOI, USA) (F. Straneo) and ArcticNet-UQAR (Y. Gratton) (see summary in Table 7.1). Measurements in Hudson Strait focused on a section approximately 110 km long stretching between Big Island (Baffin Island side) and Wakeham Bay (Quebec). The mooring recovery operations were conducted by WHOI onboard the *R/V Knorr* from 17 September to 2 October 2009 (Figure 7.14 and 6.16).

In addition to the mooring recoveries, hydrographic data at twelve stations across the strait (four of which coincided with locations where the moorings were anchored) was collected. These data serve the dual purpose of obtaining a snapshot of conditions across the strait and to aid in the calibration of the moorings' instrumentation. Shipboard meteorological, acoustic doppler current profiler (ADCP), sea surface salinity and temperature data were collected while transiting.

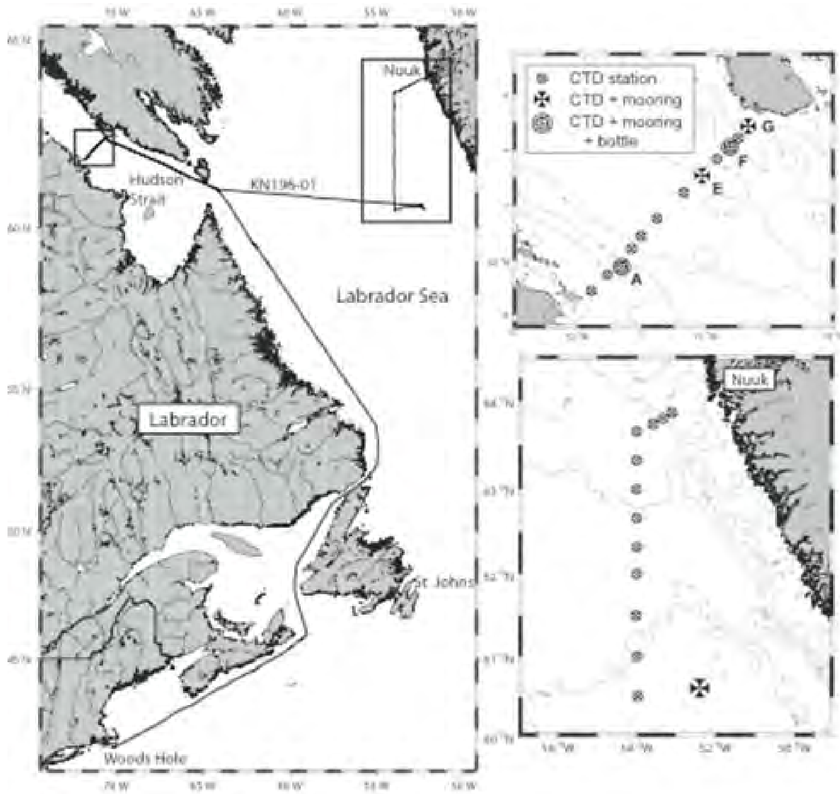


Figure 7.14. 2009 *R/V Knorr* cruise track from WHOI to Nuuk, Greenland. Left panel shows the Irminger Ring Mooring Location (US State Dept. cruise 2009-054).

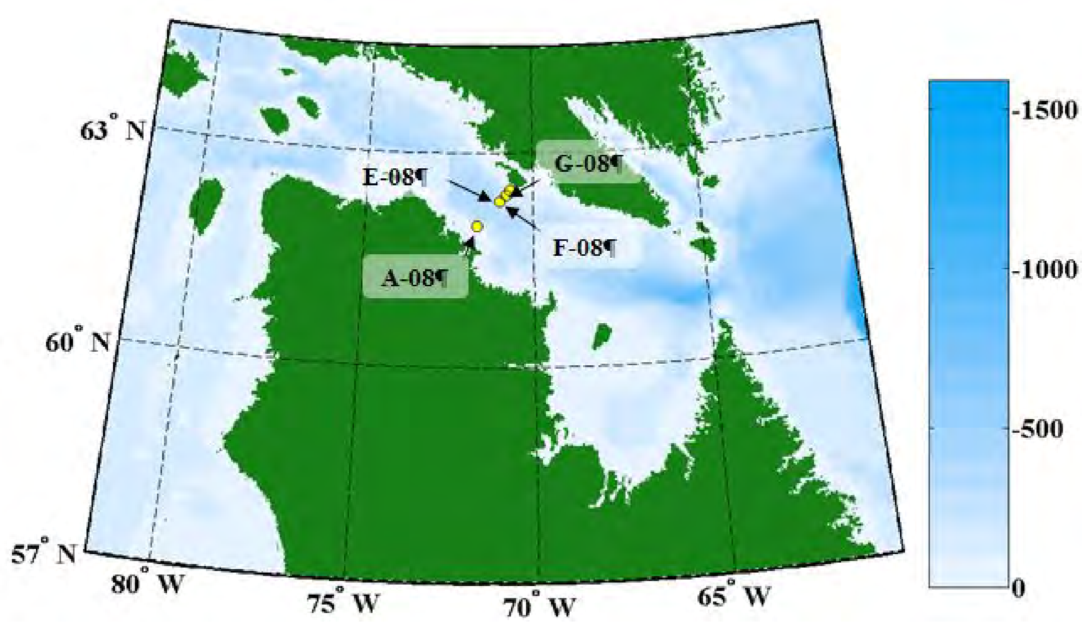


Figure 7.15. ArcticNet – MERICA-Nord – WHOI moorings deployed in Hudson Strait in summer 2008, all moorings were recovered in 2009 by WHOI onboard the *R/V Knorr*.

7.2.5 Mooring deployment and recovery methodology

<u>**Deployment methodology**</u>

In preparation for the deployment, all the instruments were programmed and mounted into their respective frames or floats, and the mooring releases were verified for proper functioning. The mooring was then assembled top-down on the foredeck according to the planned design and instrumentation, and all attachments were double checked.

A Toolbox Meeting with Mooring and Ship's crew was held on the foredeck to identify roles and review safety considerations. The Zodiac was launched (if deemed necessary) and the date and time were recorded at the start of mooring operations.

All components of the mooring were lowered from the deck to the water surface using the A-frame, starting with the top float, until all mooring component were in the water. The Zodiac maintained the mooring line taut as it was deployed to avoid getting the equipment entangled. The final release of the anchor was preceded by the Zodiac releasing its tack of the top float and the confirmation of the correct depth and position for the mooring. The mooring was left to free-fall into position and the time and target location of the last seen position of the top float were noted down.

The vessel verified communications with the acoustic releases and proceeded to 3 triangulation points at ~100 m around the target location to calculate the anchor position using a MatLab® script (Figure 7.16). The resulting triangulated position of the mooring was recorded in the field deployment sheets.

A post-deployment CTD cast was conducted and the CTD profile plots for each mooring site were kept within the field deployment Excel workbook and archived at ArcticNet (Figure 7.17). The foredeck was cleaned and the remaining mooring equipment and cages were secured on the foredeck.

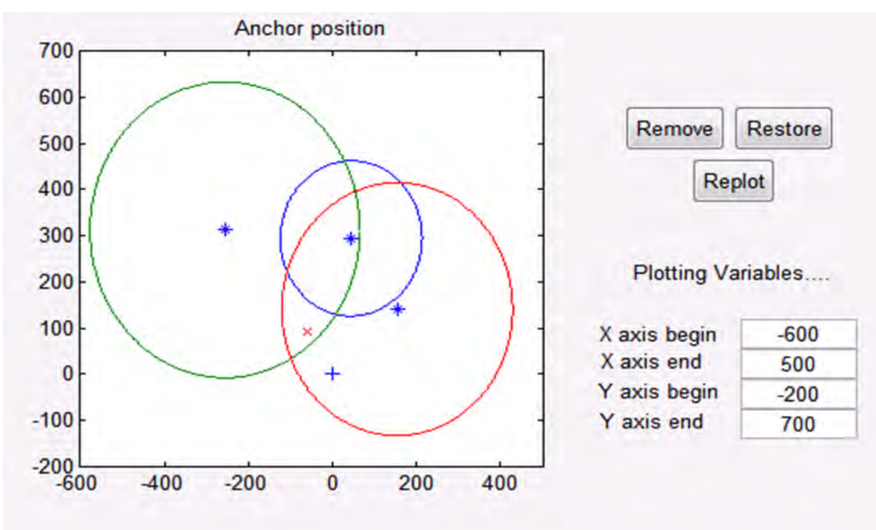


Figure 7.16. Triangulation plot from BS1-14 using Art's Acoustic Survey Matlab Script.

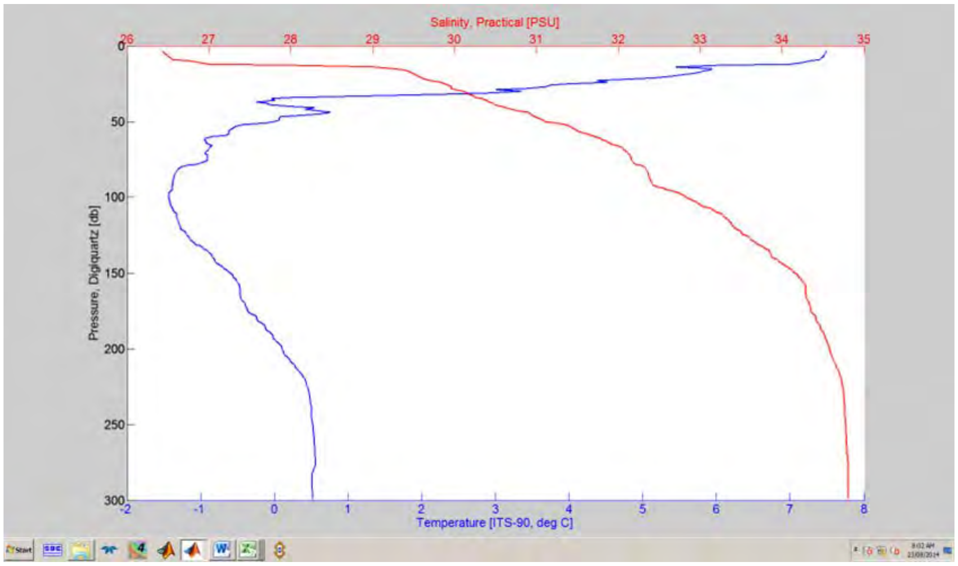


Figure 7.17. Example of a CTD-Rosette temperature and salinity profile (BS2-14).

<u>Recovery methodology</u>

A CTD cast was conducted at each mooring site prior to recovery to obtain a profile of water column properties near the mooring while it was still in place. This cast also served to determine possible sensor drift over time for the moored instruments and obtain accurate data on the acoustic properties of the water.

Transducer ranges were taken on the mooring's acoustic releases from several positions around the mooring site to verify approximate location and distance from the ship. When greater accuracy was needed (due to poor visibility or nearby ice), triangulation was done by taking three range fixes from points surrounding the target location: ranges and locations were logged and a program was run to determine the most likely location of the mooring. The ship was then re-positioned down-drift from this location and another range was taken before sending the release code and the release time logged.

When the mooring surfaced, the time and its location (distance and direction from the ship's position) were logged. The Zodiac was launched and hooked onto the top float when all floatation components had reached the surface. The Zodiac then pulled the mooring alongside the ship and hooked it onto the A-frame winch hook. As the sections of mooring were lifted on deck, the time was logged when each instrument came out of the water.

7.2.6 Mooring instrumentation setup and data quality

Detailed information identifying how each mooring instrument was programmed for its deployment, including data quality from each instrument recovered in 2009 and 2010, is given in ArcticNet 2009 mooring report (Meredyk 2014) as well as in the Appendices of ASL Field Reports for Leg 2a and 3b (Birch et al. 2009).

7.3 Preliminary results

7.3.1 ASL/IOL-BP mooring C-09

The currents at Site C were largely tidal, which was expected considering its proximity to the coastline, and maximum speeds of about 25 cm/s were recorded (Figure 7.18; note that directions in the ADCP data were recorded in XYZ coordinates and the heading has yet to be applied in post-processing).

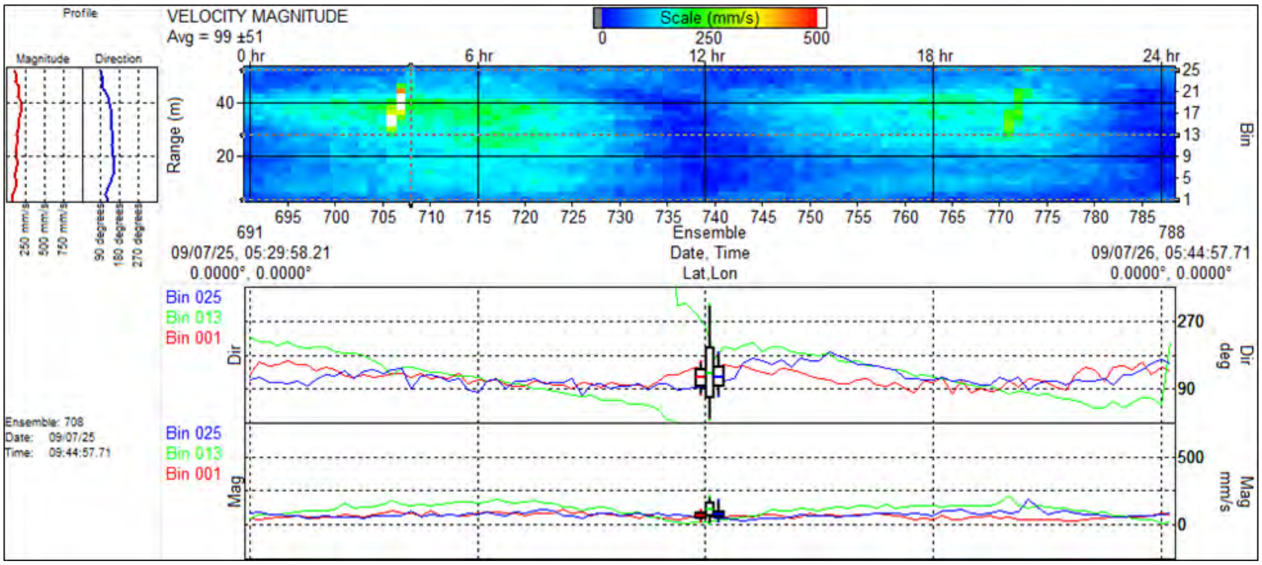


Figure 7.18. ADCP data from mooring C-09 for 25 July showing current speed contour plot (upper) and time-series for near-surface, mid-depth & near-bottom (lower) (ASL Cruise Report 2009).

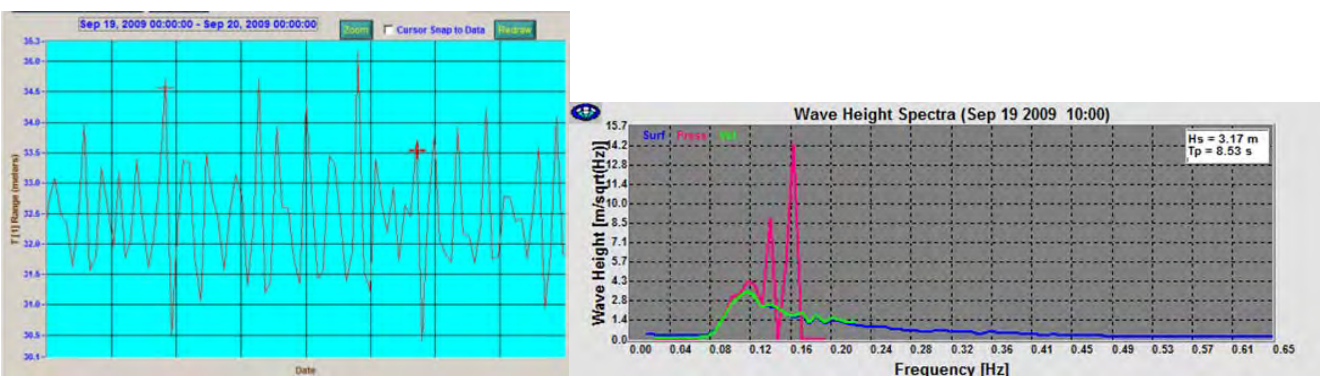


Figure 7.19. Data recorded on 19 September during an episode of strong winds. Left: IPS ranges at Site A1. Right: ADCP measured wave spectra at Site C (ASL Cruise Report 2009).

On 19 September, during a period of strong winds, waves up to 4 m height were measured by the IPS at Site A1 and by the ADCP at Site C (Figure 7.19). Preliminary wave spectra from the ADCP show significant wave height that reached 3.2 m with a peak wave period of 8.5 seconds.

7.3.2 ASL/IOL-BP mooring B-09

Preliminary results from the mooring at Site B are presented for 22 July 2009 as a representative example of the data sets (Figure 7.20 and 6.22). The upper panel shows the tidal signal form the Paros pressure sensor on the IPS5. The sinusoidal pattern of 12-hour period is due to the rise and fall of the tide. Tidal range is small in the Beaufort Sea, typically less than one meter in height. The middle panel shows targets from the upward looking IPS5 sonar. The IPS was at ~60 m depth and the targets at that range are echoes received back from the water surface. The tidal signal is evident and tracks that from the pressure. There are also echo returns from ice keels with ice drafts up to ~6 m. During processing, the tidal height will be taken out of the range data, otherwise ice keels would look deeper during periods of low tide and vice versa.

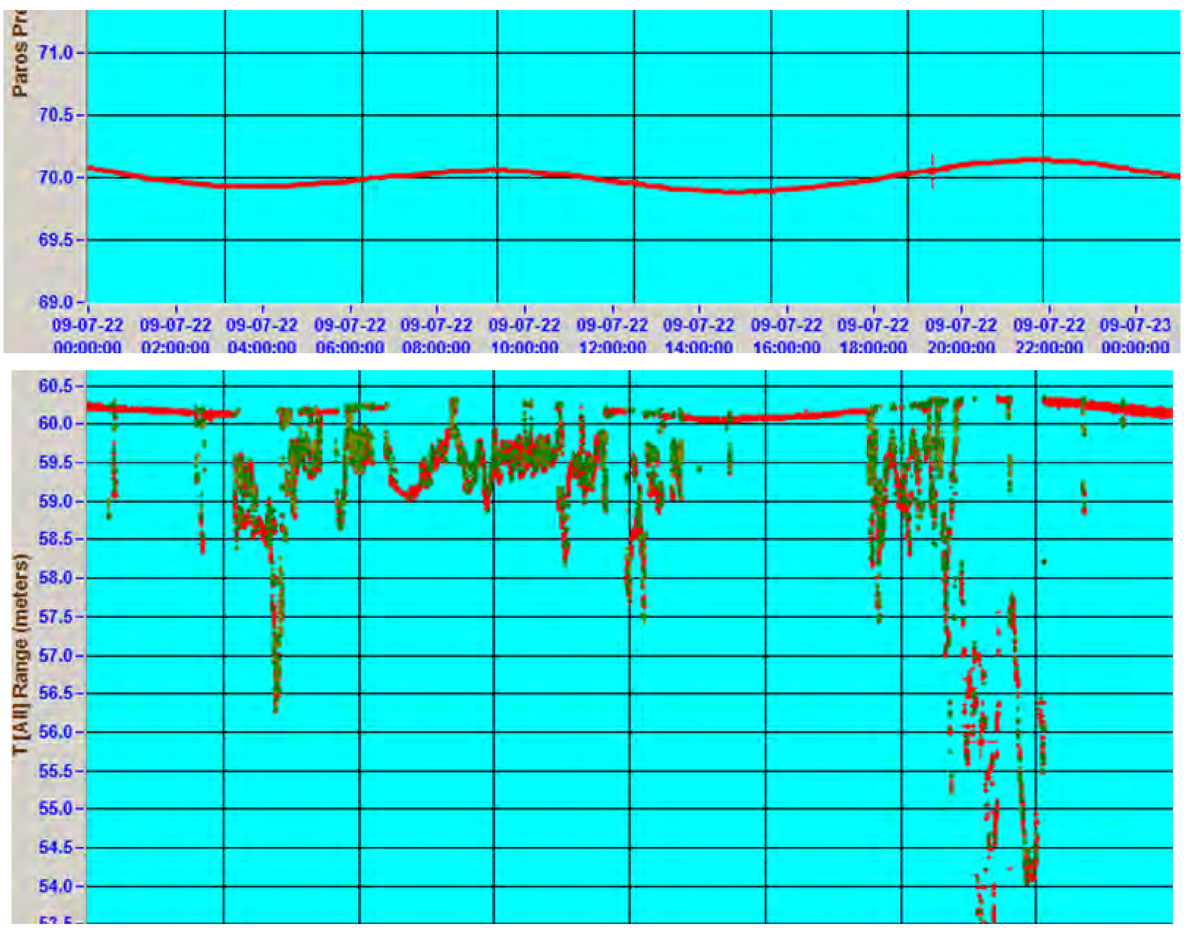


Figure 7.20. Preliminary IPS results obtained from the mooring deployed at Site B (example data from 22 July 2009).

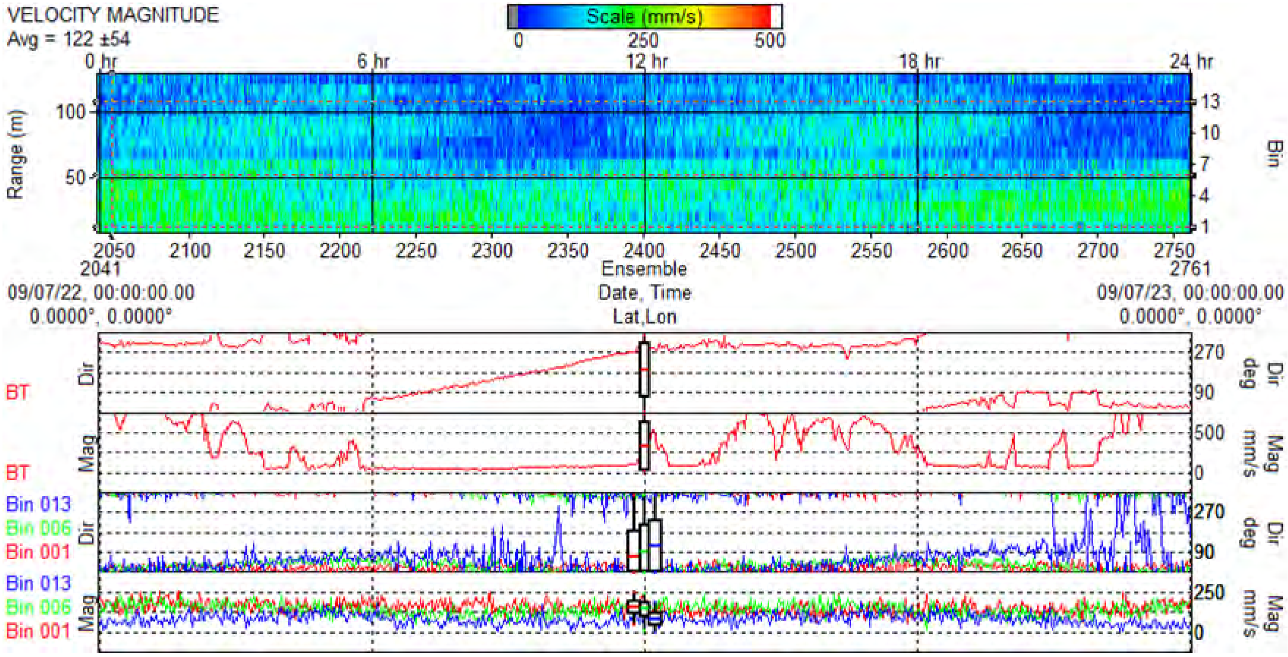


Figure 7.21. Preliminary ADCP results obtained from the mooring deployed at Site B (example data from 22 July 2009).

Some of the corresponding ADCP data is shown in Figure 7.21. The velocity contour plot of current speed shows current speeds up to ~25 cm/s possibly exhibiting a tidal periodicity. The ADCP also measures ice velocity via the bottom-track feature. Ice speeds up to ~10-20 cm/s were measured, and the ice velocity directions exhibited an increasing or "rotary" change of direction, possibly a tidal ellipse. The ADCP bottom-tracked ice velocity will be used to convert the ice draft time series into a distance series, allowing for statistical analyses such as the distribution of extremal ice draft features.

When there is no ice present, the IPS5 receives echo returns from the surface of the water and can therefore record wave data. At site B, burst data were collected at 2 Hz rate for 34 minutes starting every hour and a half (Figure 7.22). Below is an example of wave data from 11 September 2009 when the *Amundsen* was returning to Paulatuk at the end of Leg 3a. The waves were up to 2 m height and had a period of 6-7 seconds.

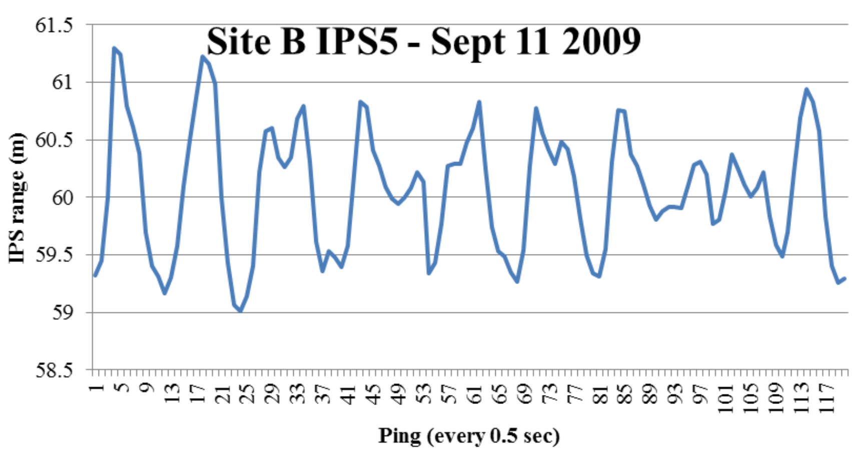


Figure 7.22. IPS data from an ice free period on 11 September 2009, showing surface waves.

The current distribution over the entire record (19 July – 16 September 2009) for 19 m depth at Site B shows that currents were generally aligned northeast-southwest, more frequently toward the northeast (Figure 7.23). The vector-averaged velocity was 3 cm/s towards 48 degrees true and the mean and maximum speeds were 11 and 49 cm/s respectively.

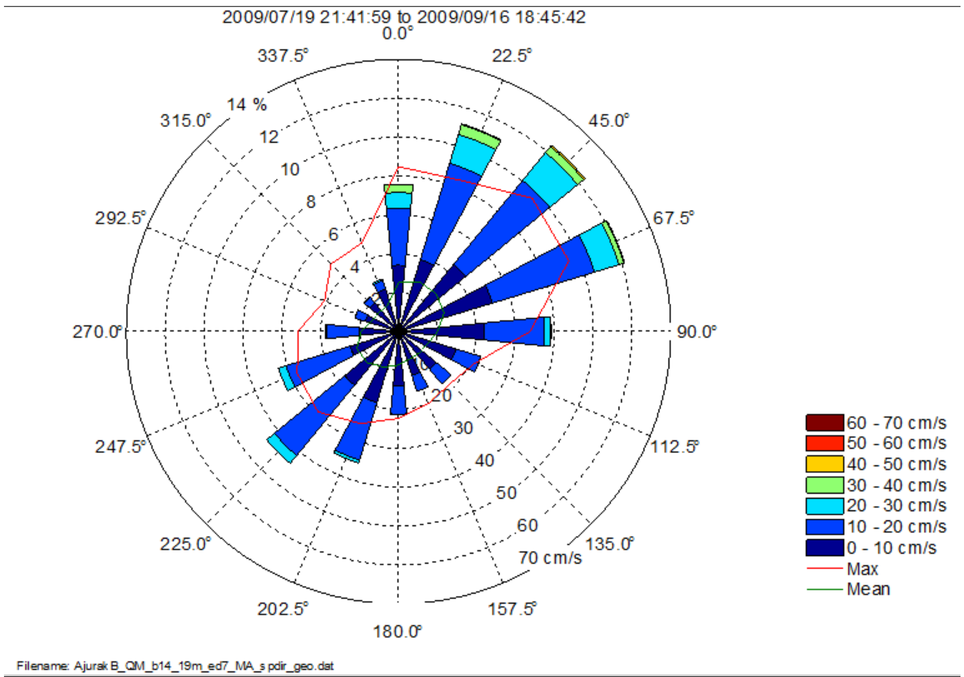


Figure 7.23. The current distribution over the entire record (19 July – 16 September 2009) for 19 m depth at Site B.

An RBR XR420 attached to the IPS cage of the mooring at Site B recorded conductivity, temperature, dissolved oxygen, fluorescence and turbidity. Derived parameters include sound speed and salinity. The data were plotted to verify proper operation of the instrument (Figure 7.24) and values were reasonable and the instrument was re-deployed logging, using the same setup.

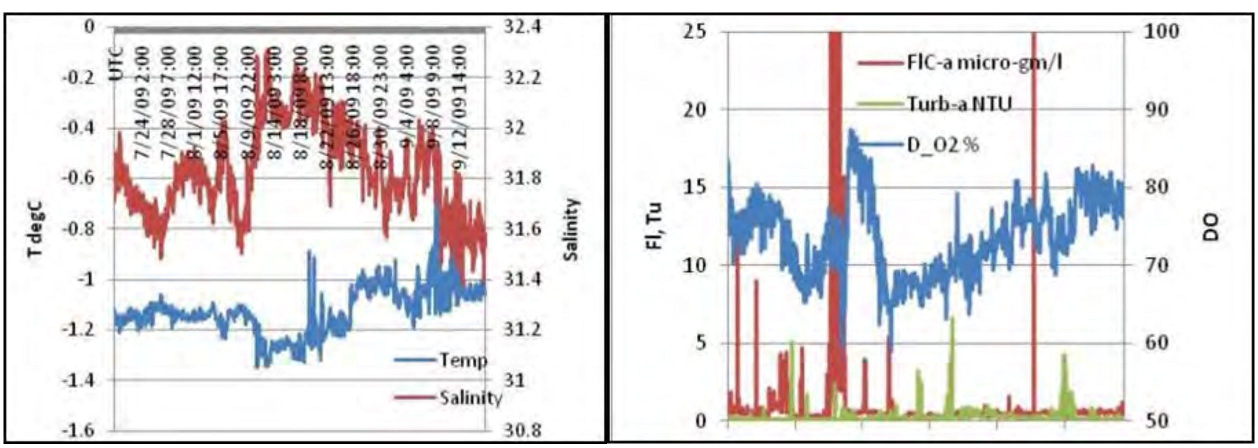


Figure 7.24. Time series plot of the data from the RBR logger attached to the IPS at site B: temperature, salinity (left); dissolved oxygen, fluorescence, turbidity (right) (ASL Cruise report Leg 3b, 2009).

An RBR CT logger attached to the QM ADCP cage recorded conductivity and temperature at Site B. Derived parameters include sound speed and salinity. The data was plotted to verify proper operation of the instrument and values were reasonable and the instrument was left logging using the same setup.

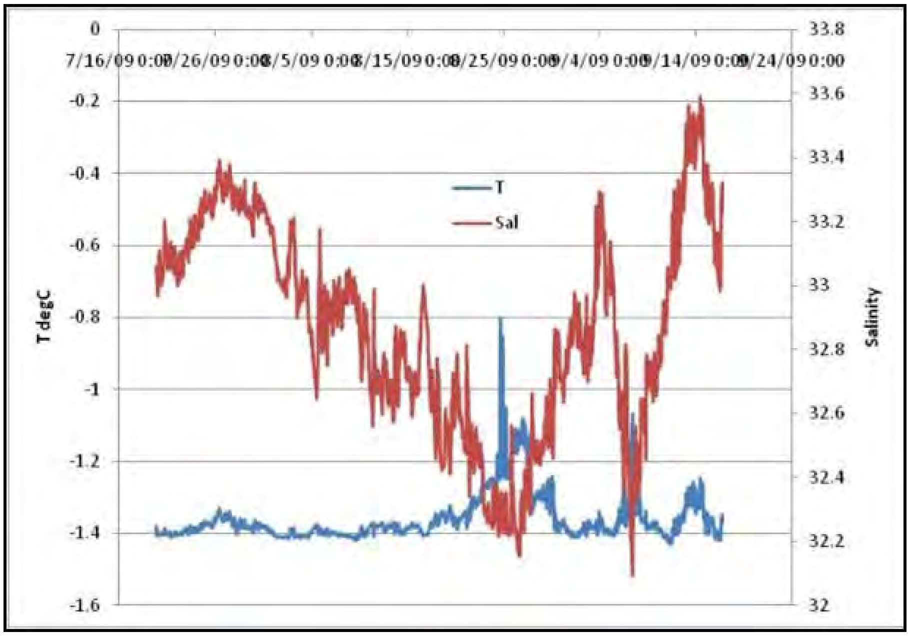


Figure 7.25. Time series of temperature and salinity obtained from the RBR logger attached to the ADCP at site B (ASL Cruise report Leg 3b, 2009).

7.3.3 ASL/IOL-BP mooring A1-09

Preliminary results from the upward-looking LRP at site A1 for a 2-day period show strong currents, up to ~60 cm/s, recorded at depths of ~50-150 m (Figure 7.26).

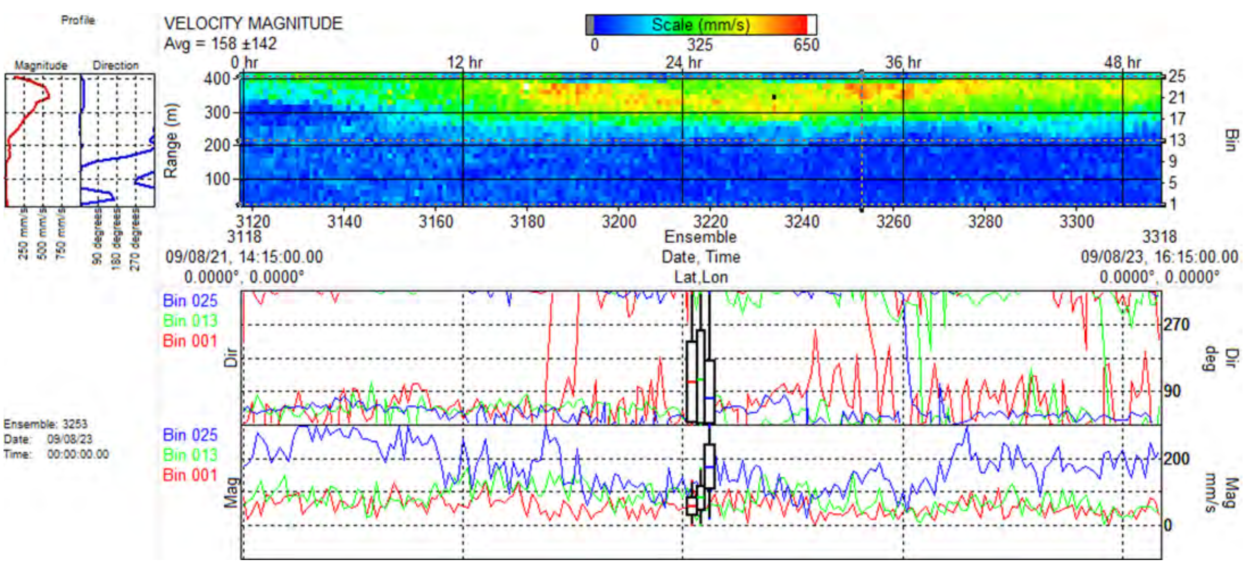


Figure 7.26. Two-day period of data from the upward-looking LR ADCP at ~450 m depth at site A1 (ASL Cruise Report Leg 3b, 2009).

7.3.4 *MetOcean – AXYS buoy at Site A1*

The current profile data extended over the upper 50 m of the water column. Twenty-five 2 m bins were sampled every 10 minutes, based on 125 second averages. The recorded water current data, averaged hourly, and speed contour plot, show current speeds up to ~ 50 cm/sec (Figure 7.27). There was a ~12-hour periodicity evident with the strongest currents occurring around 23-26 September. Since this was after a period of strong winds and the inertial period at these latitudes is about 12 hours, these currents may be due to inertial oscillations. The current directions are not shown and may not be useful since the magnetic compass on the current profiler may have been unable to obtain reliable headings due to the steel portion of the buoy that the profiler was attached to. The tilts recorded by the profiler were very low (< 3°), indicated that the 3 m buoy was very stable even in 2 m waves (check pitch/roll of buoy sensors).

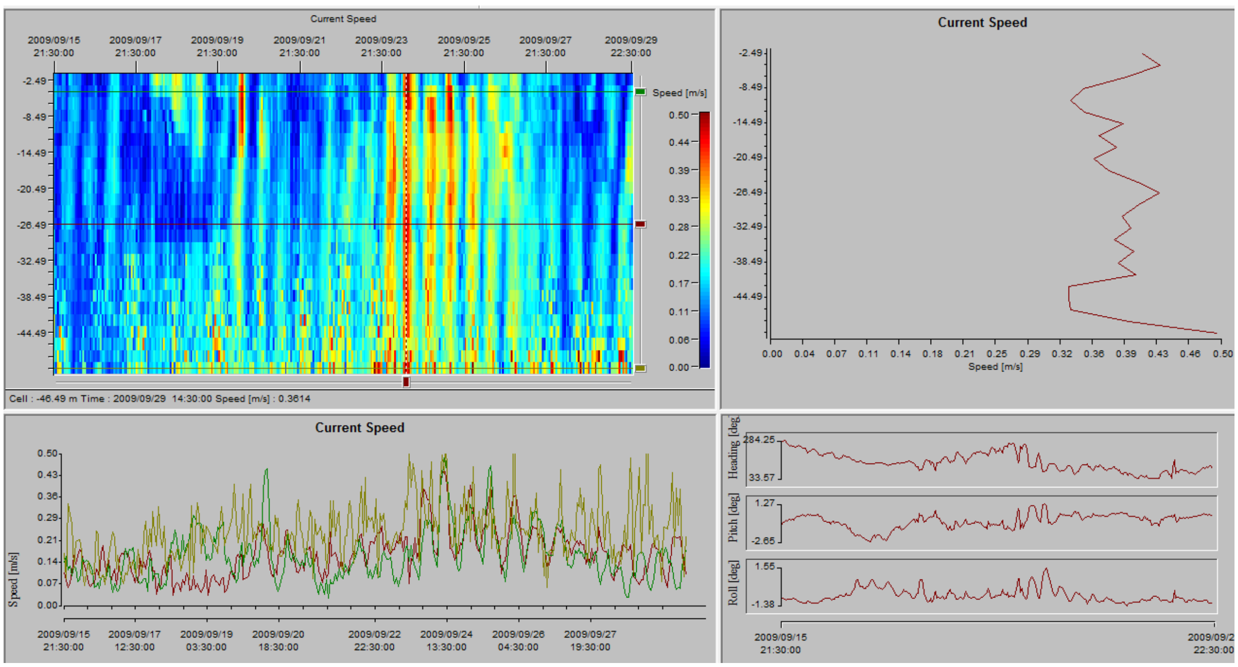


Figure 7.27. Preliminary data from the Nortek Current Profiler from MetOcean AXYS Buoy at Site A1 deployed during Leg 3b. Hourly-averaged speed contour plot (upper left), speed time series at 3 levels (lower left), velocity profile (upper right), and heading/pitch/roll time series (lower right) (ASL Cruise Report Leg 3b, 2009).

7.3.5 *Secondary surface buoy at Sites A & B*

Preliminary results are presented for the Alec EM current sensors located at 3 m depth on the secondary surface at Site A (EM #0123) and Site B (EM #0125) (Figure 7.28). They recorded current speeds of up to 60 cm/s and a semi-diurnal (~12 hr) periodicity.

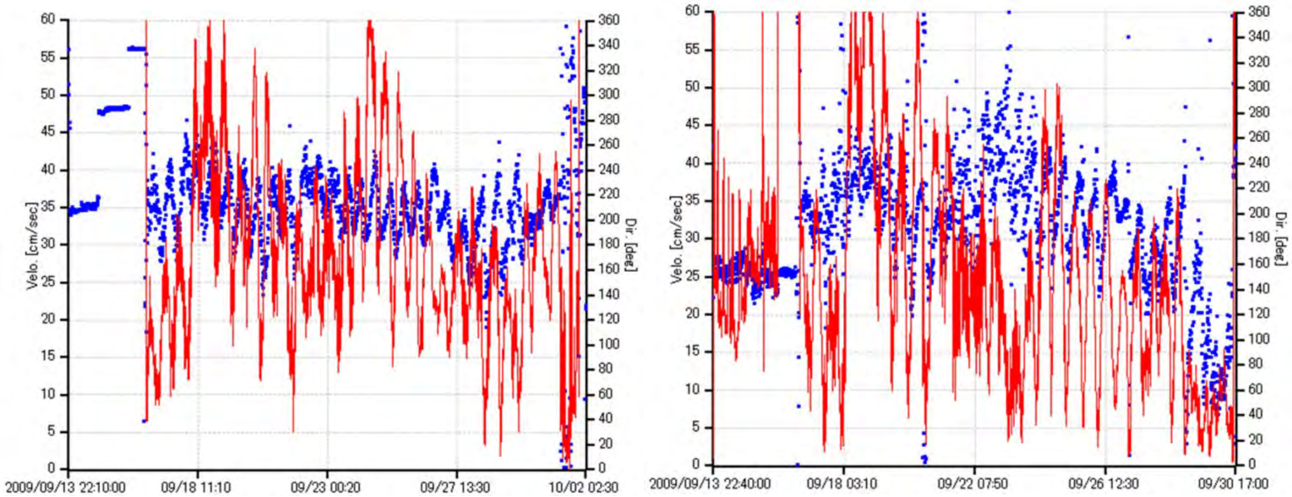


Figure 7.28. Preliminary current data from the Alec EM sensors at Site A (#0123) and Site B (EM #0125) located 3 m beneath the secondary buoy. Current speed (red), direction (blue). The in-air portions at the beginning and end have not yet been removed (ASL Cruise Report Leg 3b, 2009).

7.4 Comments and recommendations

7.4.1 Leg 2a – 16 July to 30 July 2009 – Beaufort Sea

RBR #17114 deployed at Site I: The DO cap inadvertently removed and electrolyte drained out. Refilled with electrolyte but did not re-calibrate. DO cap should be taped / affixed more firmly to prevent inadvertent removal.

Mooring CA16-08: At the surface, upon recovery, the Benthos 17" buoys (installed on the line just above the releases) weren't on the line anymore. A lack of buoyancy in the lower part of this mooring line explains why the mooring took a long time to surface. An ORE-SS30 could be added to the mooring line, next year (2010) as redundant / extra buoyancy in-case a loss of floats occurs again.

7.4.2 Leg 3b – 12 September to 8 October 2009 – Beaufort Sea

<u>Echo-sounder accuracy and IPS5 depth</u>

The taut-line mooring design required that the upper instrument, the IPS5 ice profiler, be deeper than 50 m to avoid contact with seismic arrays and deep ice keels. However data quality degrades with range so the IPS5s were planned for 60 m depth. The IPS5 also has a gated return window, typically 28-90 m range, outside of which echo returns are not recorded. Therefore it is important to make sure the IPS is close to the target depth, or valid ice keel data may be ignored.

In the deeper Ajurak water depths of 700-1000 m, depth sounding accuracy of 1% was required in order to make sure the IPS ends up within ±10 m or so of the targeted 60 m depth. This can generally be achieved with the echosounders on the *Amundsen*, but only if the sound speed profile is accurately known.

Mooring A1-09 was deployed at a reported depth of 688 m in July 2009, was found to be about 25 m shallower than expected when it was recovered in September 2009. This error in sounding depth (~4%) was apparently due to using a sound speed profile in July that was not accurate enough. The problem with deploying the IPS shallower than planned is that targets may fall outside the ~28-90 m window. Fortunately, the IPS collects ranges from several targets and if keel ranges are less than 28 m, then the IPS can often receive the echo as a double bounce and the ice draft can still be determined. A quick review of the Site A1 IPS data identified several cases of this, primarily during late July. In future it is important that the sound speed profile be measured (via a CTD profile or with the MVP) at each site, particularly the deeper sites, in order to be able to measure the water depth accurately.

Groundline – Bottom frame

At Site C, the groundline tangled with the pop-up buoy, preventing it from surfacing. The groundline consisted of 1" 3-strand polypropylene. The frame had been lowered using an acoustic release and released when it touched bottom. Then the 120 m groundline was paid out while the ship drifted away. The pop-up at the end of the groundline was then lowered about 20-30 m on a slip line and allowed to freefall the last 30 or so meters to bottom. It was probably here that the groundline had enough slack to be able to twist around the pop-up. Possible ways to prevent this from happening again in the future:

- Lower the pop-up right to bottom (another acoustic release is required) instead of free falling it.
- Use a torque-balance rope for the groundline that does not tend to twist back upon itself.
- Add weights to the groundline for the 20-odd meters closest to the pop-up. We always add small ~1lb weights every 10 m or so to keep the groundline from rising too high off the bottom (polypropylene rope floats) but additional weight near the pop-up would help keep the groundline down and away from the pop-up as it is being lowered.
- Make sure the groundline is taut by pulling on it before letting go of the pop-up.

RF-Flasher beacons on LR M40 floats & float visibility

The LR ADCPs in the M40 floats were found to lie on their side and not upright when on surface, and therefore the RF/Flasher was not pointing upward. This can be remedied by adding some ballast weight at the base of the ADCP cage, however it might be better to move these beacons to the IPS cages. The white float used on the Site C pop-up was not easily visible in rough water. A fluorescent orange float should be used.

Mousing wire

Tie wraps used to "mouse" shackle pins become brittle in sub-zero temperatures and tend to break. In future wire should be used.

Anode protection on the dual cart releases

The anodes provided by the manufacturer for the tandem assembly for the dual Cart releases are not adequate. Much larger anodes are required.

Deck space and storage

Crowding of the foredeck on the *Amundsen* continues to be an issue, as is storage. It is inefficient to store gear in a second story container on the helideck while it is needed for work on the foredeck. There is also an increase in risk having to access equipment from a container stacked atop another container. This will continue to be a problem as long as the ship is being used for multiple programs on a tight schedule.

7.4.3 NABOS program on the Kapitan Dranitsyn

In general, the multi-year NABOS mooring effort, to get mooring data from the Laptev and East-Siberian Seas, only produced data from two moorings from a single year. This lack of data relative to investment was a function of bad timing, heavy ice cover, poor mooring designs and several equipment failures. Future endeavours in this area must heed the advice and warnings from previous cruise reports.

References

INRS technical reports:

Rail M.E., Gratton Y. and Prieur L. 2011. Distribution of temperature and salinity in the Canadian Arctic Archipelago during the 2009 ArcticNet sampling expeditions. Report No R1248, INRS-ETE, Québec (Qc): vii + 69 p.

Boisvert D., Rail M.E., Bélanger C. and Gratton Y. 2011. ArcticNet/IOL 2009-2010 mooring data – Quality control report. Internal report (unpublished), INRS-ETE, Québec (Qc): v + 28 p.

ArcticNet mooring report:

Meredyk, S. 2014. 2009 Mooring Field Operations Report. ArcticNet Inc., Québec (Qc), 90 p.

8 Ice beacons – Leg 4a

ArcticNet Phase 2 – Project titled *Long-Term Observatories in Canadian Arctic Waters*. ArcticNet/Phase2/Gratton_marine_observatories.

Project leader: Yves Gratton[1] (yves_gratton@ete.inrs.ca)
Cruise participant Leg 4a: David Huard[1]
[1] *Institut national de la recherche scientifique (INRS) – Eau, terre et environnement (ETE), 490, de la Couronne, Québec, QC, G1K 9A9, Canada.*

8.1 Introduction

The objective of the Canadian Arctic Buoy Program (CABP) is to increase knowledge of ice processes in the Canadian Arctic Archipelago through ice floe instrumentation. Buoys have been launched in October 2007 and May 2009 using, respectively, the *Amundsen*'s helicopter and a plane chartered through the Polar Continental Shelf Program in Resolute. The cost of such deployments is high, in part due to travel expenses, but also due to the cost of the instruments themselves. The simplest ice beacons, manufactured by MetOcean, cost around 4 000$. The objective of the buoy deployment taking place during Leg 4a was to test a simple ice beacon made from a GPS tracker usually used to monitor truck and container fleets and sold for 200 US$. The tracker is mounted on a wooden base that stands about one foot above the ground.

8.2 Methodology

8.2.1 Deployment

The deployment took place in Viscount Melville Sound during the afternoon of 20 October (Leg 4a) using the *Amundsen*'s helicopter piloted by M. Dubé. The primary objective of the flight was to garner information on sea ice thickness using the EM pic mounted on the helicopter's nose. R. Galley and E. Stainton were aboard the helicopter to conduct the thickness survey, and kindly offered D. Huard to stop along the transects to deploy three ice beacons. Each deployment took about five minutes and consisted in turning on the device and anchoring it into the ice. The beacons were separated by about 10 nautical miles from each other and stood on separate multiyear ice floes located around 74°01.56'N and 106°04.26'W.

Figure 8.1. Deployment of an experimental ice beacon on a multiyear ice floe in Viscount Melville Sound during Leg 4a.

Two of the three beacons are now emitting their position which can be retrieved through the tracker vendors' website. The cause for the malfunction of the third buoy is yet unknown. One possibility is that is has been overturned by the wind generated by the helico's rotor. Tracker malfunction is unlikely since it had been tested on 18 October and was working at the time. The other buoys will communicate their position until their batteries die.

8.2.2 Data usage and dissemination

Ice floe GPS tracks will be used within the ice modelling group at McGill to evaluate and calibrate sea ice models. It provides accurate measurement of ice floe velocity, something that is hard to obtain using satellite data. The data will be transmitted to the Arctic Buoy Program for dissemination.

9 Water column structure and ocean circulation (CTD-Rosette, MVP and ADCP operations) – Legs 2a, 2b, 3a, 3b, 4a and 4b

ArcticNet Phase 2 – Project titled *Long-Term Observatories in Canadian Arctic Waters*. ArcticNet/Phase2/Gratton_Marine_observatories .

Project leaders: Yves Gratton[1] (yves_gratton@ete.inrs.ca) and Imperial Oil (Legs 2a and 3b)
Cruise participants Leg 2a: Imperial Oil, Yves Gratton[1], Claudie Marec[2], Marc Picheral[3] and Louis Prieur[3]
Cruise participants Leg 2b: Yves Gratton[1], Claudie Marec[2], Marc Picheral[3] and Louis Prieur[3]
Cruise participants Leg 3a: Dominique Boisvert[1] and Véronique Dansereau[1]
Cruise participants Leg 3b: Imperial Oil, Dominique Boisvert[1] and Véronique Dansereau[1]
Cruise participants Legs 4a and 4b: Dominique Boisvert[1] and David Huard[1]

[1] *Institut national de la recherche scientifique (INRS) – Eau, terre et environnement (ETE), 490, de la Couronne, Québec, QC, G1K 9A9, Canada.*

[2] *Institut national des sciences de l'univers (INSU), Centre national de la recherche scientifique (CNRS), Bâtiment IPEV - Centre Ifremer, Technopôle Brest-Iroise, BP 74, 29280, Plouzane, France.*

[3] *Laboratoire d'Océanographie de Villefranche (LOV), B.P. 8, 06238 Villefranche-sur-Mer, France.*

9.1 Introduction

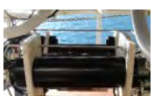
The main objective of this project is to describe the water masses and the general circulation in the Canadian Arctic and to characterize the water column physical and chemical properties: temperature, salinity, fluorescence, pH, dissolved oxygen, nitrates concentration, light penetration and turbidity.

9.2 Methodology

9.2.1 Instrumentation

The General Oceanics Rosette was equipped with twenty-four 12 liter Niskin bottles that were remotely closed at predetermined depths. A SBE 911 CTD and various other sensors were used mounted on the Rosette frame (Table 9.1). The Rosette also provided water samples for biologists and chemists. A LADCP (Lowered Acoustic Doppler Current Profiler; Figure 9.1 left) and a UVP 5 (Underwater Vision Profiler; Figure 9.1 right) were also added to the Rosette during some legs. See Section 10 for a detailed report for the UVP 5 operations during Leg 2a. A Trace Metal Rosette was used during the GEOTRACES campaign in Leg 3a.

Table 9.1. Sensors equipped on the Rosette.

Photo	Item	Manufacturer	Type & Properties	Serial Number
	CTD	SeaBird	SBE-911 Sampling rate : 24 Hz	2696 0679 (Leg 4)
	Temperature	SeaBird	SBE 3plus Range: -5°C to + 35°C Accuracy: 0.001	4204
	Pressure	Digiquartz (Legs 1 and 2) SeaBird (Leg 3a, 4a)	Accuracy: 0.015% of full range	0730 90584
	Conductivity	SeaBird	SBE 4C Range: 0 to 7 S/m Accuracy: 0.0003	2696
	Oxygen	SeaBird	SBE-43 Range: 120% of saturation Accuracy: 2% of saturation	0240 (Legs 1, 2, 3b) 0427 (Legs 3a, 4)
	pH [a,b]	SeaBird	SBE-18 Range: pH from 0 to 14 Accuracy: pH 0.01	0714 (Legs 1, 2, 3b) 0444 (Leg 3a)
	Nitrates [a]	Satlantic	MBARI ISUS Range: 0.5 to 200 μM Accuracy: ± 2 μM	132 (Legs 1, 2, 3b) 134 (Leg 3a, 4a)
	PAR [a]	Biospherical		4664
	SPAR	Biospherical		20147 20123 (Leg 4b)
	Fluorometer [c]	Sea Point		2900 (Legs 1, 2, 3b) 2465 (Legs 3a, 4)
	Transmissometer	WetLab	Path length: 25 cm	CST-671DR (Legs 1, 2, 3b) CST-558DR (Leg 3a, 4a)
	Altimeter	Benthos		1061 1044 (Leg 4)
	ECO fluorometer (CDOM) on Leg 4a and 4b only	Wet Labs	FL(RT)D Digital output resolution:14 bit Analog output signal: 0-5 V Range: 0.09-500 ppb Ex/Em: 370/460 nm	

[a] The Rosette was restricted to the first 1000 m because of the PAR, Nitrates and pH sensors.
[b] After cast #0902045, the pH sensor was replaced by a CDOM (owned by Prof. Ron Benner, U. of South Carolina). The instrument was a Haardt backstcat CDOM fluorometer with a depth range of 0-6000 m.
[c] A new Seapoint fluorometer cable was installed before cast 0902102. The correct range is now 0-15 μg/L instead of 0-5 μg/L.

Figure 9.1. Photos of the LADCP (left) and UVP 5 (right) equipped on the Rosette during Leg 2a.

Table 9.2. Rosette's sensors specifications.

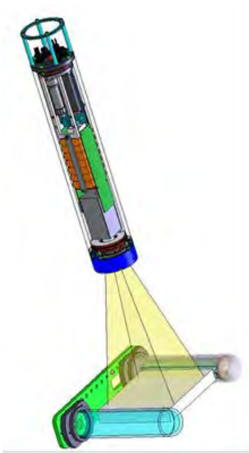
Parameter	Sensor		Range	Accuracy	Resolution
	Manufacturer	Instrument Type			
CTD	SeaBird	SBE-9plus [1]			
Temperature	SeaBird	SBE-03 [1]	-5°C à +35°C	0.001°C	0.0002°C
Conductivity	SeaBird	SBE-4C [1]	0-7 S/m (0-70mmho/cm)	0.0003 S/m (0.003mmho/cm)	0.00004 S/m (0.0004 mmho/cm)
Pressure	Paroscientific	410K-105	up to 10 500m (15 000psia)[2]	0.015% of full scale	0.001% of full scale
Dissolved oxygen	SeaBird	SBE-43 [3]	120% of surface saturation[4]	2% of saturation	unknown
pH	SeaBird	SBE-18-I [5]	0-14 pH units	0,1 pH unit	unknown
Nitrates concentration	Satlantic	MBARI-ISUS 5T[6]	0.5 to 2000 μM	±2 μM	±0.5 μM
Light intensity (PAR)	Biospherical	QCP2300	1.4×10^{-5} to 0.5 μE/(cm^2·sec)	□	□
sPAR	Biospherical	QCP2200	1.4×10^{-5} to 0.5 μE/(cm^2·sec)	□	
Fluorescence	Seapoint	Chlorophyll-fluorometer	0.02-150 μg/l	unknown	30
Transmissiometer	Wetlabs	C-Star	0-5 V	unknown	1.25 mV
Altimeter	Benthos	PSA-916 [7]	0 - 100 m	unknown	0.01 m

Notes: [1] Maximum depth of 6800m
[2] Depending on the configuration
[3] Maximum depth of 7000m
[4] In all natural waters, fresh and marine
[5] Maximum depth of 1200m
[6] Maximum depth of 1000m
[7] Maximum depth of 6000m

The Rosette team also handled other physical oceanographic instruments on board. They included a 150 kHz Ship-Mounted Acoustic Current Profiler (SM-ADCP), a Moving Vehicle Profiler (MVP) and a Self-Contained Autonomous Micro-Profiler (SCAMP). The MVP was not used in Legs 2a and 3a, and the SCAMP was not used in Legs 2a, 3a and 3b.

Figure 9.2. The SM-ADCP (Ship-Mounted Acoustic Current Profiler; left), the MVP (Moving Vehicle Profiler; center) and the SCAMP (Self-Contained Autonomous Micro-Profiler; right) used on the *Amundsen*.

The 300 kHz LADCP (Lowered Acoustic Current Profiler) was mounted on the Rosette frame during casts. The LADCP was programmed in *individual ping* mode (one every second). The horizontal velocities were averaged over thirty-two, 4 m *bins* for a total (theoretical) range of 100 to 120 m. Since the ADCP was lowered in the water column with the Rosette, there will be several measurements for each depth interval. The data processing was done in Matlab® according to Visbek (2002).



The UVP 5 (Underwater Vision Profiler; Figure 9.3) is an autonomous underwater imaging system designed and built at the LOV (Laboratoire d'océanographie de Villefranche) in Villefranche-sur-mer, France (see Section 10 for more details).

Figure 9.3. The UVP 5 profiler used during Leg 2a.

9.2.2 Sensor calibration

pH: tests were done at least twice on each leg using two buffers: one at pH 4 and the other at pH 7. The pH sensor was removed before cast #0902045 of Leg 2b, and no pH was recorded during Legs 3a and 3b.

CDOM: A new Haardt backscat CDOM fluorometer replaced the pH sensor (see above) during Legs 3a and 3b, and a Wet Labs ECO CDOM fluorometer was equipped on the Rosette on Legs 4a and 4b (Table 9.1).

Salinity: Samples were usually taken on contaminants' casts as well as nutrients casts and were analyzed onboard with a Guildline model 8400B (range from 0.005 to 42 and accuracy < 0.002).

Figure 9.4. Bottles used to collect samples (left) for salinity calibration and the Guildline instrument (right) used to analyze the samples onboard the *Amundsen*.

Oxygen: Oxygen calibrations were performed onboard during or after each leg using Winkler's method and a Mettler Toledo Titrator. Reagent blanks were tested at least once per leg. Water samples for oxygen titration were generally obtained from approximatively a dozen casts per leg, except for Legs 3a, 3b, 4a and 4b where oxygen was sampled on one cast at five depths of different oxygen concentration, sampled in triplicates.

Figure 9.5. Bottles used to collect samples (left) for oxygen calibration and the Mettler Toledo titrator (right) used to analyze the samples onboard the *Amundsen*.

9.2.3 Sampling sites

<u>Leg 2a – 16 July to 30 July 2009 – Beaufort Sea</u>

The sampling region was centred in the IOL's Ajurak lease block (Figure 9.6).

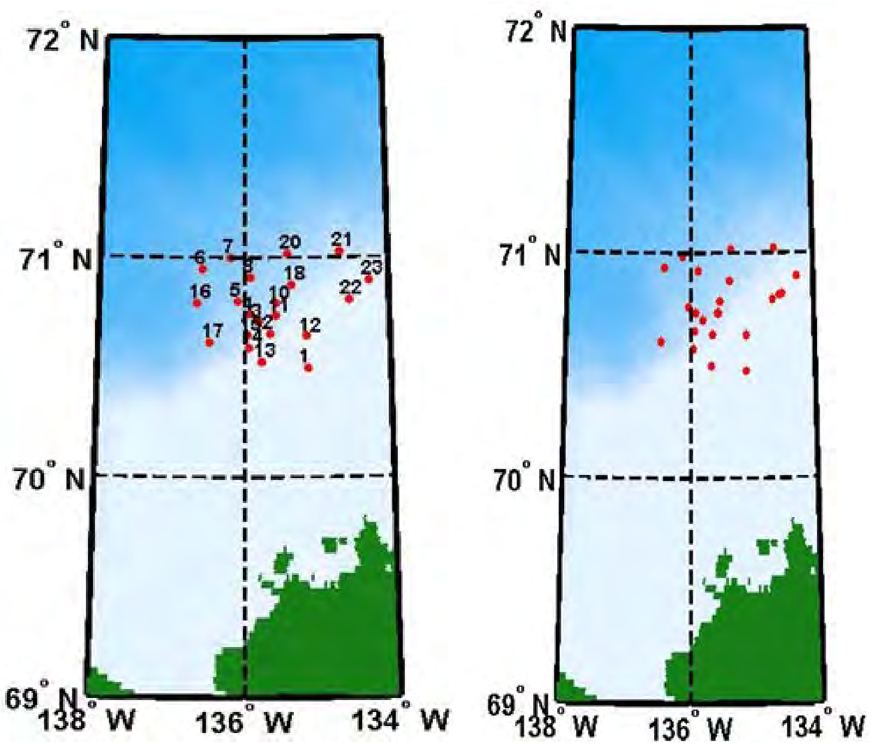


Figure 9.6. Map with the locations and number ID of IOL's stations (left) and the actual sites of CTD-Rosette casts (right) for Leg 2a.

Leg 2b – 30 July to 27 August 2009 – Beaufort Sea

The sampling region was very similar to the CASES overwintering expedition (2002-2003). The locations of all the CTD-Rosette casts are shown on Figure 9.7.

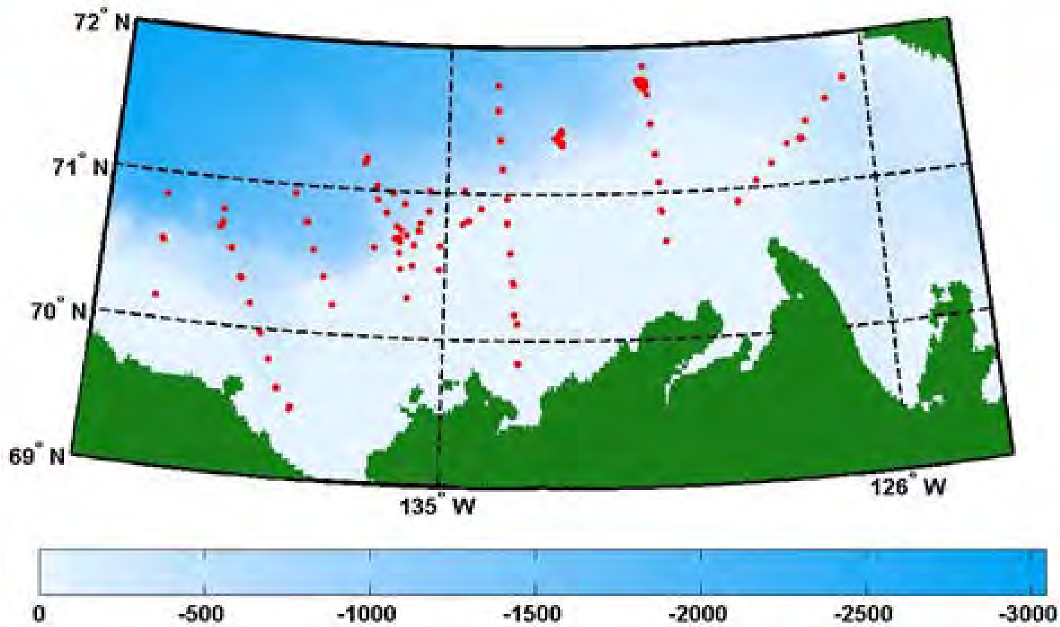


Figure 9.7. Locations of all the Malina CTD-Rosette casts conducted during Leg 2b.

Leg 3a – 27 August to 12 September 2009 – Beaufort Sea

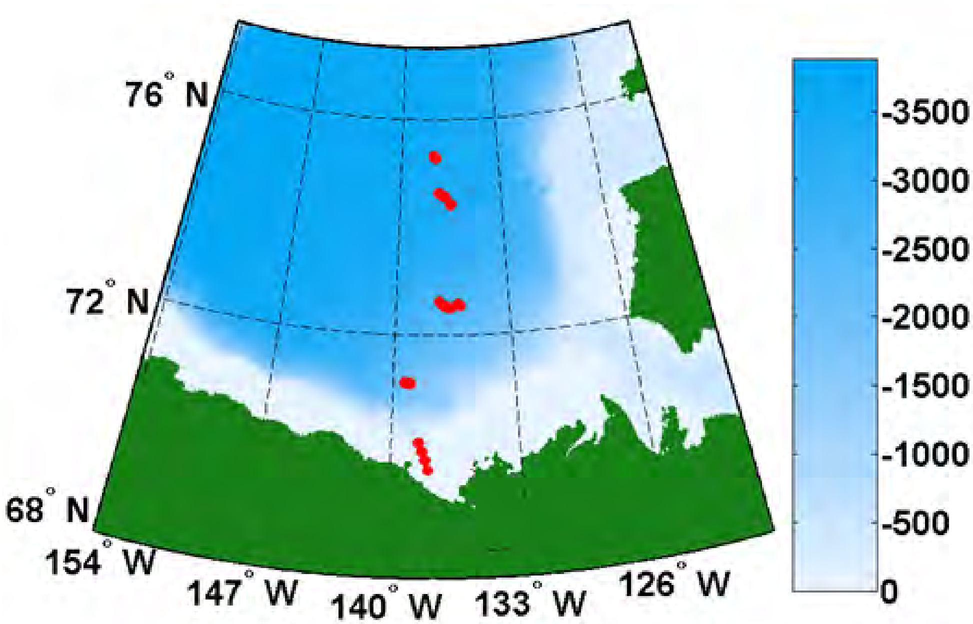


Figure 9.8. Locations of the GEOTRACES stations where CTD-Rosette casts (either regular or Trace Metals) were carried out during Leg 3a.

Leg 3b – 12 September to 8 October 2009 – Beaufort Sea

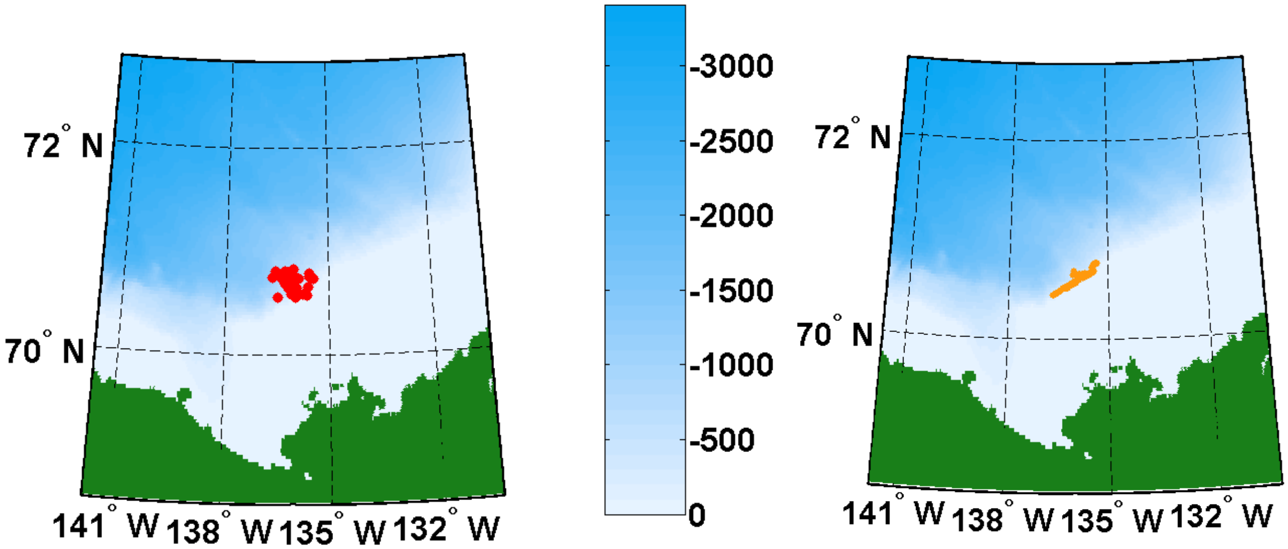


Figure 9.9. Locations of the stations where CTD-Rosette casts (red, left panel) and MVP casts (orange, right panel) were done in the IOL Ajurak exploration lease during Leg 3b.

Leg 4a – 8 October to 6 November – Beaufort Sea, NW Passage, Baffin Bay

Sampling operations during Leg 4a included the Amundsen Gulf, the Northwest Passage and Baffin Bay.

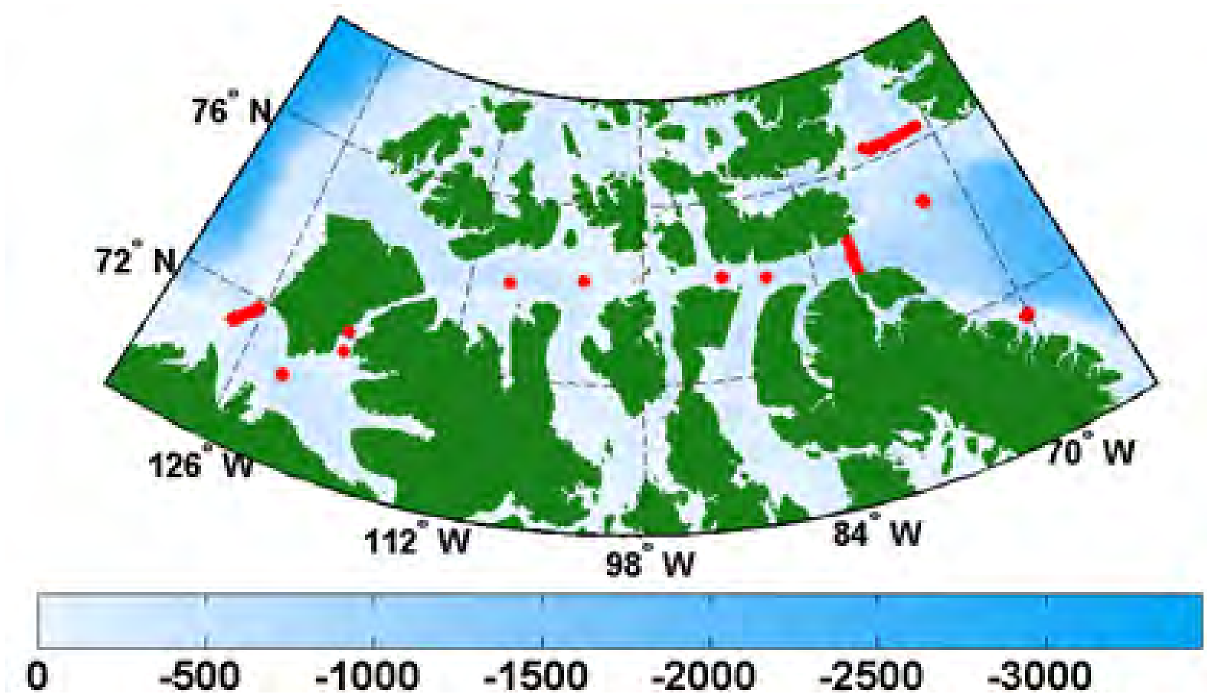


Figure 9.10. Map showing the location of stations where CTD-Rosette casts were conducted in Leg 4a.

Leg 4b – 6 November to 18 November – Labrador fjords

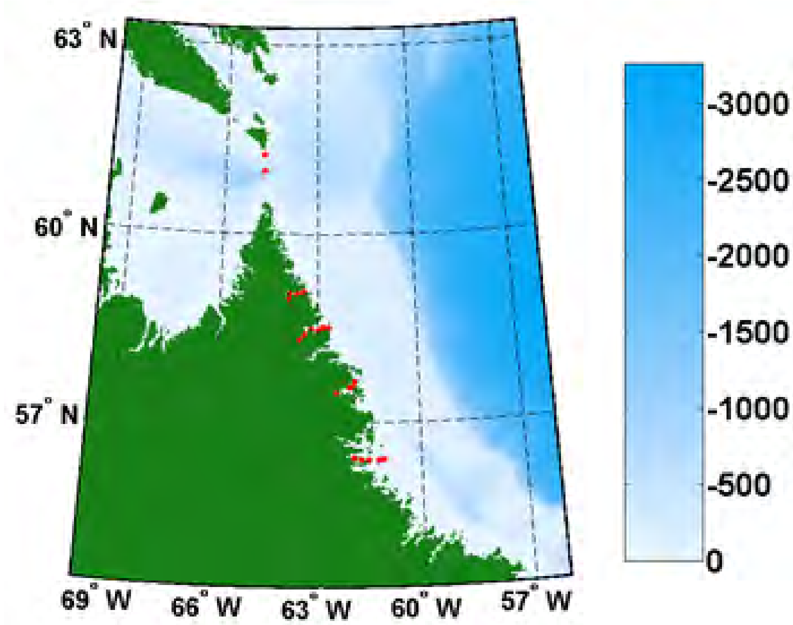


Figure 9.11. Map showing the location of stations where CTD-Rosette casts were conducted in Leg 4b.

9.2.4 Water samples

Leg 2a – 16 July to 30 July 2009 – Beaufort Sea

Water samples were collected with the Rosette for quality control and calibration of the salinity and dissolved oxygen sensors as well as for the different teams at the following depths:

Nutrients (J.-É. Tremblay's team): chlorophyll maximum, 10 m above and 10 m under chlorophyll maximum, salinity of 33.1, 5 m, 10 m, 20 m, 30 m, 40 m, 50 m, 60 m, 70 m, 80 m, 100 m, 120 m, 140 m, 160 m, 180 m, 200 m, 250 m, 300 m and every 100 m down to the bottom.

Primary production (N. Garcia's team) new and regenerated production associated with total and dissolved organic matter: surface, 5 m, 10 m, 15 m, 20 m, 30 m, 40 m, 50 m, 60 m, 70 m, 120 m, 160 m, 200 m, 300 m and 600 m.

Contaminants (G. Stern's team): same depths as for nutrients.

Leg 3a – 27 August to 12 September 2009 – Beaufort Sea

Water was sampled according to each team's requests, usually at the following depths:

Biology (D. Varela): Surface, 50% light, 10% light, 1% light, 0.1% light, chlorophyll maximum.

Biogeochemistry (R. Rivkin): Bottom, every 200 m up to the surface.

DIC (A. Mucci): 5 m, 10 m, 20 m, 30 m, 40 m, 50 m, 60 m, 80 m, 100 m, 125 m, 150 m, 175 m, 200 m, 250 m, 300 m and every 100 m down to the bottom.

Leg 4a – 8 October to 6 November – Beaufort Sea, NW Passage, Baffin Bay

Water was sampled according to each team's requests, usually at the following depths:

Nutrients (J.-É. Tremblay): Salinity of 33.1, Chlorophyll maximum, Surface, 10 m, 20 m, 30 m, 40 m, 50 m, 60 m, 80 m, 100 m, 120 m, 140 m, 160 m, 180 m, 200 m, 250 m, 300 m and every 100 m down to the bottom.

DIC, ^{18}O, pH (A. Mucci): Salinity of 33.1, Surface, 10 m, 20 m, 30 m, 40 m, 50 m, 60 m, 80 m, 100 m, 120 m, 140 m, 160 m, 180 m, 200 m, 250 m, 300 m and every 100 m down to the bottom.

Mercury (H. Hintelmann): Surface, Bottom and Mid-water column (unusual biological activity).

DOC/DON (C. Michel): Salinity of 33.1, Surface, 10 m, 20 m, 30 m, 40 m, 50 m, 60 m, 80 m, 100 m, 120 m, 140 m, 160 m, 180 m, 200 m, 250 m, 300 m and every 100 m down to the bottom.

Diversity (C. Lovejoy): Surface, Bottom, Temperature min/max, Oxygen min/max, Nitracline, Chlorophyll maximum.

CDOM (M. Babin): Surface, 10 m, 20 m, 30 m, 40 m, 50 m, 60 m, 80 m, 100 m and 150 m.

Primary production (M. Gosselin): 50%, 30%, 15%, 5%, 1%, 0.2% of incident light, Chlorophyll maximum, 75 m and 100 m while in open water, or nutrients profile above 100 m deep.

Microlayer (L. Miller): Surface, 10 m, 20 m, 30 m, 40 m, 50 m, 60 m, 80 m, 100 m, 150 m and bottom.

Leg 4b –6 November to 18 November – Labrador fjords

Nutrients (T. Brown and M. Gosselin): Salinity of 33.1, Chlorophyll maximum, Surface, 10 m, 20 m, 30 m, 40 m, 50 m, 60 m, 80 m, 100 m, 120 m, 140 m, 160 m, 180 m, 200 m, 250 m, 300 m and every 100 m down to the bottom.

Mercury (H. Hintelmann): Surface, Bottom and Mid-water column (unusual biological activity).

DOC/DON (C. Michel): Salinity of 33.1, Surface, 10 m, 20 m, 30 m, 40 m, 50 m, 60 m, 80 m, 100 m, 120 m, 140 m, 160 m, 180 m, 200 m, 250 m, 300 m and every 100 m down to the bottom.

CDOM (M. Babin): Surface

Primary production (M. Gosselin): 50%, 30%, 15%, 5%, 1%, 0.2% of incident light, Chlorophyll maximum, 75 m and 100 m while in open water, or nutrients profile above 100 m deep.

Microlayer (L. Miller): Surface, 10 m, 20 m, 30 m, 40 m, 50 m, 60 m, 80 m, 100 m, 150 m and bottom.

9.2.5 *Data availability*

All the information related to the CTD-Rosette casts for all legs of the 2009 Expedition is summarized in the CTD Logbook (Appendix 3) and includes cast number and station ID, date and time of sampling in UTC, latitude and longitude, bottom and cast depths, and comments concerning each cast. For every cast, data from three seconds before a bottle was closed to seven seconds after was averaged and recorded in the ascii '*bottle files*'. The information in these files included the bottle number, time and date, trip pressure, temperature, salinity, light transmission, fluorescence, dissolved oxygen, irradiance and pH measurements.

Leg 2a – 16 July to 30 July 2009 – Beaufort Sea

During Leg 2a between 17 July and 30 July 2009:

- 24 CTD casts were obtained with the Rosette (see CTD logbook in Appendix 3).
- The SM-ADCP (150 kHz) produced good quality data as long as it "saw" the bottom.
- No MVP sections were carried out.
- No SCAMP profiles were conducted.

Leg 2b – 30 July to 27 August 2009 – Beaufort Sea

During Leg 2b (Malina program) between 31 July and 26 August:

- 167 CTD casts were obtained with the Rosette (see CTD logbook in Appendix 3).
- The SM-ADCP (150 kHz) recorded continuously and the data was of good quality as long as it "saw" the bottom.
- No MVP sections were carried out.
- 32 SCAMP profiles were obtained.

Leg 3a – 27 August to 12 September 2009 – Beaufort Sea

During Leg 3a (GEOTRACES program) between 27 August and 12 September, a total of 45 casts were obtained with the CTD-Rosette (see CTD logbook in Appendix 3).

The ship mounted RDInstruments Ocean Surveyor ADCP (SM-ADCP) recorded data continuously throughout Leg 3a.

Leg 3b – 12 September to 8 October 2009 – Beaufort Sea

A total of 31 CTD-Rosette casts were performed between 12 September and 8 October (see CTD logbook in Appendix 3) and a total of 107 MVP casts were done along 4 transects. Examples of comparisons between the MVP and CTD vertical profiles are shown in the preliminary results section below.

The ship mounted RDInstruments Ocean Surveyor ADCP (SM-ADCP) recorded data continuously throughout Leg 3b.

Leg 4a – 8 October to 6 November – Beaufort Sea, NW Passage, Baffin Bay

A total of 65 CTD-Rosette casts were performed during Leg 4a between 8 October and 3 November 2009. One MVP transect was done just south of Prince of Wales Strait. The ship mounted RDInstruments Ocean Surveyor ADCP (150 kHz) recorded data continuously during the leg. The SCAMP profiler was out of commission in Leg 4a.

Leg 4b – 6 November to 18 November – Labrador fjords

A total of 24 CTD-Rosette casts were performed during Leg 4b between 7 November and 13 November 2009. The Moving Vehicle Profiler (MVP) transects were attempted in Nachvak and Saglak Fjords, however due to technical problems, operations were cancelled. The MVP was not attempted again in Leg 4b. The ship mounted RDInstruments Ocean Surveyor ADCP (150kHz) recorded data continuously during the leg. The SCAMP profiler was out of commission in Leg 4b.

9.3 Preliminary results

9.3.1 Leg 2a – 16 July to 30 July 2009 – Beaufort Sea

SM-ADCP

The 150 kHz SM-ADCP provided dependable horizontal currents only down to 125 or 150 m, the protective ice window in the hull absorbing part of the energy. The signal could reach down to 200-300 m when the ship was on station. ADCP data from CASES (Canadian Shelf Exchange Study; 2002-2003) stations located on transect 400 (Sachs Harbor to Cape Bathurst) were especially good.

LADCP

A 300 kHz LADCP (Lowered Acoustic Doppler Current Profiler) was mounted on the Rosette frame. A profile from cast #22 at Station M-09 is presented in Figure 9.12. The currents (Figure 9.12, LADCP panel) were observed to be towards the North-Northwest at approximately 20 cm s^{-1}. This CTD profile was significantly different than all the previous ArcticNet profiles obtained in the same area (Figure 9.13). Moreover, the Beaufort Undercurrent usually flows at this depth, but towards the Northeast. A cursory comparison with the SM-ADCP confirms the LADCP estimate. The current was at its maximum around 120 m (Figure 9.12), at the location of the Arctic thermocline (Figure 9.14). The bottom of the Bering Sea Winter Water (salinity of 33.1; Figure 9.14) was found 100 m higher than usual. A more detailed analysis is obviously needed.

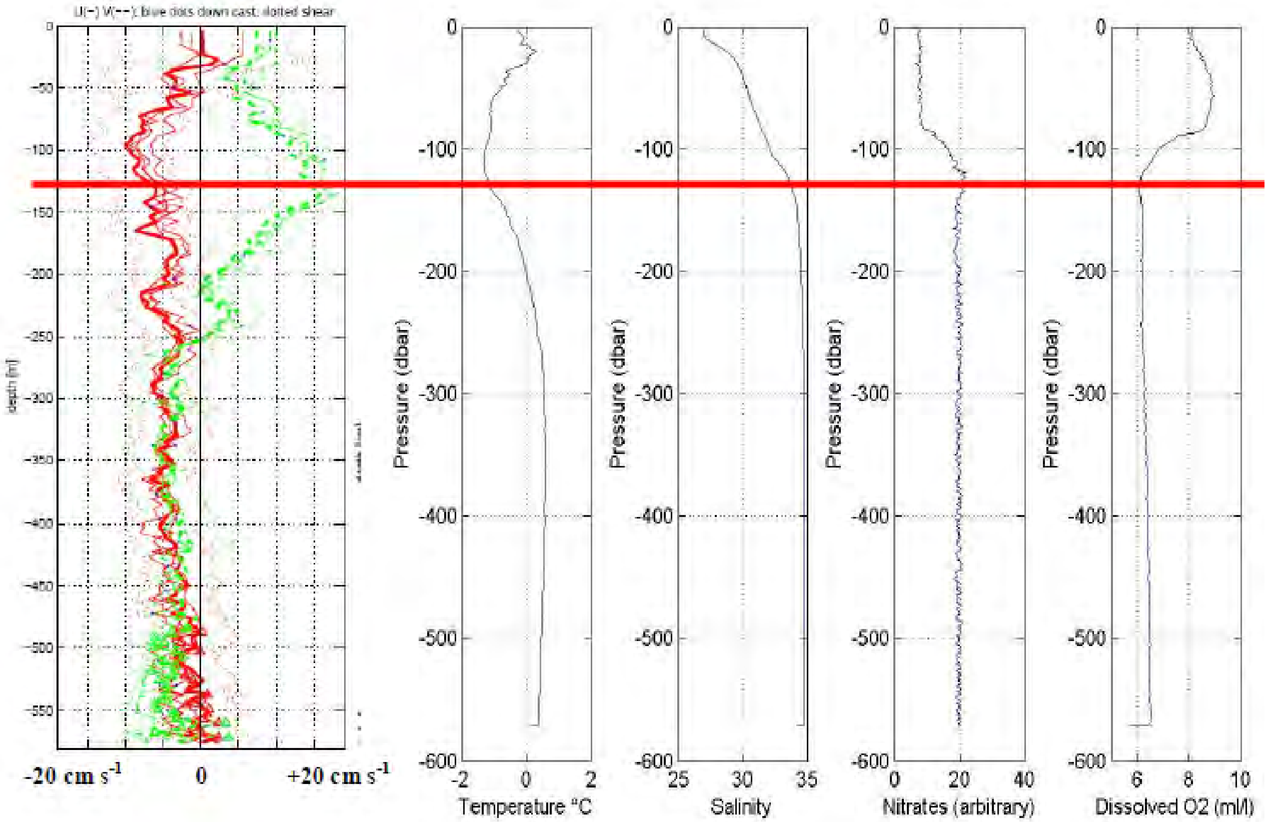


Figure 9.12. From left to right: horizontal velocities (solid red: U eastward; dashed green: V northward), temperature, salinity, nitrates and dissolved oxygen at Station M-09 in the Beaufort Sea during Leg 2a.

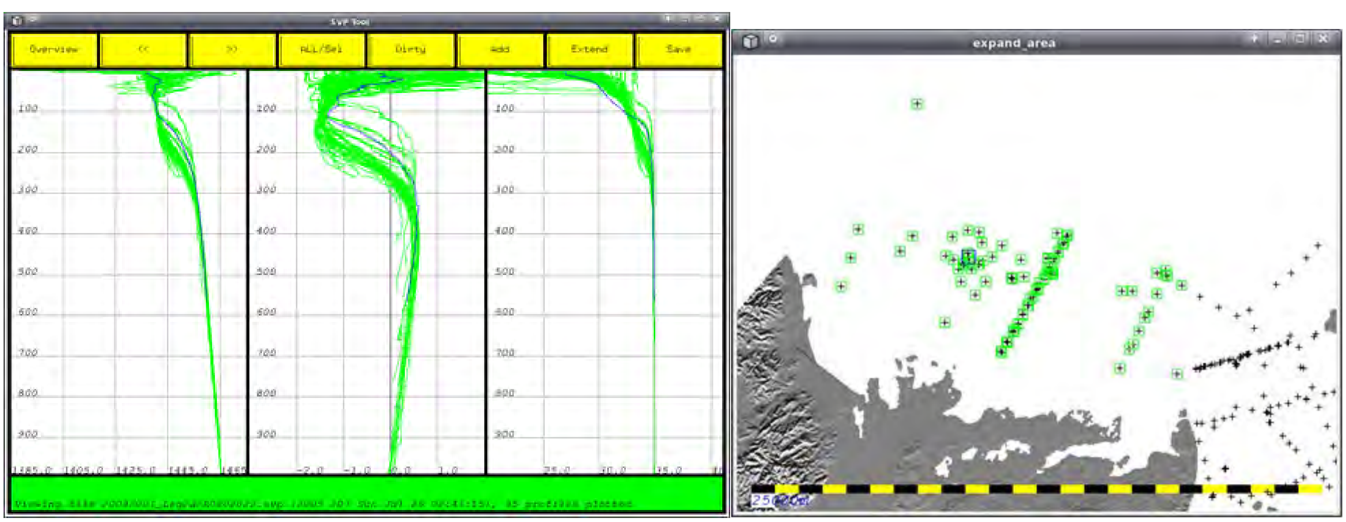


Figure 9.13. Upper panel (from left to right): sound velocity, temperature and salinity at Station M-09 (black lines) overlying all the ArcticNet CTD profiles (green lines) in the same region since 2002. The locations of the historical CTD casts are highlighted in green in the lower panel. Courtesy of J. Beaudoin (U. of New Brunswick).

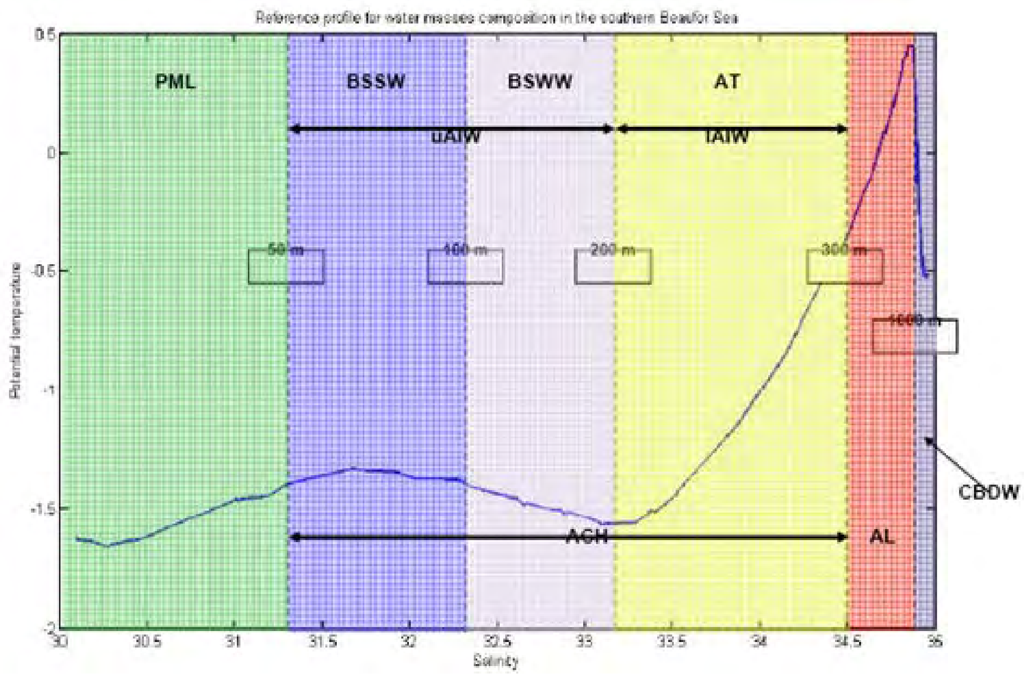


Figure 9.14. Typical Temperature-Salinity (T-S) diagram for the Southern Beaufort Sea. Pacific Mixed Layer (PML), Bering Summer Water (BSW), Bering Sea Summer Water (BSSW), Arctic Thermocline (AT), Arctic Cold Halocline (ACH), Atlantic Layer (AL), Canada Basin Deep Water (CBDW).

9.3.2 Leg 2b – 30 July to 27 August 2009 – Beaufort Sea

Figure 9.15 illustrates both the tidal variability of the currents and the fact that the LADCP must see the bottom to properly estimate the currents.

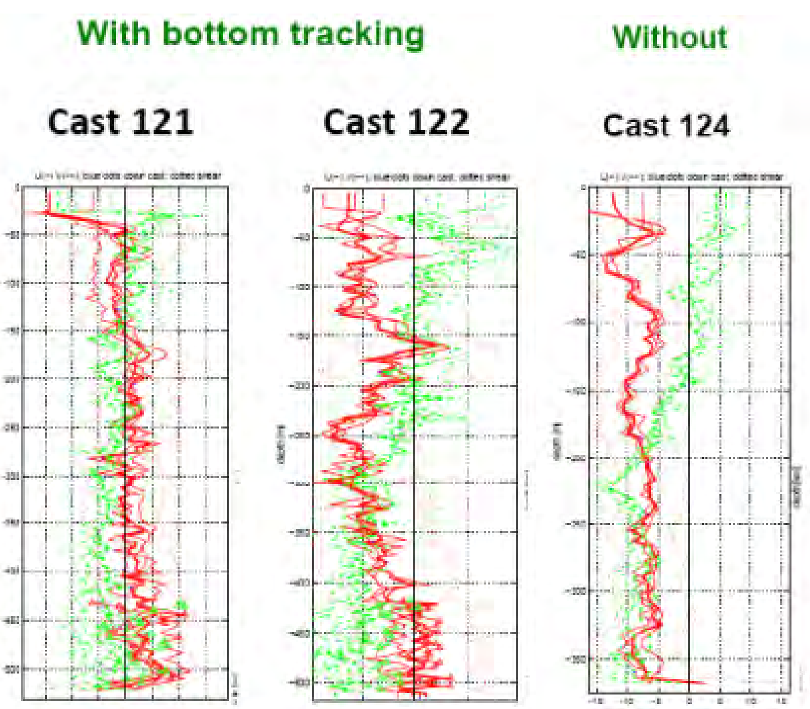


Figure 9.15. Three LADCP profiles from the Cycle Station 345 conducted during Leg 2b.

In Figure 9.16, the surface layer variability may be followed on the temperature section (upper left). The variation in thickness of the oxygen maximum layer may be followed on the upper right panel. Most of the CDOM and nitrates variability was found between 100 and 250 m (lower left and right panels, respectively).

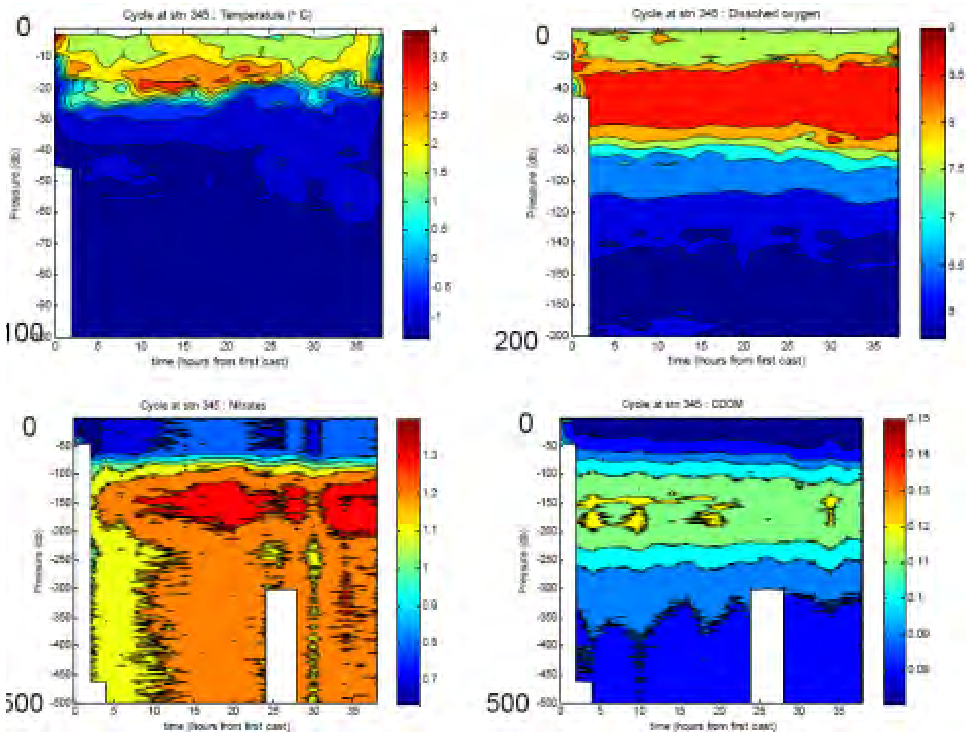


Figure 9.16. Four ‘time evolution’ sections from the Cycle Station 345 conducted during Leg 2b.

9.3.3 Leg 3a – 27 August to 12 September 2009 – Beaufort Sea

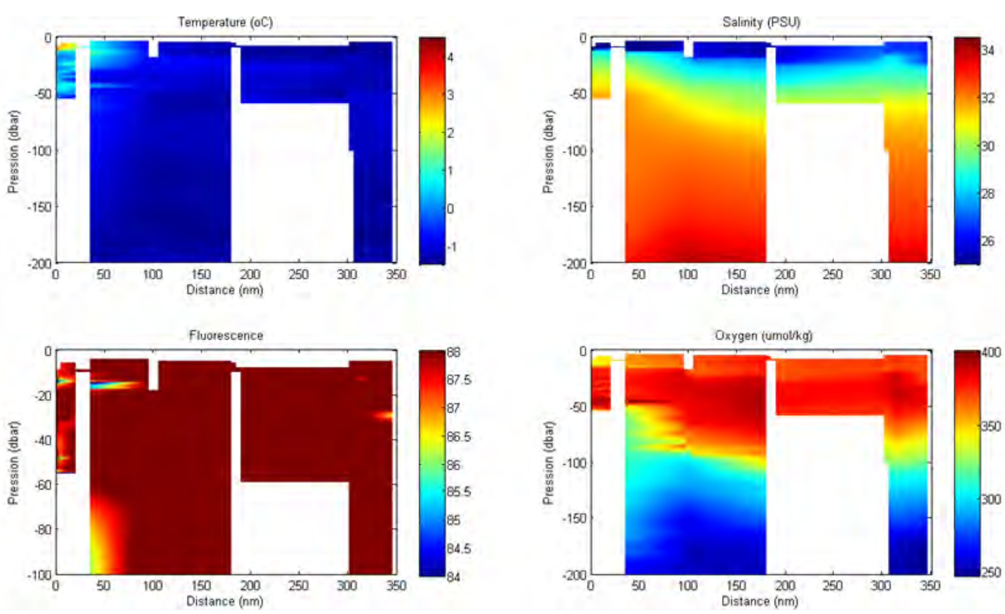


Figure 9.17. Section of profiles of temperature, salinity, fluorescence and oxygen obtained with the CTD-Rosette during Leg 3a in the Beaufort Sea.

9.3.4 Leg 3b – 12 September to 8 October 2009 – Beaufort Sea

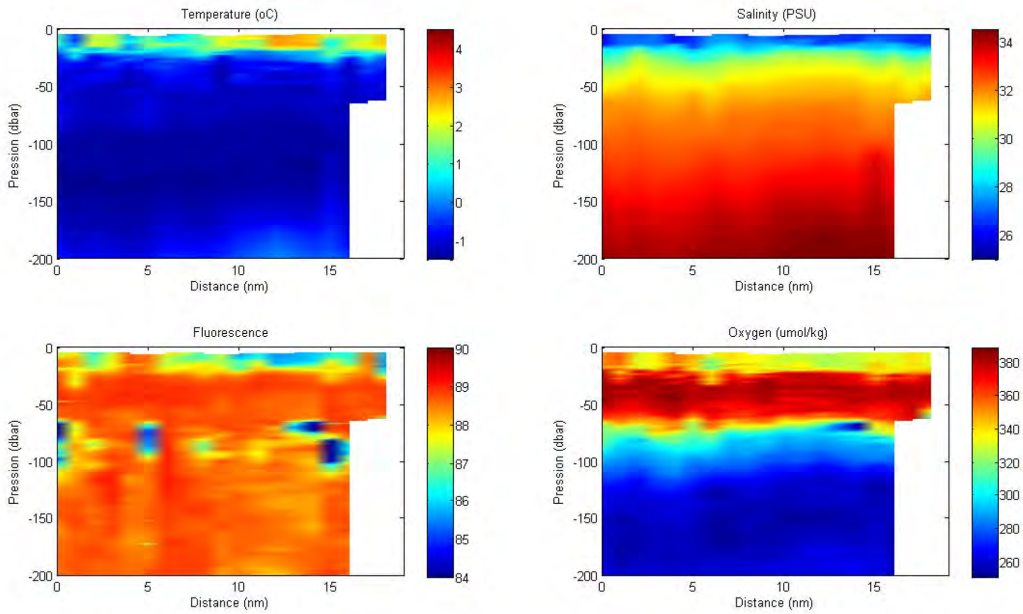


Figure 9.18. Contour plots of temperature, salinity, fluorescence and dissolved oxygen obtained from the CTD-Rosette casts conducted in the Ajurak lease block during Leg 3b and plotted along the distance from cast #046.

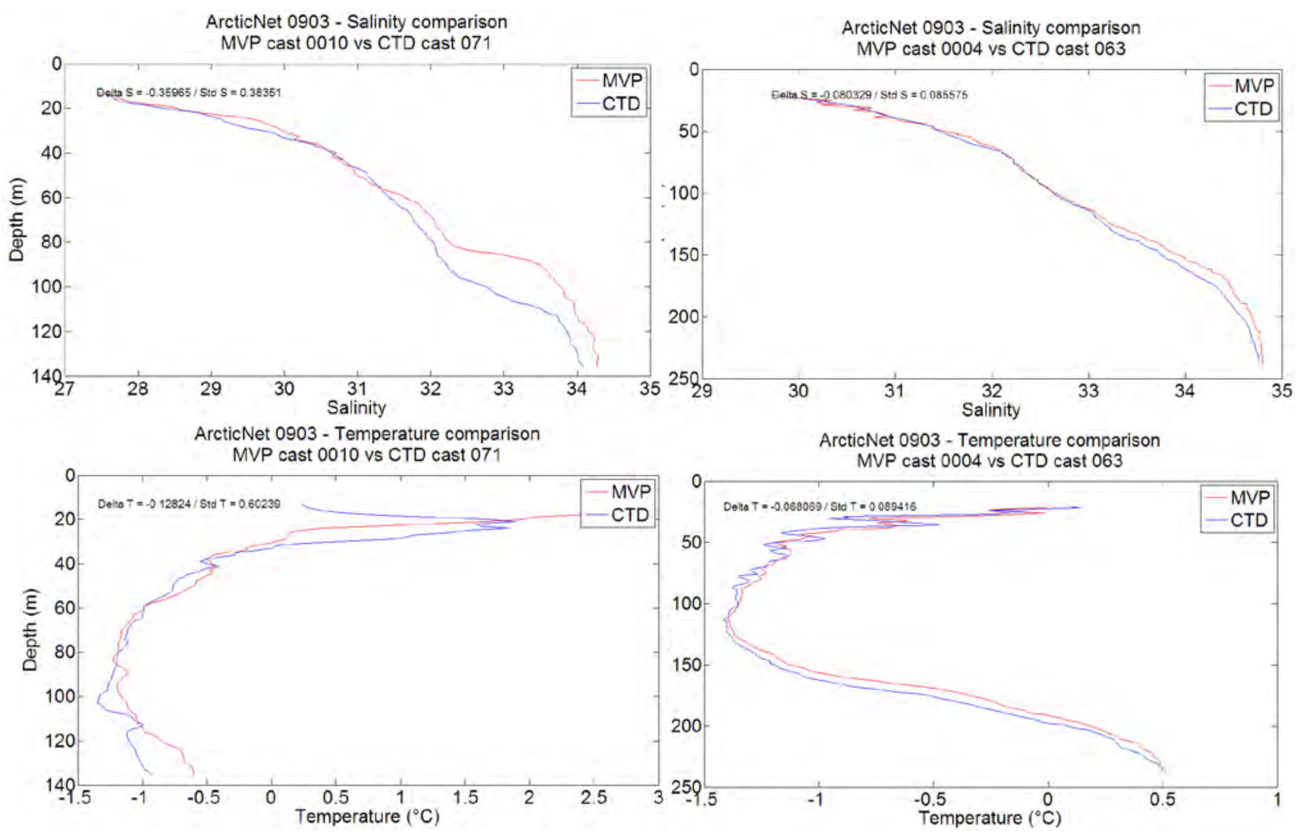


Figure 9.19. Two examples of comparison of salinity (upper panels) and temperature (lower panels) profiles between the CTD mounted on the Rosette (SBE-911) and the MVP300 profiler obtained during Leg 3b.

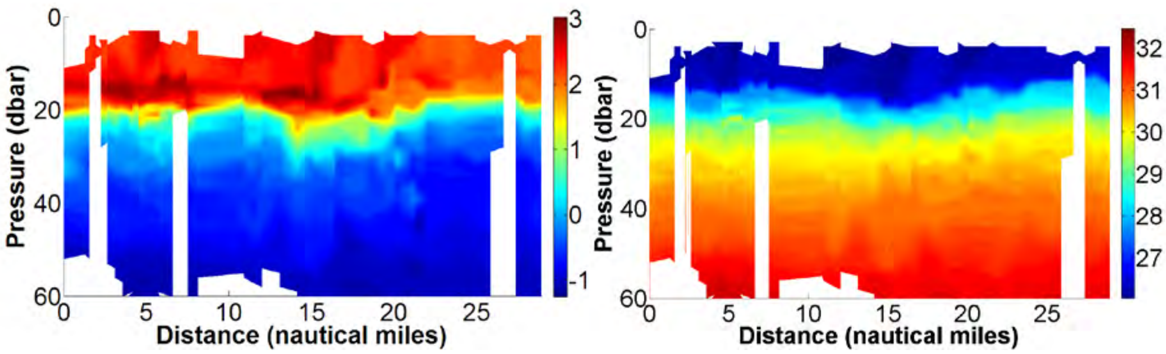


Figure 9.20. Contour plots of temperature and salinity obtained from the MVP transect #2 conducted on 30 September in the Ajurak lease block during Leg 3b.

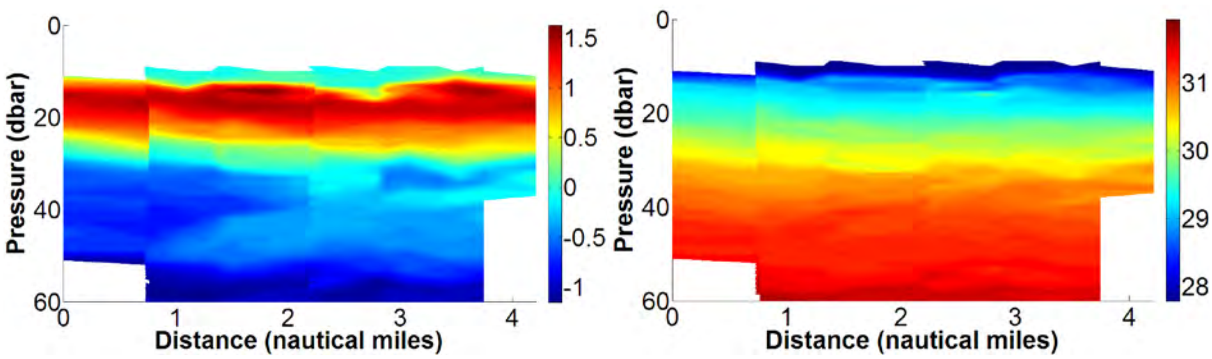


Figure 9.21. Contour plots of temperature and salinity obtained from the MVP transect #4 conducted on 5 October in the Ajurak lease block during Leg 3b.

9.3.5 Leg 4a – 8 October to 6 November – Beaufort Sea, NW Passage, Baffin Bay

Preliminary data from the CTD-Rosette casts at Station 115 show a surprising density inversion near the surface and late season chlorophyll maximum (Figure 9.22). After a couple of hours however, the water column was mixed and all the unusual features had disappeared.

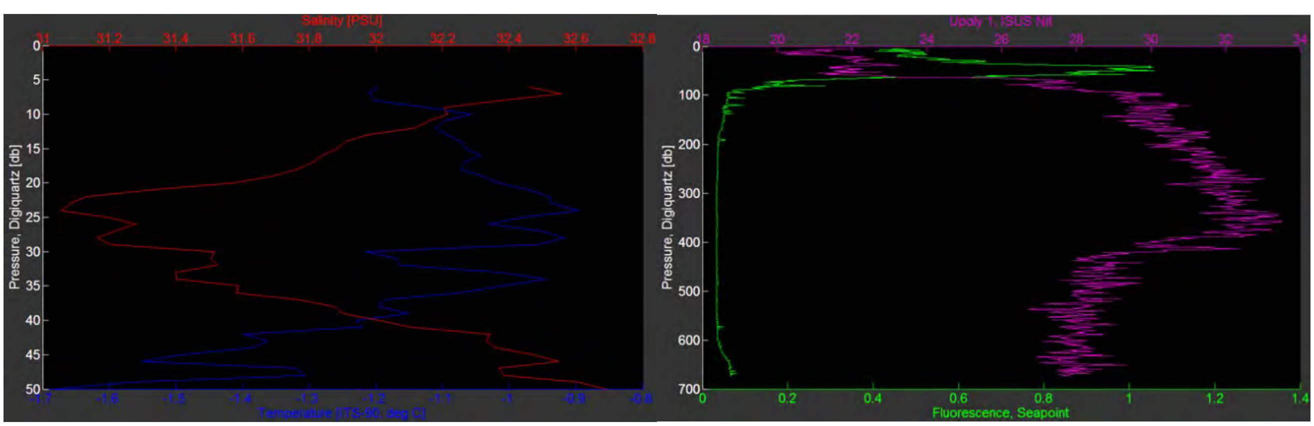


Figure 9.22. Vertical profiles of temperature and salinity (top panel) and nitrate and fluorescence (bottom panel) obtained at Station 115 during Leg 4a.

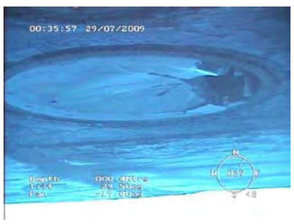
9.4 Comments and recommendations

9.4.1 Leg 2a – 16 July to 30 July 2009 – Beaufort Sea

Sensors: All sensors performed well for the whole leg, after some calibration file problems were sorted out and the first five CTD casts were reprocessed.

Bottles: Two bottles (#2 and #24) systematically did not close. There were also problems with bottles #15 and #16. The pylon and the carousel, some of the triggers and one bottle's nylon spar were changed and cleaned because they were covered in grease, which resolved the problems.

Computers: The processing computer was changed and a problem may also exist with the MVP's processing computer.



SM-ADCP: The ROV observed that the ice window covering the SM-ADCP was broken (Figure 9.23).

Figure 9.23. Photo taken by the ROV of the cracked ice window covering the SM-ADCP.

9.4.2 Leg 2b – 30 July to 27 August 2009 – Beaufort Sea

Sensors: The conductivity sensor exhibited problems at low salinities possibly because of the grease on the winch cable.

Deck material (winch, A-frame, etc.): The Rosette frame was covered with grease and it needed to be cleaned very often until most of the grease was removed from the winch cable and pulleys.

9.4.3 Leg 3a – 27 August to 12 September 2009 – Beaufort Sea

Sensors and bottles: No major problems were reported. Some bottles had trouble closing but the simple maintenance of the carrousel seemed to solve that problem. On one cast, the bottle firing didn't work but after everything was reset, it worked fine.

Deck material (winch, A-frame, etc.): On one occasion, the crew forgot to start the water cooling for the winch so the cast was stopped for a couple of minutes during the upcast. The cable guide sometimes had problems and required operations to stop while the cable was realigned.

9.4.4 Leg 3b – 12 September to 8 October 2009 – Beaufort Sea

Sensors and bottles: The altimeter gave unusual readings at times which seemed to affect some of the other instruments. Connexions between the probes and the CTD were remade and the problem was solved.

9.4.5 Leg 4a – 8 October to 6 November – Beaufort Sea, NW Passage, Baffin Bay

Sensors: The sensors worked fine throughout the leg. Ice sometimes formed on the nitrates probe, making it unreliable during the first 70 meters of the casts.

Pump: On at least two occasions, the salinity, temperature and oxygen probes generated noisy profiles. Since the probes usually work fine and are located inside the CTD, it is likely that the pump was at fault since variable water flowrates would prevent the probes from working properly.

CTD: The CTD had major issues during casts #0904034 and #0904036: it would stop communicating with the deck unit and the casts had to be cancelled. The CTD was changed but the problem came up again. Part of the cable was cut which eliminated the communication problems.

Deck unit: The deck unit lost the NMEA signal a couple of times. Replacing it resolved the problem.

Deck material (winch, A-frame, etc.): The winch lacked hydraulic power on a few casts. Parts were freezing and needed to be thawed during the casts. The speed and depth meters worked intermittently.

9.4.6 Leg 4b – 6 November to 18 November – Labrador fjords

Sensors: All sensors worked fine throughout the leg except for the SPAR (see CTD problems).

Pump: On at least one occasion, the salinity, temperature and oxygen probes generated very noisy profile. Since the probes usually work fine and are located inside the CTD, it is likely that the pump was at fault since variable water flowrates would prevent the probes from working properly.

CTD: The CTD had major problems during casts 0904066 and 0904068. It would stop communicating with the deck unit and the casts had to be cancelled. The problem was thought to originate with the cable (as in Leg 4a), however after the cable was cut the problem showed up again. Finally, the SPAR sensor was found to cause a decrease in power to the CTD (probably a short circuit) and once it was removed and changed everything worked fine.

Deck unit: The Deck Unit worked fine throughout the leg.

Deck material (winch, A-frame, etc.): Everything worked fine.

10 Turbulence measurements (MVP and SCAMP) – Leg 2b

ArcticNet Phase 2 – Project titled *Long-Term Observatories in Canadian Arctic Waters*.
ArcticNet/Phase2/Gratton_Marine_observatories

Project leader: Yves Gratton[1] (yves_gratton@ete.inrs.ca)
Cruise participant Leg 2b: Yves Gratton[1]
[1] *Institut national de la recherche scientifique (INRS) – Eau, terre et environnement (ETE), 490, de la Couronne, Québec, QC, G1K 9A9, Canada.*

10.1 Introduction

Turbulent transports and mixing are among the most important processes in natural systems. They are much more efficient and act much faster than purely diffusive (i.e. molecular) processes. By analogy with the molecular diffusive processes, turbulent mixing is often called "eddy diffusion". The mixing energy is introduced at large scales, often by the wind at the sea surface and tides at the bottom. Turbulent mixing is called "eddy diffusion" because energy can be thought as being transferred from larger scales to smaller scales, i.e. cascading from larger eddies to smaller and smaller eddies until it reaches the molecular scale where it will be ultimately dissipated into heat. Studying turbulent processes allows to better understand how the Mixed Layer (ML) is formed and how it evolves over daily, seasonally and yearly time scales. A better characterization of the ML properties will help determine how the biological production is affected by the physical processes in the surface layer, while a better knowledge of the dynamics of the ML will improve climatic forecasting abilities. Indeed, the mixed layer is the main buffer between the atmosphere and the ocean and it controls most of the heat exchange between the two. One of the major problems is that the ML is evolving hourly, making it very difficult to parameterize in larger numerical circulation models. A better understanding of the ML dynamics will improve the forecasting capacities of both oceanic and atmospheric models.

10.2 Methodology

10.2.1 Description of profiling instruments (MVP and SCAMP)

The Moving Vehicle Profiler (MVP) is a towed CTD (with fluorescence and dissolved oxygen sensors) usually used in automatic mode. The "fish" (see photo of deployment in Figure 10.1 left) freefalls at ~5 m s^{-1} and is automatically winched back to 10 m under the surface (green line in Figure 10.2) after each cast. Hence, the first 10 and last 10 meters of the water column are lost. A MVP300-1700 model was used, meaning that it was equipped with 1700 m of cable and could profile down to 300 m at 12 knots. The slower the cruising speed, the deeper the MVP could reach.

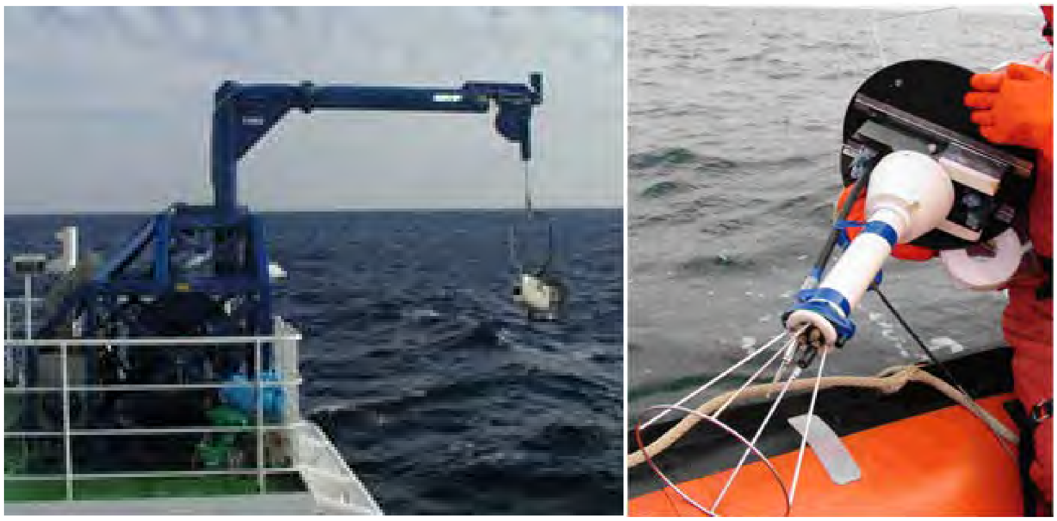


Figure 10.1. Left: The Moving Vessel Profiler (MVP) being deployed. Right: The SCAMP profiler used during Leg 2b.

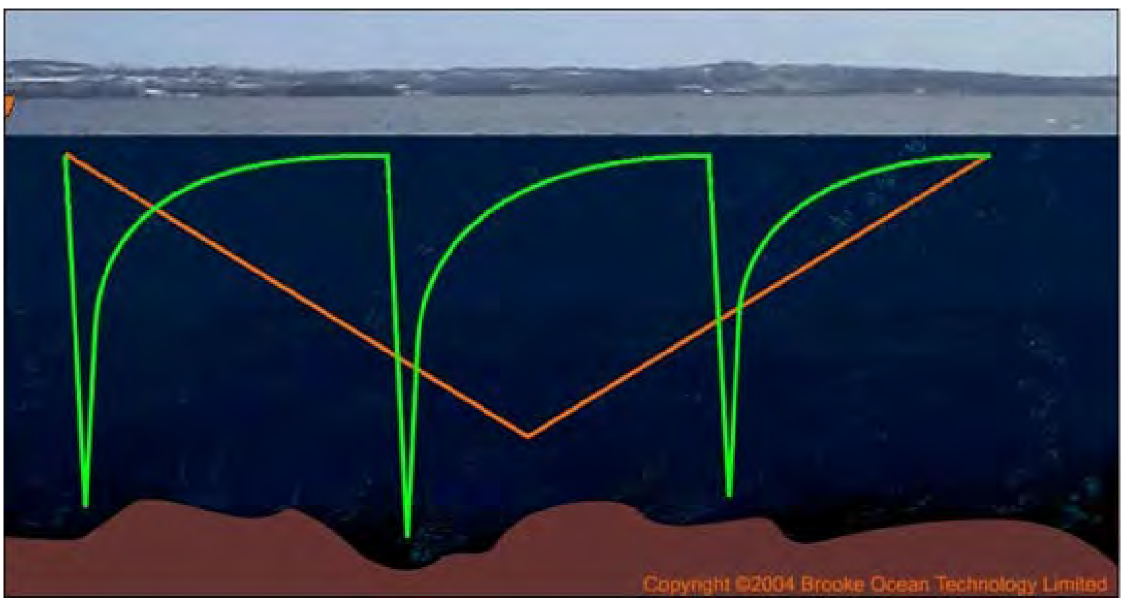


Figure 10.2. Schematic of the MVP profiling. The green line represents the trajectory of the 'fish' being towed by the *Amundsen*.

The SCAMP is a CTD type profiler (**Error! Reference source not found.**) sampling at a frequency of 100 Hz (i.e. 100 times per second). It free falls at approximately 10 cm s^{-1}, resulting in a vertical resolution of approximately one millimetre, down to a maximum depth of 100 m. The instrument measures the temperature and salinity fluctuations at the micro-scale in order to estimate the turbulent mixing occurring in the water column. To properly measure (as opposed to "estimate") turbulence the velocity fluctuations should also be measured, but unfortunately, velocity sensors were not equipped on the SCAMP (too expensive for now). The sensors on the SCAMP included temperature (three sensors), salinity (i.e. conductivity; two sensors) and fluorescence.

Thirty-two SCAMP profiles were obtained at four different stations in Leg 2b during the Malina-ArcticNet field campaign in the Beaufort Sea (Table 10.1). However, three of these stations were long stations (24 or 48 hours) where the CTD-Rosette was deployed every two hours. The aim was to capture the evolution of the mixing signature over 24 hours and, hopefully, in different weather conditions.

Table 10.1. List of stations and casts where SCAMP profiles were conducted during Leg 2b (Malina program).

Station ID	Cast ID	# profiles	Latitude N	Longitude W
Malina 680	R0902036	3	69° 36.570	
Malina 345	R0902115	3	71° 21.262	
Malina 345	R0902123	3	71° 21.262	
Malina 345	R0902127	2	71° 25.293	
Malina 345	R0902129	3	71° 25.150	
Malina 135	R0902151	3	71° 18.623	127° 29.253
Malina 135	R0902153	3	71° 18.685	127° 29.594
Malina 135	R0902158	3	71° 45.784	130° 50.083
Malina 240	R0902172	2	71° 46.628	130° 51.142
Malina 240	R0902180	4	71° 45.622	130° 53.735
Malina 240	R0902183	2	71° 45.038	130° 54.300

10.3 Preliminary results

In general, there appears to have been very little mixing present in the water column. However, that can be deceptive and data processing will need to be performed before proposing a general conclusion. Below, the high resolution temperature in the first 8 m from one of the August 15 profiles is shown (Figure 10.3).

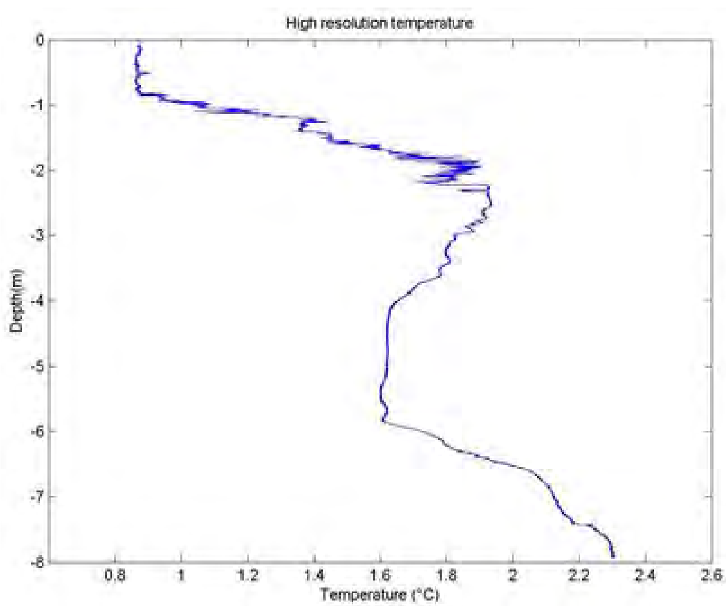


Figure 10.3. High resolution temperature profile obtained with the SCAMP profiler for the first 8 m of the water column (15 August on Leg 2b).

11 Underwater Vision Profiler (UVP 5) – Leg 2a (and 2b)

Project leader: Yves Gratton[1] (yves_gratton@ete.inrs.ca)
Cruise participant Leg 2a: Marc Picheral[2]
[1] *Institut national de la recherche scientifique (INRS) – Eau, terre et environnement (ETE), 490, de la Couronne, Québec, QC, G1K 9A9, Canada.*
[2] *Laboratoire d'Océanographie de Villefranche (LOV), CNRS-UPMC, 181 chemin du Lazaret, 06230 Villefranche sur mer, France.*

11.1 Methodology

The methods and results presented here describe activities conducted during Leg 2a in preparation for the Malina-ArcticNet field campaign which took place in Leg 2b. Details of methods and results for Leg 2b are not available in this report and can be obtained by contacting the project leader or researchers who participated in the cruise.

The Underwater Vision Profiler 5 (UVP5) is an autonomous underwater imaging system designed and constructed in Villefranche-sur-mer at the LOV (Picheral, submitted). In Leg 2a (and during the ArcticNet-Malina field campaign in Leg 2b), the UVP5 was installed inside the Rosette frame and collected information on organisms in the water column during CTD-Rosette casts (Figure 11.2).

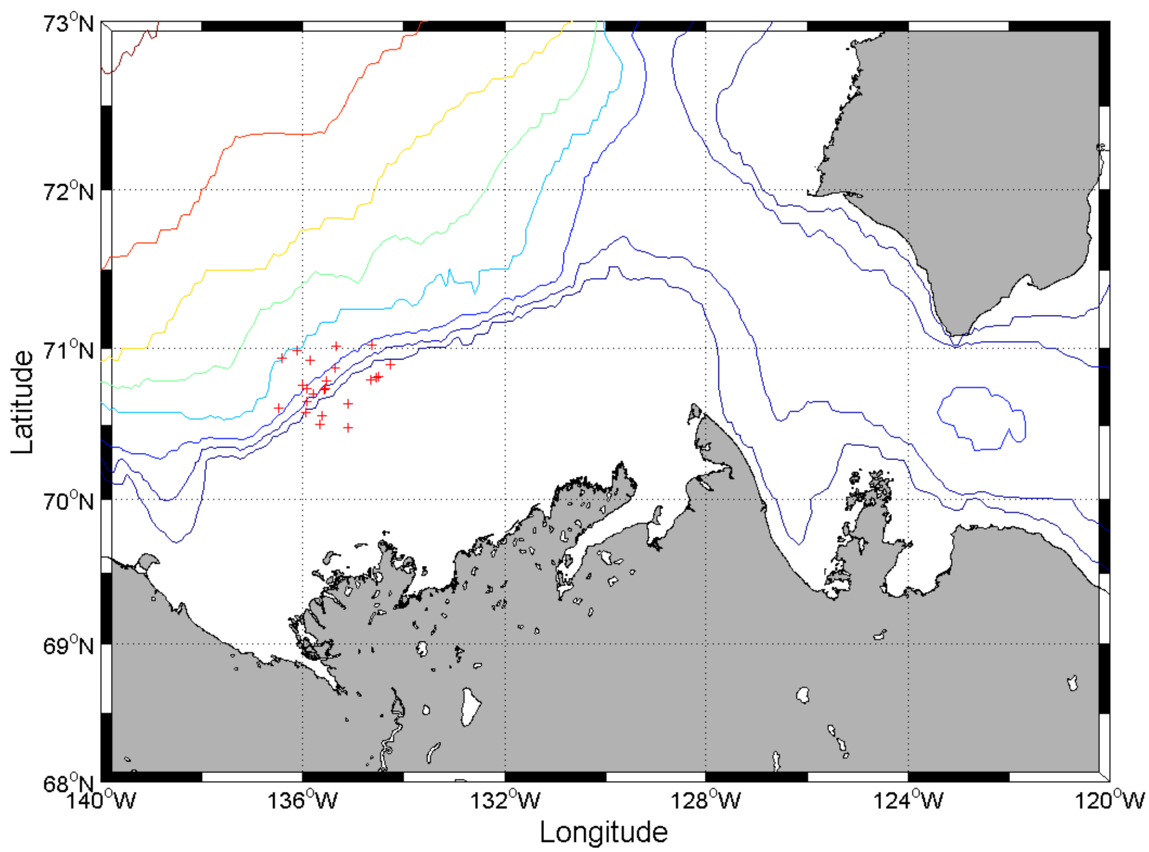


Figure 11.1. Locations of stations where the UVP5 was used during Leg 2a.

The UVP5 is an instrument acquiring and processing undisturbed images at a frequency up to 5.5 Hz during the descent of CTD casts in the water column. The 1.02 litre (22 cm x 18 cm) imaging area is located between two glass cylinders at the bottom of the system (Figure 11.2).

All objects measuring more than 100 µm (i.e., particulate matter and zooplankton) are recorded and measured in real time. If an analogue input is available on the CTD probe, the total concentration of particles can be displayed on the CTD screen monitor during the descent of the system. In addition, the images of the targets measuring more than 600 µm are recorded for later analysis.

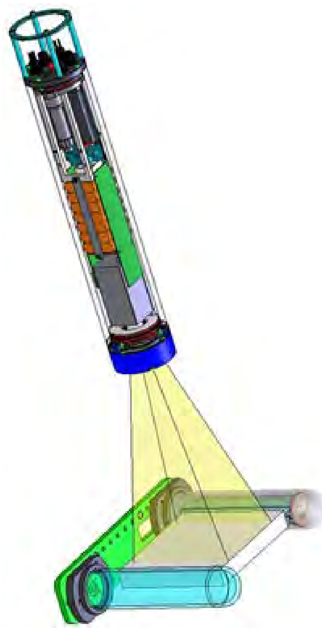


Figure 11.2. Schematic of the UVP5 equipped on the CTD-Rosette during Leg 2a.

When the instrument was back on deck, both the complete dataset of particles and the images were transferred on a PC for complete analysis. Particles size spectra were computed every 5 m, while the biomass, dry weight and carbon fluxes were derived and archived in text files. The images of “large” targets were re-processed using the Zooprocess image software (www.zooscan.com) to measure about 30 variables to be used by Plankton Identifier to predict the identification of the targets. The prediction was then validated by an expert onboard to get a validated zooplankton dataset of organisms larger than 600 µm. The prediction error rate ranged between 4% and 20% (mean of 8%) for the analysed profiles. The final results of particles and zooplankton were interfaced with the CTD and bottles data in a unique Matlab database for further analysis.

11.2 Preliminary results

UVP5-CTD-Rosette profiles were analysed and preliminary UVP5 results are presented. This data will be linked to the parallel CTD data during post-processing.

11.2.1 Biovolume of particles

Maps of the mean biovolume of three size ranges of particles (100-200 µm, 200-500 µm and 500-2600 µm) in the 0-200 m depths and 200-500 m depths show that most of the biovolume was contained in particles larger than 500 µm, that there was an evident gradient from the coastal stations to the deep ones and that this gradient was stronger between above 200m. Finally, the biovolumes seem to be higher on the shelves in the 200 to 500 m depth range.

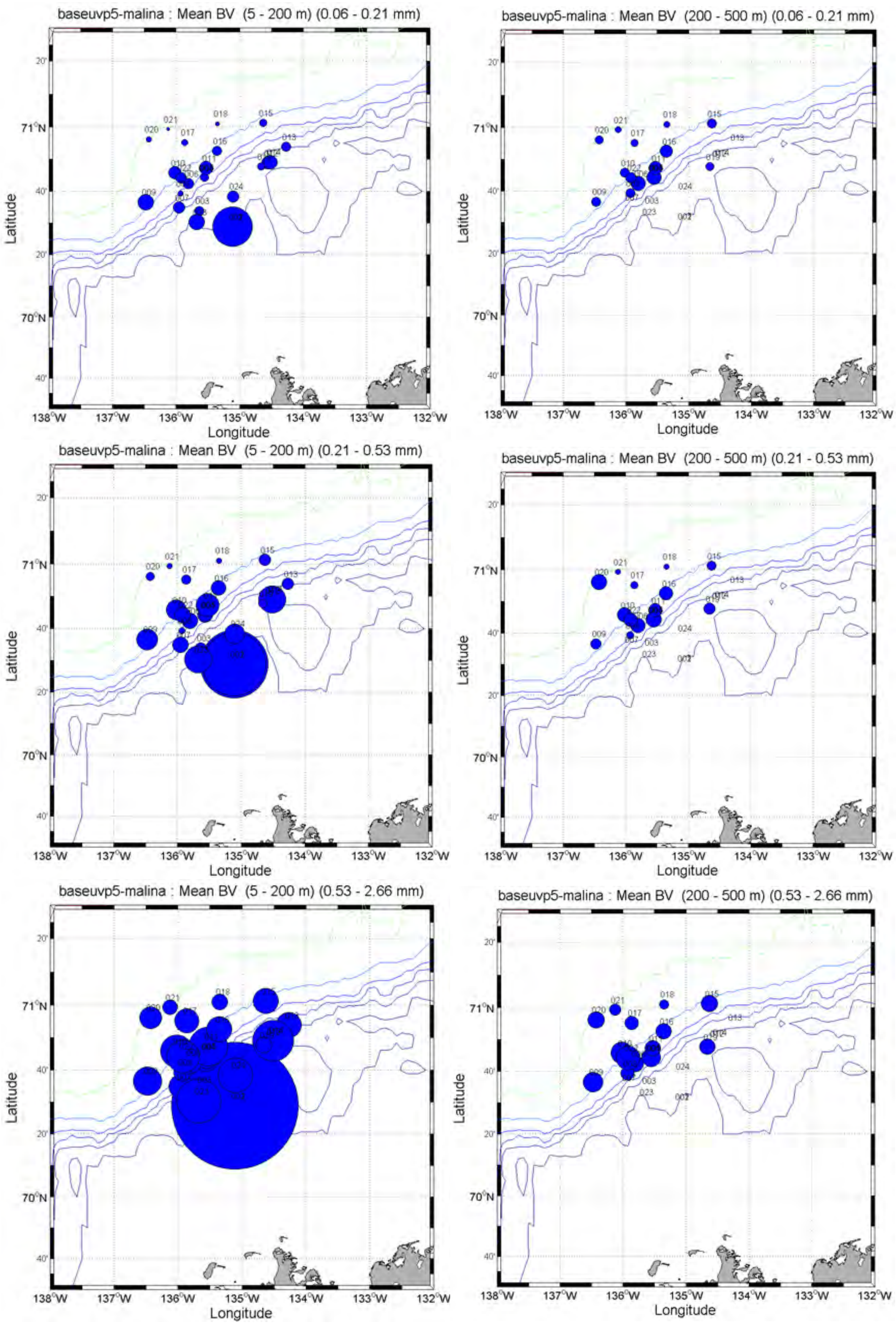


Figure 11.3. Maps showing mean biovolumes of 3 size ranges of particles (100-200 µm, 200-500µm and 500-2600µm) in defined vertical ranges in the water column (5-200 m in left panels and 200-500 m in right panels). Data was collected during Leg 2a in the Beaufort Sea.

11.2.2 Validation of target organisms

During Leg 2a, the organisms measuring more than 600 µm were initially sorted in the following groups:

- Appendicularia
- Copepoda
- Fish
- Diatoms_like
- Aggregates larger than 600 µm (except very large ones)
- Very large aggregates (mainly old appendicularia houses)
- Gelatinous (Medusa, Ctenophores, Siphonophores)
- Other (Chaetognaths, Annelids, Radiolarians and strange stuff…)

Every identified organism was perfectly located and the environmental variables were acquired precisely at the same location giving a complete knowledge of the ecological niche.

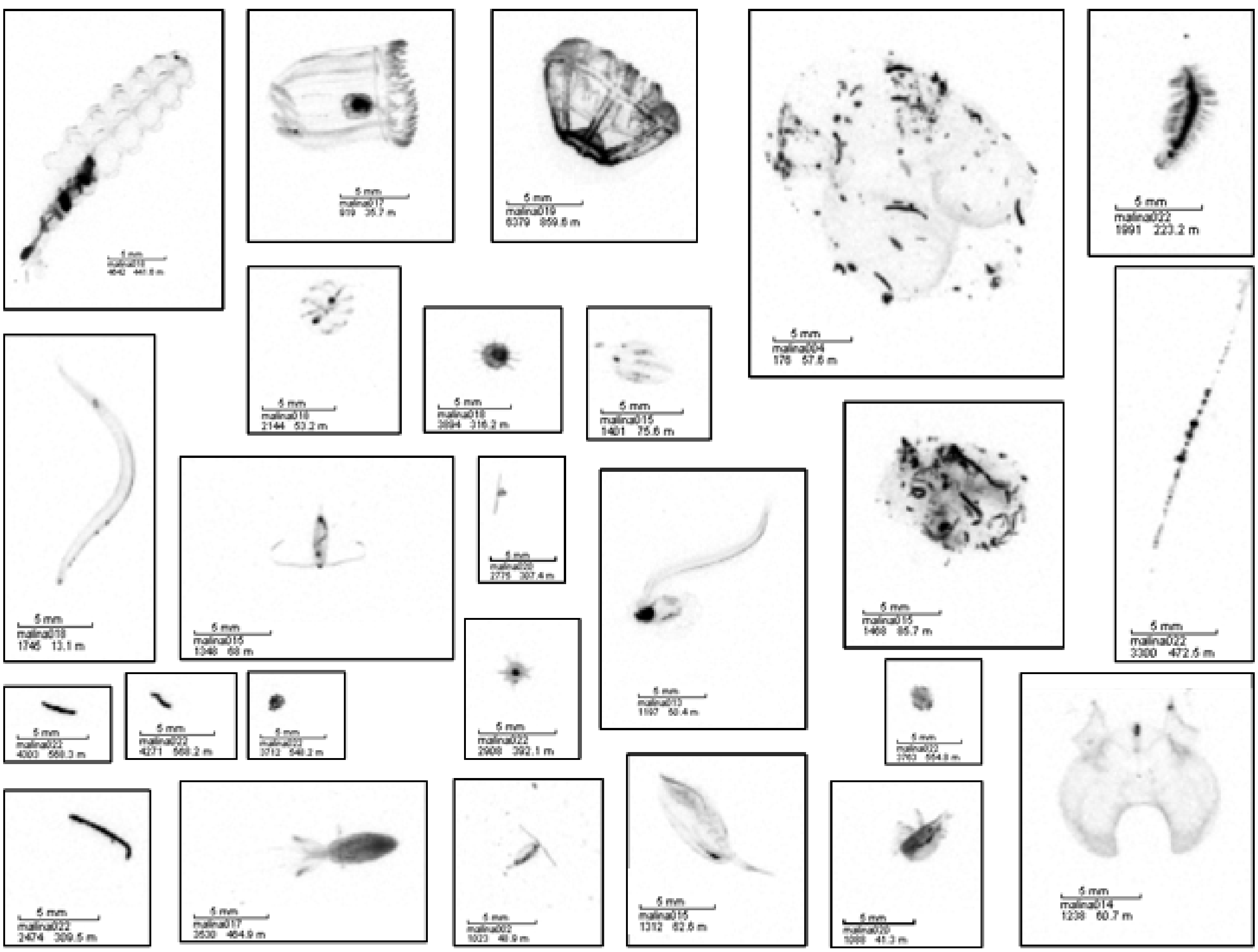


Figure 11.4. Examples of pictures of organisms and particles taken by the UVP5 profiler during Leg 2a.

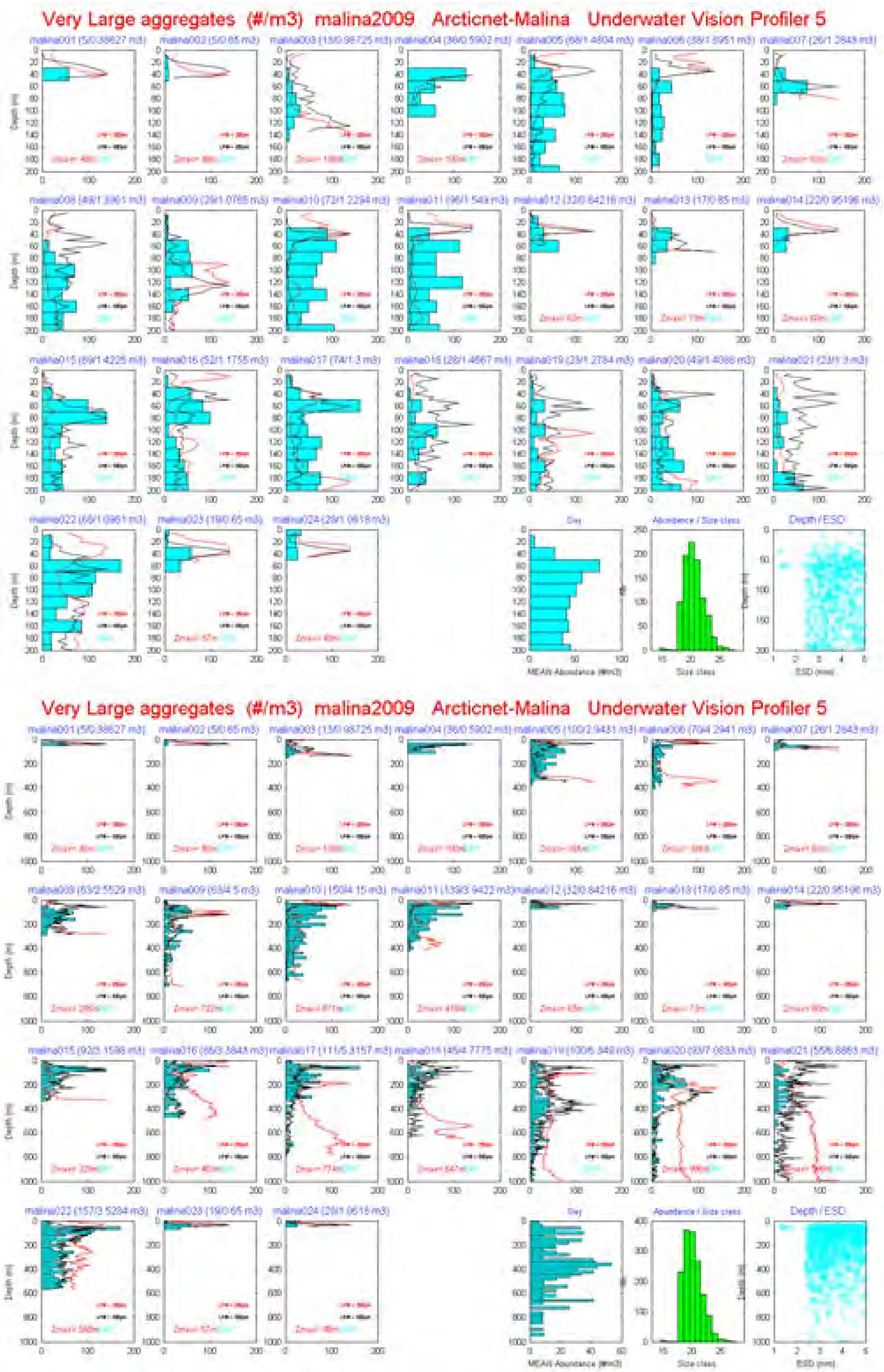


Figure 11.5. Profiles obtained at each of the stations where CTD casts were conducted for the category very large aggregates for two depth ranges 5-200 m (top panel) and 200-500 m (bottom panel). Cyan: abundance of the group (#/m^{-3}), 20 db bins. Red: relative concentration of particles ranging 100-200 µm. Black: relative concentration of particles above 500 µm.

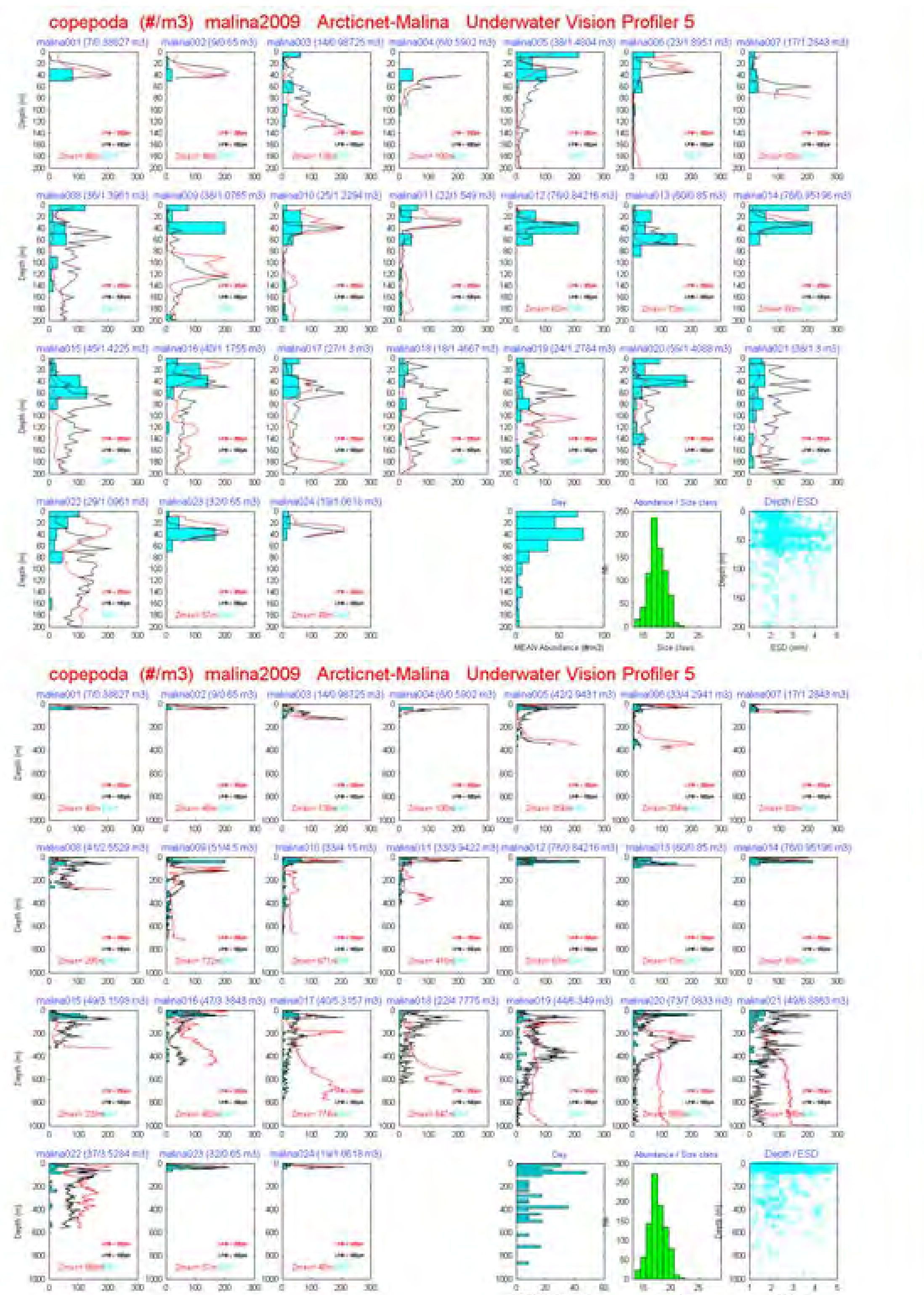


Figure 11.6. Profiles obtained at each of the stations where CTD casts were conducted for the Copepoda for two depth ranges 5-200 m (top panel) and 200-500 m (bottom panel). Cyan: abundance of the group (#/m^{-3}), 20 db bins. Red: relative concentration of particles ranging 100-200 µm. Black: relative concentration of particles above 500 µm.

Two examples of profiles obtained with the UVP5 at each of the stations are provided for the categories ‘very large aggregates’ (Figure 11.5) and ‘copepoda’ (Figure 11.6). In the graphs, the total number of organisms and the total volume of sampled water are displayed on top of each profile. The “Mean abundance” profile is displayed at the bottom of the figures and the depth and size of each of the target is presented in the lower left corner graph.

Results show that aggregates made about 80% of the total abundance of the targets measuring more than 600 µm. Appendicularians were present mainly above 100 m but many old houses (very large aggregates) could be found at all depths and an accumulation was important at the last shallow stations just above the bottom. Copepods abundances were higher also in the upper 100 m but specimens were also spread in the water column with a slight increase of abundances around 400 m. The highest measured concentration was 200 individuals/m^3 between 35 and 45 m at cast #14. The so-called “long diatoms chains like” group may be partly feces and should be later checked.

12 Marine optics (MALINA) – Legs 1b, (2b), 4a and 4b

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12.1 Introduction

How will changes in ice cover, permafrost and UV radiation impact biodiversity and biogeochemical fluxes in the Arctic Ocean? Understanding how biodiversity and biogeochemical fluxes are controlled by light penetration of the ocean and how they are affected by ongoing changes in the climate in the Arctic is the overall goal of the Malina project. The Malina project was launched in Fall 2008 and will be active for the next four years studying the southern Beaufort Sea and the shelf adjacent to Mackenzie River. The field component of Malina will be undertaken in the area during the summer and early fall of 2009 (Leg 2b). The focus was set on three processes – primary production, bacterial activity and organic matter photo-oxidation – that play a major role in the organic and inorganic carbon fluxes. Thus the general objective was to determine the impact of climate change on the fate of terrestrial carbon exported to the Arctic Ocean, on photosynthetic production of organic carbon, and on microbial diversity.

12.1.1 Leg 1b – 30 June to 16 July 2009 – Victoria to Sachs Harbour

The western Arctic Ocean has recently recorded the most significant reduction of summer sea ice cover and the greatest positive sea surface temperature warming anomalies of any Arctic region (e.g., Shimada et al. 2006, Strove et al. 2008). Since this area is highly productive (Hill and Cota 2005, and references therein), concern as to the impact of these changes on the physical environment (e.g., solar insolation, strengthening stratification), leading to modifications in biogeochemical processes is at the forefront of Arctic research.

The light absorption properties of particulate and dissolved materials have been recently examined in this region (Wang et al. 2005, Matsuoka et al. 2007, Hill 2008). Since the absorption properties are tightly linked to the biogeochemical processes that influence the ocean carbon cycles (e.g., Morel 1988, 1991), the detailed study of those properties indirectly allows us to examine changes in the Arctic ecosystem.

Particulate organic carbon (POC)

In the context of climate warming, the global carbon cycle is changing and the concentration of carbon in the oceans is rising as the oceans constitute one of the most important sink to absorb atmospheric carbon. Phytoplankton growing at the surface of the oceans is responsible for approximately half of the carbon recycling. During photosynthesis processes, phytoplankton cells absorb carbon dioxide (CO_2) and produce particulate organic carbon (POC). By measuring the particulate organic carbon in surface waters, an estimate of phytoplankton concentration can be made and used in turn to approximate the amount of CO_2 absorbed at the location of sampling.

Polarized Volume Scattering Meter (POLVSM) prototype

Polarized Volume Scattering Meter (POLVSM) experiments consist in measuring polarized and non-polarized diffusion indicators of marine particulates with a prototype instrument developed at the Laboratoire d'océanographie de Villefrance. These diffusion indicators are very important in marine optics because they allow to 1) characterize directional properties of particles, 2) know the fraction of radiations diffused in a given direction, in particular in the direction of satellite observation, and 3) link marine reflectance to properties of diffusion through the equation of radiative transfer, which also constitutes an input into radiative models.

The novelty of the POLVSM instrument is to measure polarization rates of marine particles, which have not been measured in recent decades. Recent measurements are rare and the POLVSM is the only available instrument to make these measurements for a large angular range. Radiation polarization of marine particles will provide valuable information of the nature and composition of these particles, since polarized information is sensitive to refraction indices and allow discrimination of biogenic and inorganic fractions and of suspended matter in seawater.

Coccolithophores

The diminishing Arctic sea ice extent in summer and the lengthening of the melt period are inducing important changes in environmental conditions into Arctic marine ecosystems: changes in salinity and stratification of the water column, increased luminosity, temperatures and greater river inputs. These changes in turn bring profound ecological modifications to Arctic ecosystems. Recent studies showed a northward shift in blooms of coccolithophorids toward sub-polar areas in the Barents Sea (Smyth 2004) and the new occurrence of blooms in the Bering Sea since 2002.

The objectives of this coccolithophore project were to 1) characterize the coccolithophore bloom in the Bering Sea in terms of cell abundance and species diversity, as well as the size, weight and calcification of the cells, 2) validate the hypothesis that blooms are shifting northward, 3) obtain in situ data in the Beaufort Sea to validate satellite observations that coccolithophores are present in this area and 4) conduct pigment analyses to determine the relationship between the coccolithophorid cells and the pigment 19'HP associated with this phytoplankton group.

<u>General objectives</u>

The aim of the Malina project for Leg 1b was to examine light absorption properties of particles and dissolved organic matter along the transect line from lower to higher latitudes (Victoria BC to Sachs Harbour). The specific objectives of this project for Leg 1b were to:

- Test the systems and methods in Arctic environments before the start of the Malina campaign in Leg 2b.
- Obtain a first assessment of the spatial variations (in amplitude and spectral dependence) of POM and DOM absorption properties in surface waters along the transect from Victoria BC to the Beaufort Sea.
- Compare the results obtained with different methods of CDOM determination.
- Measure suspended particulate matter (SPM) and organic carbon (POC) in surface waters. Intercomparisons will be made between results obtained using the method developed at R. Reynolds' Ocean Optics Lab at Scripps Institution of Oceanography, with other POC/SPM results obtained by the Malina project teams.
- Determine the particle size distribution (PSD) of SPM/POC, a measurement which is critical to calculate volume scattering function (VSF) of bulk seawater using Mie theory.
- Set up the Polarized Volume Scattering Meter (POLVSM) prototype and test the sampling and analysis protocols in preparation for the Malina cruise in the Beaufort Sea during Leg 2b.
- Sample phytoplankton for biomass, species composition, pigment analyses, physiological condition and light acclimatation/adaptation.

12.1.2 Leg 4a – 8 October to 6 November – Beaufort Sea, NW Passage, Baffin Bay

During Leg 4a, a reduced team was present to sample as widely as possible the Northwest Passage and Baffin Bay areas, to collect a preliminary dataset for the planning of future missions in the Eastern Arctic Ocean. The objectives were focused on marine optics: Inherent and apparent optical properties of seawater and water sampling for phytoplankton pigments analysis.

12.2 Methodology

The methods and results presented here describe activities conducted during Legs 1b, 4a and 4b by members of the Malina program. Details of methods and results for the core field campaign of the Malina project which took place in the Beaufort Sea during Leg 2b are not available in this report and can be obtained by contacting the project leader or researchers who participated in the leg.

12.2.1 Leg 1b – 30 June to 16 July 2009 – Victoria to Sachs Harbour

<u>**Sampling**</u>

Sampling was conducted long the ship track, with a sampling area extending between latitudes 48°N to 72°N and longitudes from 136°W to 170°W (Figure 12.1). Samples were collected underway, either from the pumping system (8 m depth) or with a bucket (surface). Sampling was performed three times per day (9:00, 13:00, 18:00) from 5 July (18:00) to 14 July (18:00) for a total of 28 samples. Seawater was collected and pooled into two carboys (A and B) which were subsampled by the different teams.

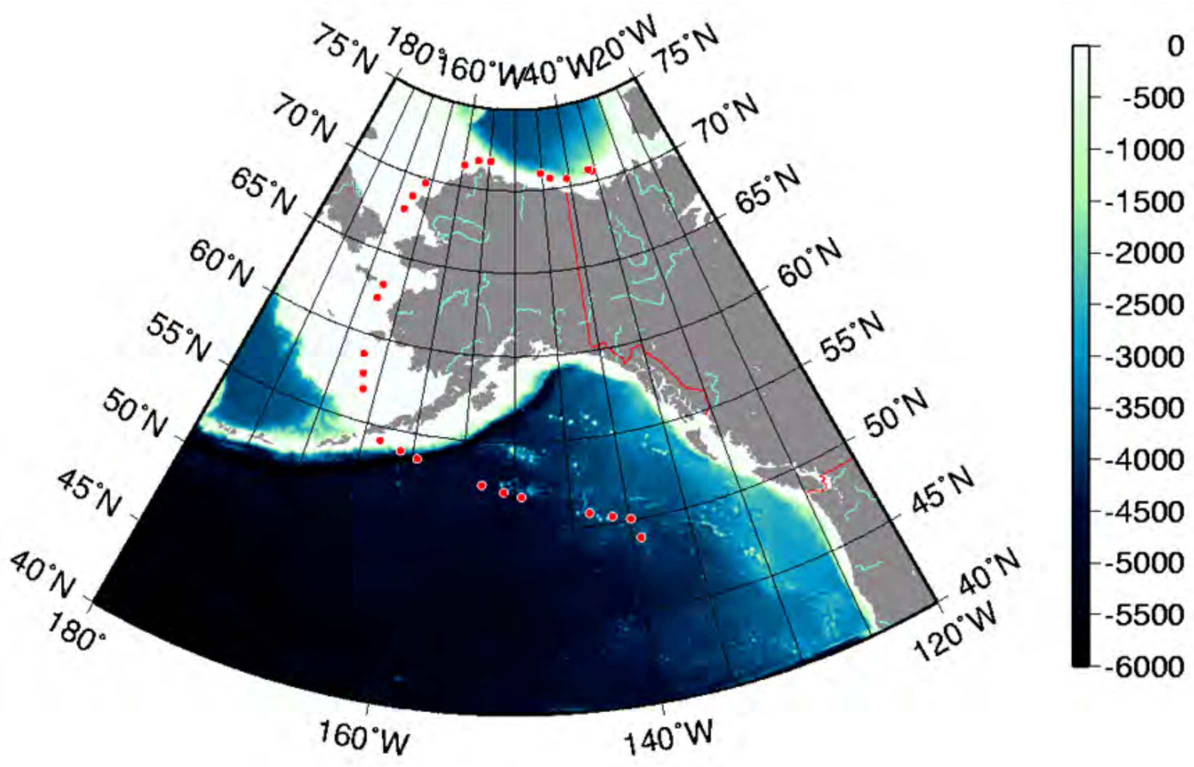

Figure 12.1. Underway sampling locations for particulate and dissolved organic matter light absorption measurements during Leg 1b.

CDOM light absorption

Light absorption spectra of CDOM were measured onboard for each sample in the UV-visible spectral range (300 to 735 nm), with an ULTRAPATH system (World Precision Instruments). This system is a spectrophotometer in which the light source and detector are connected via optical fibres to a capillary cell with a selectable path length (2 cm to 2 meters). The longest path length enables absorption measurements down to 0.002 m^{-1}. The system allows CDOM absorption spectra to be measured both in turbid and clear waters.

Light absorption spectra of CDOM and particulate matter were also measured for each sample between 350 and 750 nm by using a PSICAM prototype developed in Villefranche. This prototype allows the measurement of very low absorption coefficient with a very weak scattering dependency. For each sample, two measurements were done. The first after a filtration at 0.2 µm gave the CDOM absorption coefficient. The second, without filtration, gave the total absorption coefficient. The difference of these coefficients gives the absorption by particulates.

Suspended particulate matter (SPM) and organic carbon (POC)

Samples were taken along the ship track using the TSG pumping system three times per day. Water samples were filtered through precombusted (450°C for 5 hours) and pre-weighed (0.001 mg precision) Whatman GF/F filters (nominal pore size 0.7 µm) using glass funnels. The glass funnels leaked during filtration and were changed to plastic funnels on 9 July.

POC/SPM water samples were also taken from 10 stations by the Scripps team (from “PAC_8Jul2009_0900” to “BEA_14Jul2009_1800”). The POC/SPM sampling followed protocols of Ocean Optics Lab (Scripps Institution of Oceanography). Duplicates were done for most stations except at “ARC_11Jul2009_1300”, where triplicates were done for both POC and SPM. This station occurred at local noon and the cloud condition should be good for satellite validation.

The particle size distribution (PSD) of suspended particulate matter (SPM) and organic carbon (POC) was measured by Coulter Counter Multisizer 3 (Coulter hereafter) and Laser In-Situ Scattering and Transmissometry (LISST) 100X. The nominal range of measurement was 1 to 120 microns for Coulter (for the 30 micron 200 micron apertures used during the cruise), and 1 to 250 microns for LISST.

Water samples for PSD measurement were taken from the same carboy that M. Chami’s team (LOV) was sampling from, ensuring that intercomparisons of calculated VSFs and those measured by Dr. Chami’s new POLVSF instrument were possible. Seven water samples were taken, usually at 9:00AM stations from “PAC_8Jul2009_0900” to “BEA_14Jul2009_0900”.

Additional analyses of the PSD of 1 micron and 3.2 micron calibration beads were made, as well as unknown marine minerals, to help the calibration of the POLVSF.

The PSD of water samples from surface bucket and flow through system (~8 m) were also compared at three stations (ARC_12Jul2009_1300_B, BEA_13Jul2009_1300_B and BEA_14Jul2009_1300_B). This will provide information on any possible changes the particles undergo after flowing through the pump and pipe system.

Polarized Volume Scattering Meter (POLVSM) prototype

The first measurements showed that the natural degassing of seawater during measurements induced the production of little bubbles on the prism which increased the bidirectional function (BRDF) and the resulting measured signal above 145 degree of diffusion. A procedure was implemented to limit this effect which consisted of cleaning the prisms between 2 wave lengths, of degassing the samples before measurement and maintaining the sample at constant temperature.

The first measurements also revealed that the protecting glass slides of the prisms were thicker that the black-painted ones (which oxidized in seawater). These glass slide covers induced a degradation of angular performance for measurements in the range of 6-7 degrees. The black painted slides will likely be used during the Malina cruise in Leg 2b to avoid this effect.

A series of tests was conducted to assess the response of the POLVSM instrument for theoretical examples or model outputs. The comparison of results with radiative transfer models will allow understanding and validating the measurements made with the instrument.

Calibration with 3.2 micron beads: Calibration beads (3.2 micron) of known polarized diffusion indicators calculated according to Mie Theory were used on two occasions (9 July and 11 July) to validate the settings of the instrument. Results indicated that the dilution solvent (MilliQ water or 0.2 µm-filtered artificial seawater) increased by about 30% the signal in the angular range 60-120 degree in the blank samples, conforming to the known effects of salt on diffusion. Further tests with the beads also showed that it was possible to dilute them in saltwater and that they conform with Mie Theory under these conditions. Calibrations can thus be made with 0.2 µm-filtered seawater by subtracting a blank reference sample measured under identical conditions. The calibration beads were also analyzed on the Coulter instrument brought onboard by G. Zheng (Scripps) to determine the size distribution in a sample. This last test will allow a tight comparison with theoretical values obtained by Mie theory and to more finely calibrate the POLVSM instrument.

Maalox diffusion indicators: Maalox antiacid is known to strongly diffuse incident signal in the range of 90-180 degree (directional effects are very low in this angular range). When diluted in water, diffusion indicators of Maalox show a 2-3 fold difference in the 90-170 degree range, which is consistent with expected results. This experiment also revealed that samples with no salt do not produce fouling of the prism by the bubbles.

Sample composed exclusively of inorganic matter: On 12 July, a natural dried sample of mineral inorganic matter collected from the Gironde estuary was tested for diffusive polarized properties of these strongly refractive compounds (instead of the underway surface sample). The minerals were dissolved in filtered seawater to a concentration of 1 mg/L and analyzed on the POLVSM for diffusion indicators and on the Coulter for size distribution of particles. POLVSM results showed an increase in non-polarized diffusion indicator above 140 degree but maximum values are consistent for this type of particles. A more detailed analysis using models will be performed at the laboratory after the cruise. Coulter measurements were consistent values normally encountered in ocean waters and validate the sample collection and preparation procedures.

Dilution of natural samples: High turbidity waters will likely be encountered in the Beaufort Sea in the plume of the MacKenzie River during the Malina cruise (Leg 2b) and will require the dilution of samples before their analysis on the POLVSM. A surface samples collected on 13 July (visibly turbid) was diluted 10X with MilliQ water. The non diluted sample was run only at wavelength 532 nm whereas the diluted sample, as well as MilliQ and filtered seawater blanks, were analyzed for all wavelengths. Results showed that dilution with MilliQ water seemed inappropriate, but a similar dilution experiment performed on 14 July with filtered seawater was impeded by strong vibrations from the ship's engine and did not produce conclusive results. Nevertheless, the experiment confirmed that dilution with filtered seawater should be used in future measurements.

Setup of detector C: The detector C was installed for the first time on the instrument on 14 July. This detector is equipped with a 500 pixel 8-bit camera which should measure beam variations due to the ships movements. Preliminary results suggested that it was possible to use this method to measure beam variations (after running a blank) but that this lengthened the sample analysis protocol and complicated the cleaning of prisms if fouling occurs. Finally, the camera did not allow measurements of indicator at low angles (i.e., less than 2 degree).

Partial occultation of the basin's window: Preliminary tests showed that bidirectional function (BRDF) strongly influenced angular diffusion at 140-170 degree so further tests were conducted on 15 July. This effect was countered by partially blocking the window so that the detector could not see the prism in retrodiffusion or see the bubbles or fouling forming on the prism. Results seem to confirm that partially blocking the window would improve data in the 140-170 degree range and would eliminate the bubble/fouling effects, but more thorough experiments and analyses need to be run in the lab before the Malina cruise.

Nutrients

Samples for nutrients were taken in coordination with the group sampling from the ship's water intake. The samples were preserved for analysis on Leg 2a.

Phytoplankton and non-algal particles (NAP)

Water samples were filtered under low vacuum on Whatman GF/F glass fiber filters immediately after data collection. Optical density (OD, dimensionless; Kirk 1994) of all particles (phytoplankton plus non-algal particles (NAP or detritus)) on these filters, $OD_p(\lambda)$, was then measured from 350 to 750 nm with 1 nm intervals using a Lambda 19 spectrophotometer (Perkin Elmer) with an integrated sphere unit (Rottgers and Gehnke submitted). Phytoplankton pigments were extracted using methanol (Kishino et al. 1985), and the OD of NAP, $OD_{NAP}(\lambda)$, was measured in the same way as $OD_p(\lambda)$. The OD of phytoplankton, $OD_\phi(\lambda)$, was obtained subtracting $OD_{NAP}(\lambda)$ from $OD_p(\lambda)$. Using the c for β (β=4.5: amplification factor between geometric pathlength and optical pathlength) correction obtained by Rottgers and Gehnke (submitted). OD values were then converted into absorption coefficients of phytoplankton ($a_\phi(\lambda)$, m^{-1}) and NAP ($a_{NAP}(\lambda)$, m^{-1}).

Total non-water absorption coefficient of a seawater sample, $a_t(\lambda)$, (m^{-1}) was calculated as the sum of $a_\phi(\lambda)$, $a_{NAP}(\lambda)$, absorption coefficient of colored dissolved organic matter ($a_{CDOM}(\lambda)$, m^{-1}) measured by A. Bricaud during this cruise, and of pure water ($a_w(\lambda)$, m^{-1}):

$$a_t(\lambda)=a_\phi(\lambda)+a_{NAP}(\lambda)+a_{CDOM}(\lambda)+a_w(\lambda)$$

Phytoplankton pigments

Surface seawater samples were collected underway along the ship's track using the thermosaligraph (TSG) outlet which pumped water at the bow of the ship from 8 m depth, or by using a bucket. Water was first collected into polycarbonate carboys and subsamples varying from 0.63 to 2.23 L, depending on the amounts of particles were taken from carboy A, to compare with parallel measurements made by other teams. A number of samples have been collected for an international HPLC pigment intercomparison exercise (SeaHARRE-6) coordinated by S. Hooker (NASA). For this, 12 replicates were collected twice during Leg 1b. A number of duplicates were also sampled for an eventual determination of MAAs (Mycosporine-like Amino Acids). The locations of samples and volumes collected are summarized in Table 12.1.

Filtration was carried out on GF/F Whatman filters (25 mm diameter) by vacuum. Filters were stored in cryotubes and frozen at -80°C until liquid nitrogen was made available. Samples remained on the ship until the end of Leg 2b when they will be sent to Villefranche-sur-mer in dry shippers with other samples for the Malina project. At the laboratory in Villefranche (LOV), phytoplankton pigments will be extracted in methanol and analysed using an HPLC method.

Table 12.1. Summary of the time and volumes of surface seawater samples collected for phytoplankton pigments during Leg 1b.

Local Date (dd/mm/yy)	Time (UTC)	Sample name*	Volume (L)	Pigments	MAAs	SeaHARRE-6
05/07/09	01:20	1B-05JUL09-1800-P	2.28	1	-	-
06/07/09	16:01	1B-06JUL09-0900-P	2.28	1	-	-
06/07/09	20:00	1B-06JUL09-1300-P	2.28	1	-	-
06/07/09	01:01	1B-06JUL09-1800-P	2.28	1	-	-
07/07/09	15:59	1B-07JUL09-0900-P	2.28	1	-	-
07/07/09	20:00	1B-07JUL09-1300-P	1.59	1	-	-
07/07/09	00:58	1B-07JUL09-1800-P	1.59	1	-	-
08/07/09	16:00	1B-08JUL09-0900-P	1.59	1	-	-
08/07/09	19:59	1B-08JUL09-1300-P	1.59	1	-	-
09/07/09	16:02	1B-09JUL09-0900-P	1.59	1	-	-
09/07/09	20:01	1B-09JUL09-1300-P	1.59	1	-	-
09/07/09	01:00	1B-09JUL09-1800-P	1.09	1	-	-
10/07/09	15:00	1B-10JUL09-0900-P	1.09	1	-	-
10/07/09	20:01	1B-10JUL09-1300-P	1.09	1	-	-
10/07/09	20:01	SH6-01	1.09	-	-	12
11/07/09	16:01	1B-11JUL09-0900-P	1.09	1	-	-
11/07/09	20:06	1B-11JUL09-1300-P	1.09	1	-	-
11/07/09	01:01	1B-11JUL09-1800-P	1.09	1	-	-
12/07/09	15:02	1B-12JUL09-0900-P	0.63	1	1	-
12/07/09	19:10	1B-12JUL09-1300-B	1.09	1	1	-
12/07/09	00:50	1B-12JUL09-1900-P	0.63	1	1	-
13/07/09	15:00	1B-13JUL09-0900-P	1.09	1	-	-
13/07/09	19:05	1B-13JUL09-1300-B	1.09	1	-	-
13/07/09	00:02	1B-13JUL09-1800-P	1.09	1	-	-
14/07/09	15:01	1B-14JUL09-0900-P	1.215	1	-	-
14/07/09	15:01	1B-14JUL09-0900-P	1.09	-	1	-
14/07/09	19:20	1B-14JUL09-1300-B	1.20	1	-	-
14/07/09	19:20	1B-14JUL09-1300-B	1.09	-	1	-
14/07/09	19:20	SH6-02	1.09	-	-	12
14/07/09	00:02	1B-14JUL09-1800-P	1.20	1	-	-
14/07/09	00:02	1B-14JUL09-1800-P	1.20	-	1	-

* The last letter of the sample ID refers to the type of sampling: 'P' for a pump sample and 'B' for a bucket sample.

Phytoplankton and microbial molecular biodiversity

During Leg 1b, the flow cytometer was installed and tested. Sampling was conducted underway during transit from Victoria BC to the Beaufort Sea and the following measurements were made:

- Flow cytometry enumeration of phytoplankton and heterotrophs
- Flow cytometric sorting of the different populations present in the samples in different culture media, in order to get new cultures of phototrophs
- Flow cytometric sorting for microscopy and molecular purposes after concentration of the samples by tangential filtration: diversity of the different populations, single cell genomics
- Enrichments of seawater to get cultures

- Scanning microscopy (filtration)
- Quantitative PCR (filtration)
- Molecular diversity (filtration)
- AAPB abundances (filtration)

Samples for flow cytometry enumerations were collected 3 times per day while samples for the other measurements were taken once per day every morning (Table 12.2).

Table 12.2. Total number of samples analyzed on board or collected for further analysis in the laboratory for molecular phytoplankton and microbial diversity measurements during Leg 1b.

	Samples analyzed on board	Samples preserved for subsequent analyses	
		Liquid samples	Filters
Cell enumeration by flow cytometry	54	27	
Cultures obtained by Flow cytometric sorting	136	136	
Flow cytometric sorting for diversity	17	17	
Flow cytometric sorting for single cell genomics	26 x 12	26 x 12	
Flow cytometric sorting for scanning microscopy	14		14
Tangential filtration for future sorting	7	7	
Enrichment cultures (50 ml)	50	50	
Eukaryote scanning microscopy	8		8
Quantitative PCR	10	10	
Molecular diversity	8	8	
APPB abundance	24		24

Phytoplankton photosynthesis and proteins

Underway sampling was carried out together with the other Malina teams, using the TSG system. Samples for proteins were taken three times per day. Two liters (or less when particle charge was too heavy) were filtered onto GF/F filters and quickly frozen at -80°C for later analysis. Triplicate of P *vs.* E curves were done at each 13:00 sampling point together with a low light curve. A total of 40 curves were made according to the method of Babin et al. (1994). Samples were counted onboard.

Coccolithophores

Samples were collected underway along the cruise track using sub-surface water pumped at 8 m. Between 0.5 to 1 L of seawater was filtered using a vacuum pump through cellulose filter (25 mm diameter, 45 µm pore size). Filters were dried and placed in air-tight Ziploc bags to avoid humidity damaging the cells by dissolving calcite. Seawater was also filtered through GF/F filters (25 mm diameter, 0.45 µm pore size) for pigment extraction and filters were placed in cryotubes and frozen at -80°C.

In total, 40 samples were taken at 8 m for coccolithores (24 joint measurements with other teams) and 3 samples were collected at the surface. Filtration for pigment analyses were performed 24 times.

Coccolithophore abundance will be determined using optical microscopy and their morphological parameters (size, weight and calcification) with the SYRACO method developed by L. Beaufort (CEREGE). Pigments will be extracted and analysed with by HPLC. This information will be compared and assessed with nutrient concentrations and particulate organic matter also measured in this leg.

Sampling for coccolithophores will be continued in Leg 2b in the Beaufort Sea, both at the surface and at the chlorophyll maximum, to validate remote sensing information suggesting the presence of coccolithophorid blooms in that area.

12.2.2 Leg 4a – 8 October to 6 November – Beaufort Sea, NW Passage, Baffin Bay Leg 4b – 6 November to 18 November – Labrador fjords

During Legs 4a and 4b, each Full and Basic stations were sampled, and some additional Nutrients stations were added at the end of the cruise. The planned sampling strategy also included data gathering during transits on surface seawater collected underway with the hull sub-surface pump.

Depending on light conditions, sea state or ice conditions, a Satlantic MicroNESS free falling radiometer was deployed manually from the bow of the ship, for downwelling and upwelling irradiance measurements at 8 wavelengths.

Inherent optical properties of seawater profiles were gathered by the mean of an optical frame deployed from the front port side A-Frame. The optical frame was equipped with the following sensors:

- A Wetlabs AC9 spectrometer measuring absorption and diffusion by water and its contents at 9 wavelengths.
- A Wetlabs BB3 measuring backscattering at 3 wavelengths.
- A Wetlabs WetStar Coloured Dissolved Organic Matter fluorometer.
- A Chelsea MiniTracka Chlorophyll Fluorometer.
- A Seabird SBE37IM CTD for physical parameters (salinity, temperature, pressure).

On each Primary Production Rosette cast, water was sampled at fixed depths (150 m, 100 m and from 80 m to the surface in 10 m intervals) for lab analyses:

- Filtrations on GF/F fiberglass filters for later HPLC pigments analysis
- Filtrations on GF/F filters for *in vivo* particulate absorption (total and non algal)
- Filtrations on pre-weighted clean GF/F filters in triplicate for Total Suspended Matter measurements.
- A small amount of water was also filtered through 0.22 µm caps for CDOM absorption/diffusion measurements.

Determination of particulate absorption was done following Röttgers and Gehnke (2008) methodology using a Perkin Elmer Lambda 19 Spectrophotometer equipped with its Integrating Sphere allowing the filter to be placed inside the Sphere.

Determination of CDOM absorption/diffusion was done using a World Precision Instruments UltraPATH system, set on 200 cm optical path. For optical frame absorption/diffusion measurements comparison, the Wetlabs AC9 was used on the bench on the same samples, before and after 0.22 μm filtration.

Table 12.3. Sampling stations where optical water column measurements were conducted during Legs 4a and 4b.

Stn ID	Latitude N	Longitude W	CTD Cast #	Date in 2009	Samples taken
Leg 4a					
437	71°47.070	126°29.206	0904-003	12/10	HPLC, TSM, CDOM, Ap, IOPs
408	71°18.437	127°35.183	0904-007	13/10	HPLC, TSM, CDOM, Ap, IOPs
405	70°39.769	123°00.252	0904-023	15/10	HPLC, TSM, CDOM, Ap, IOPs
450	72°05.567	119°47.482	0904-026	17/10	HPLC, TSM, CDOM, Ap, IOPs, AC9 on bench
308	74°06.145	108°49.718	0904-027	19/10	HPLC, TSM, CDOM, Ap, IOPs, AC9 on bench
334	74°17.812	102°44.940	0904-029	22/10	HPLC, TSM, CDOM, Ap, AC9 on bench
304	74°18.727	091°20.016	0904-030	23/10	HPLC, TSM, CDOM, Ap, IOPs
323	74°06.978	080°40.681	0904-038	25/10	HPLC, TSM, CDOM, Ap, IOPs, AC9 on bench
103	76°21.235	076°32.227	0904-041	26/10	HPLC, TSM, CDOM, Ap, IOPs, AC9 on bench
105	76°14.83	075°50.580	0904-043	27/10	HPLC, TSM, CDOM, Ap, IOPs, AC9 on bench
107	76°16.855	074°59.233	0904-046	27/10	HPLC, TSM, CDOM, Ap, AC9 on bench
109	76°17.227	074°06.940	0904-048	27/10	HPLC, TSM, CDOM, Ap, IOPs, AOPs, AC9 on bench
110	76°17.716	073°37.427	0904-051	28/10	HPLC, TSM, CDOM, Ap, AC9 on bench
111	76°17.700	073°12.628	0904-051	28/10	HPLC, TSM, CDOM, Ap, IOPs, AC9 on bench
113	76°19.337	072°13.716	0904-054	28/10	HPLC, TSM, CDOM, Ap, AC9 on bench
115	76°20.017	071°11.738	0904-057	29/10	HPLC, TSM, CDOM, Ap, IOPs, AOPs, AC9 on bench
136	74°45.458	073°33.466	0904-060	30/10	HPLC, TSM, CDOM, Ap, IOPs, AOPs, AC9 on bench
141	71°23.950	070°09.295	0904-065	02/11	HPLC, TSM, CDOM, Ap, IOPs, AOPs, AC9 on bench
Leg 4b					
352	61°16.076	064°48.226	66	07/11	HPLC, TSM, CDOM, Ap,
600	59°05.257	063°25.801	68	08/11	HPLC, TSM, CDOM, Ap, IOPs
602	59°03.065	063°52.289	70	08/11	HPLC, TSM, CDOM, Ap,
604	58°59.664	063°53.528	71	08/11	HPLC, TSM, CDOM, Ap, AC9 on bench
613	58°29.011	063°12.865	74	09/11	HPLC, TSM, CDOM, Ap, AC9 on bench
615	58°19.381	063°32.464	76	09/11	HPLC, TSM, CDOM, Ap, AC9 on bench
610	58°31.303	062°50.303	77	10/11	HPLC, TSM, CDOM, Ap,AC9 on bench
617	58°30.074	062°41.082	78	10/11	HPLC, TSM, CDOM, Ap, IOPs, AC9 on bench
633	57°33.996	062°03.335	80	10/11	HPLC, TSM, CDOM, Ap, IOPs, AC9 on bench
631	57°29.574	062°11.689	81	11/11	HPLC, TSM, CDOM, Ap, IOPs, AC9 on bench
630	57°29.574	062°11.689	82	11/11	HPLC, TSM, CDOM, Ap, AC9 on bench
620	57°34.128	061°56.434	84	12/11	HPLC, TSM, CDOM, Ap, AC9 on bench
622	56°24.880	061°43.932	87	12/11	HPLC, TSM, CDOM, Ap, AC9 on bench, IOPs
624	56°25.219	062°04.352	89	13/11	HPLC, TSM, CDOM, Ap, AC9 on bench

12.3 Preliminary results

12.3.1 Leg 1b – 30 June to 16 July 2009 – Victoria to Sachs Harbour

Leg 1b allowed establishing a sampling and analysis protocol and the preliminary results already highlight changes and updates that need to be made before the Malina cruise in August (Leg 2b). The results are still being analyzed but the measurements were sensitive to observed variations. More analyses of the samples will be made in the lab upon return to Villefranche.

Phytoplankton and non-algal particles (NAP)

Expected results coming out of the particulate and dissolved organic matter light absorption measurements include:

- Changes in phytoplankton species composition combined with HPLC and fluorocytometry along the south-to-north transect
- Light acclimation and/or adaptation of phytoplankton
- Phytoplankton physiological condition combined with light, temperature, and nutrients
- Abundance of non-algal particles (NAP or detritus)
- Linkage between NAP and phytoplankton biomass, between NAP and suspended matter

Ultimately, the data collected will be used to develop ocean color algorithms and primary production models for the Arctic.

Phytoplankton and microbial molecular biodiversity

Abundance of phytoplankton and heterotroph cells was determined onboard using flow cytometry (Table 12.4).

Table 12.4. Abundance of phytoplankton and heterotrophs enumerated using flow cytometry during Leg 1b.

Bottle	Sample ID	Syne (cells/ml)	Pico (cells/ml)	Nano (cells/ml)	Bacteria (cells/ml)
A	PAC05JUL09-A_Rate89	3199	14153	2718	967469
B	PAC05JUL09-B_Rate89	3631	12022	2729	997407
C	PAC05JUL09-C_Rate89	4717	12521	2876	1023490
A	PAC06JUL09-A_Rate86	2200	6902	7212	563272
B	PAC06JUL09-B_Rate86	2578	6455	7424	555826
C	PAC06JUL09-C_Rate86	2520	7097	7945	565896
D	PAC06JUL09-D-Rate86	2096	7464	6919	530577
A	PAC06JUL09-1300-A_Rate86	11446	15434	9626	631447
B	PAC06JUL09-1300-B_Rate86	2587	5502	2774	535994
C	PAC06JUL09-1300-C_Rate86	11826	13250	9665	334423
D	PAC06JUL09-1300-D_Rate86	11078	15309	9161	634906
A	PAC06JUL09-A_Rate86	2715	6461	7630	
B	PAC06JUL09-B_Rate86	2904	6484	7349	

Bottle	Sample ID	Syne (cells/ml)	Pico (cells/ml)	Nano (cells/ml)	Bacteria (cells/ml)
C	PAC06JUL09-C_Rate86	2967	7103	7836	798281
D	PAC06JUL09-D-Rate86	2475	6765	7527	
A	PAC07JUL09-0900-A_Rate86	26097	3672	11622	877800
B	PAC07JUL09-0900-B_Rate86	21305	2745	9853	814720
C	PAC07JUL09-0900-C_Rate86	24069	2641	10603	775679
D	PAC07JUL09-0900-D_Rate86	25616	2864	10540	765962
A	PAC07JUL09-1300-A_Rate78	22269	4288	10831	974125
B	PAC07JUL09-1300-B_Rate78	23191	4187	10275	1013375
C	PAC07JUL09-1300-C_Rate78	22610	4465	10781	1053020
D	PAC07JUL09-13200-D_Rate78	22925	4358	10143	1125578
A	PAC07JUL09-1800-A_Rate78	63013	16586	5655	2126882
B	PAC07JUL09-1800-B_Rate78	61232	16585	6398	1981803
C	PAC07JUL09-1800-C_Rate78	60482	15954	6448	1974146
D	PAC07JUL09-1800-D_Rate78	54653	14234	5747	2042365
A	PAC08JUL09-A_Rate83	10115	10514	1928	723440
B	PAC08JUL09-B_Rate83	6440	10386	2867	616250
C	PAC08JUL09-C_Rate83	6582	12203	3591	634004
D	PAC08JUL09-D_Rate83	8754	12778	3793	690274
A	PAC08JUL09-1300-A_Rate83	11146	6226	3276	789949
B	PAC08JUL09-1300-B_Rate83	13947	5642	3732	738394
C	PAC08JUL09-1300-C_Rate83	18948	6800	4426	827073
D	PAC08JUL09-1300-D_Rate83	20268	8582	4131	851037
A	PAC08JUL09-1800-A_Rate83	2272	13372	1742	1406683
B	PAC08JUL09-1800-B_Rate83	4267	15539	2222	1502915
C	PAC08JUL09-1800-C_Rate83	3051	19390	1846	1779066
D	PAC08JUL09-1800-D_Rate83	3756	21699	1816	1929358
A	BER09JUL09-0900-A_Rate77	512	21105	4101	1166032
B	BER09JUL09-0900-B_Rate77	377	33050	5975	1072503
C	BER09JUL09-0900-C_Rate77	326	33408	5707	1075384
D	BER09JUL09-0900-D_Rate77	313	33395	5329	1104645
A	BER09JUL09-1300-A_Rate77	209	21191	7273	1404778
B	BER09JUL09-1300-B_Rate77	304	26627	8761	1606452
C	BER09JUL09-1300-C_Rate77	96	26806	7575	1544690
D	BER09JUL09-1300-D_Rate77	192	27503	7760	1547738
A	BER09JUL09-1800-A_Rate77	364	4605	3476	1292993
B	BER09JUL09-1800-B_Rate77	653	4884	5036	1369878
C	BER09JUL09-1800-C_Rate77	722	3161	4549	1435909
D	BER09JUL09-1800-D_Rate77	678	480	2310	1395079
A	BER10JUL09-0900-A_Rate74	132	5063	3329	1633476
B	BER10JUL09-0900-B_Rate74	158	5610	3949	850437
C	BER10JUL09-0900-C_Rate74	79	5155	3949	872219
D	BER10JUL09-0900-D_Rate74	105	4548	3606	863293
A	BER10JUL09-1300-A_Rate74	103	2569	1012	1059893
B	BER10JUL09-1300-B_Rate74	58	2158	957	560940
C	BER10JUL09-1300-C_Rate74		1927	669	489881
D	BER10JUL09-1300-D_Rate74		1476	847	395209
A	ARC11JUL09-0900-A_Rate79		5331	2223	3401415
B	ARC11JUL09-0900-B_Rate79	66	5096	4955	4403197
C	ARC11JUL09-0900-C_Rate79	42	5449	3050	4426539

Bottle	Sample ID	Syne (cells/ml)	Pico (cells/ml)	Nano (cells/ml)	Bacteria (cells/ml)
D	ARC11JUL09-0900-D_Rate79		4303	4712	4453534
A	BER11JUL09-1300-A_Rate79		13830	1360	1158920
B	BER11JUL09-1300-B_Rate79		12144	1692	1672618
C	BER11JUL09-1300-C_Rate79		11689	998	1024712
D	BER11JUL09-1300-D_Rate79		11388	1462	1256336
A	BER11JUL09-1800-A_Rate79		20204	3325	1824837
B	BER11JUL09-1800-B_Rate79		21702	2395	1813681
C	BER11JUL09-1800-C_Rate79		21206	2890	1939737
D	BER11JUL09-1800-D_Rate79		19871	3088	2017648
A	ARC12JUL09-A_Rate78		20709	6101	1856607
B	ARC12JUL09-B_Rate78		25697	6166	1660334
C	ARC12JUL09-C_Rate78		24043	7402	1454883
D	ARC12JUL09-D_Rate78		21082	6760	1426808
A	ARC12JUL09-A-1300_Rate78		1545	455	573648
B	ARC12JUL09-B-1300_Rate78		1307	404	507063
C	ARC12JUL09-C-1300_Rate78		832	383	420315
D	ARC12JUL09-D-1300_Rate78		946	361	379385
A	ARC12JUL09-A-1800_Rate78		7516	5284	1054116
B	ARC12JUL09-B-1800_Rate78		5297	5137	1000774
C	ARC12JUL09-C-1800_Rate78		4772	4764	1110361
D	ARC12JUL09-D-1800_Rate78		7020	4317	1048049
A	ARC13JUL09-A-0900_Rate77		1785	722	875134
B	ARC13JUL09-B-0900_Rate77		2134	1663	963076
C	ARC13JUL09-C-0900_Rate77		1753	664	850782
D	ARC13JUL09-D-0900_Rate77		2229	1502	902667
A	BEA13JUL09-A-1300_Rate77		1882	440	1325885
B	BEA13JUL09-B-1300_Rate77		1732	347	1339703
C	BEA13JUL09-C-1300_Rate77		1779	364	1338187
D	BEA13JUL09-D-1300_Rate77		1706	330	1321994
A	BER13JUL09-A-1800_Rate78		2615	977	1310131
B	BER13JUL09-B-1800_Rate78		4003	1507	986089
C	BER13JUL09-C-1800_Rate78		4176	1231	880039
D	BER13JUL09-D-1800_Rate78		4587	1354	887428
A	BEA14JUL09-A-0900_Rate77		1179	527	429332
B	BEA14JUL09-B-0900_Rate77		1170	934	397590
C	BEA14JUL09-C-1300_Rate77		703	386	328363
D	BEA14JUL09-D-0900_Rate77		1160	443	278068
A	BEA14JUL09-A-1300_Rate77		639	591	347633
B	BEA14JUL09-B-1300_Rate77		583	494	363418
C	BEA14JUL09-C-0900_Rate77		1175	992	360409
D	BEA14JUL09-D-1300_Rate77		810	373	358197

12.3.2 Leg 4a – 8 October to 6 November – Beaufort Sea, NW Passage, Baffin Bay Leg 4b – 6 November to 18 November – Labrador fjords

Due to heavy ice conditions encountered almost all along the ship’s track, the transit pumping of sub-surface seawater was not possible because of the pump overloaded with frasil. Some tests carried out on pumped seawater showed a significant difference with surface water sampled with the Rosette, especially for TSM filtrations. The suspected occurrences of rust particles coming from pipes led the team to cancel these operations. No preliminary results can be presented at this point and will need to wait for further data processing.

12.4 Comments and recommendations

The following circumstances generated inadequate results with some of the instruments: problems with the tuning of the instruments, strong vibrations from the ship, etc.

Improvements on the onboard hull sub surface pumping would be highly recommended; the installation of a permanent Thermosalinometer/ Chl fluorometer with a shortened tubes path from outside to measurement unit would be a good idea, allowing good quality surface sampling during transits times.

References

Rottgers, R. and Gehnke, S. (2008) Improvements for light absorption measurements of particles retained on glass fiber filters.

13 Water quality in Hudson Bay – BaySys

ArcticNet Phase 2 – Project titled *Freshwater-Marine Coupling in the Hudson Bay IRIS*.
ArcticNet/Phase2/Barber_freshwater-marine_coupling

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13.1 Methodology

water samples were collected at approximately 0.3 m depth at all stations (Basic, Mooring and CTD) as well as along two transects by Zodiac offshore from the mouth of the Rivière de la Grande Baleine (Figure 13.1) and off Cape Tatnam (Figure 13.2). At each of these stations, CTD profiles were carried out, each to the bottom or at least 30 m depth, using an Idronaut CTD with conductivity, temperature, depth and turbidity and WetLabs ECO Fluorometer for CDOM fluorescence. Sample coordinates are listed in Table 13.1.

Due to severe waves, the transect off the mouth of the Nelson River could not be completed, although two water samples were collected in the outer estuary (Figure 13.2). Surface water samples were also collected at 4 locations while in transit between James Bay and western Hudson Bay (Figure 13.3).

Figure 13.1. Great Whale River sampling at Station 702 with additional stations visited by Zodiac on 27 and 28 July 2009.

Figure 13.2. Nelson River sampling at Stations 705 and 713-715 with additional stations visited by Zodiac on 2 and 3 August 2009.

Figure 13.3. Locations of 4 water samples (HB01 – HB04) collected in transit from James Bay to western Hudson Bay.

Table 13.1. Geographic coordinates and sample times of water quality sampling in Hudson Bay during the BaySys cruise.

Station	Date and time	Latitude N	Longitude W
GWR	2009 Jul 26 08:55	55° 16.742	077° 40.892
GW01	2009 Jul 27 16:10	55° 15.970	077° 47.251
GW02	2009 Jul 27 16:23	55° 16.576	077° 49.183
GW03	2009 Jul 27 16:34	55° 17.224	077° 51.900
GW04	2009 Jul 27 16:57	55° 21.132	077° 53.466
702	2009 Jul 27 17:40	55° 24.587	077° 55.549
GW01	2009 Jul 28 09:48	55° 15.970	077° 47.251
GW02	2009 Jul 28 10:04	55° 16.576	077° 49.183
GW07	2009 Jul 28 10:33	55° 17.638	077° 47.271
GW08	2009 Jul 28 10:44	55° 18.877	077° 46.340
GW09	2009 Jul 28 10:58	55° 20.548	077° 44.340
GW11	2009 Jul 28 11:13	55° 20.863	077° 47.719
GW10	2009 Jul 28 11:36	55° 18.031	077° 48.547
GW05	2009 Jul 28 11:46	55° 15.866	077° 51.547
GW06	2009 Jul 28 11:55	55° 15.275	077° 52.616
703	2009 Jul 29 06:38	54° 40.732	079° 57.518
704	2009 Jul 29 15:11	54° 45.651	081° 42.490
709	2009 Jul 29 20:02	54° 42.939	080° 46.625
HB01	2009 Jul 30 18:38	57° 05.039	081° 55.233
HB02	2009 Jul 31 08:16	57° 55.286	082° 17.309
HB03	2009 Jul 31 18:43	58° 54.627	085° 35.756
HB04	2009 Jul 31 18:46	59° 24.250	089° 15.360
707	2009 Aug 01 07:23	59° 58.410	091° 56.599
706	2009 Aug 01 15:54	58° 47.016	091° 31.451
NR1	2009 Aug 02 00:00	57° 12.742	092° 16.295
NR2	2009 Aug 02 00:00	57° 14.648	092° 13.256
705	2009 Aug 02 08:35	57° 39.298	091° 35.672
715	2009 Aug 02 11:10	57° 26.501	091° 54.550
713	2009 Aug 03 08:12	57° 42.361	090° 46.363
713b	2009 Aug 03 09:03	57° 39.256	090° 46.818
713c	2009 Aug 03 09:18	57° 35.874	090° 47.049
713d	2009 Aug 03 09:25	57° 32.276	090° 47.620
713e	2009 Aug 03 09:55	57° 28.737	090° 46.021
713f	2009 Aug 03 10:11	57° 26.176	090° 48.452
713g	2009 Aug 03 10:22	57° 23.719	090° 48.707
714	2009 Aug 03 18:56	57° 34.638	091° 20.465

All water samples were filtered on board, and subsamples were retained for analysis for dissolved and particulate OC, ON and P and for TSS, chlorophyll, CDOM, O-18 and salinity. In addition, the University of Manitoba team collected several profiles of absorption and attenuation spectra off the mouth of the Rivière de la Grande Baleine, using a WetLabs hyperspectral absorption and attenuation meter (WetLabs acs). Wave and ice conditions, and time constraints prevented us from retrieving successful absorption and attenuation spectra in the Nelson River estuary.

14 Filtration of particles for alkenones and biomarkers analysis (GEOTRACES) – Leg 3a

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14.1 Introduction

Alkenones are biosynthesized by microalgae of the class Haptophyceae/ Prymnesiophyceae, and their degree of unsaturation (number of double bonds) depends on the growth temperature of the organism. Numerous studies in culture, sediment traps and sediment core tops have established a robust and linear relationship between the degree of alkenone unsaturation (the UK37 index) and water temperature in the mixed layer. These global calibrations are robust across all major biogeographic zones and cover a temperature range from -1 to 30 ºC. However, global compilations have shown the relation between UK37 and SST to be somewhat less robust at both ends of the temperature range (<5° and >25°C). This scatter reflects a greater influence of non-thermal factors on alkenone saturation near the limits of the temperature range, and has been linked to the increasing dominance of the tetra unsaturated alkenone in cold water. Fresh water inflow, either from large rivers or sea ice is a common feature among environments in which large abundances of the tetra unsaturated alkenone have been detected. This led to the idea that the biosynthesization of C37:4 is related to salinity.

14.2 Methodology

Samples were collected to analyze alkenone abundance and alkenone unsaturation patterns in suspended matter in the photic zone. The objectives were twofold:

- Establish alkenone unsaturation patterns, which have proven reliable paleo proxies for SST over large parts of the global ocean. They will be analyzed and compared to surface temperature and salinity measurements in order to confirm or refine the applicability of this proxy at the lower end of the temperature range.
- Examine the tetra unsaturated compound, specifically with respect to sea surface salinity, in order to evaluate its potential as a paleo salinity proxy. The Canadian Arctic, with its large seasonal and spatial salinity gradients, is an ideal site to explore the potential of the tetra unsaturated compound as a paleo salinity tracer and to evaluate the impact of salinity on the established relationship between the UK37 index and SST at the low temperature range of the calibration.

Water was filtered through combusted GF/F filters using an underway pump system, which collected water from 7 m water depth. The system typically ran for 3 hours, filtering between 100 and 400 L (Table 14.1).

Table 14.1. List of underway samples taken for alkenones and biomarkers analysis during Leg 3a.

SAMPLE ID	DATE	LAT. START	LONG. START	LAT. END	LONG. END	TIME START	TIME END	READING START	READING END	VOL FILTERED	CONTAMINATION
A.1	30/08/2009	69.29N	137.59W	69.50N	138.30W	2:30AM		3000	3076.5	76.5	YES
A.2	30/08/2009	70N	138.30w			10:55AM	1:40PM	3076.5	3102.3	25.8	YES
A.3	31/08/2009	70.43N	138.44W	70.51N	138.41W	7:20AM	08:30AM	3104.5	3136	31.5	YES
A.4	02/09/2009	71.59N	138.48W	72.27N	139.19W	8.14PM	10:50PM	3184.5	3452.6	268.1	NO
A.5	03/09/2009	73.18N	139.23W	73.56N	139.49W	9:10AM	12:30AM	3463.8	3885.6	421.8	NO
A.6	03/09/2009	74.22N	138.28W	74.39N	137.22W	3:35PM	6:35PM	3885.7	4240.5	354.8	NO
A.7	04/09/2009	74.35N	137.07W	74.31N	136.45W	3:20PM	6:35PM	4678.6	4958.6	280	NO
A.8	05/09/2009	74.24N	136.26W	74.27N	136.19W	3:40PM	6:10PM	6037	6375	338	NO
A.9	06/09/2009	74.27N	133.27W	74.26N	133.22W	11PM	2AM	6794.6	7146.5	315.9	NO
A.10	06/09/2009	74.28N	133.06W	74.28N	133.02W	04:20	07:15	7147	7462	315	NO
A.11	06/09/2009	75.16N	137.44W					7462	7768.5	306.5	NO
A.12	07/09/2009	75.12N	137.24W	74.38N	137.06W	9:20PM	12:20PM	8119.5	8429.5	310	NO
A.13	08/09/2009	73.12N	135.28W	72.47N	135.23W	10:20AM	1:20PM	8429.5	8800.6	371.1	NO
A.14	08/08/2009	72.37N	136.50W	72.31N	136.35W			8809.8	9012.5	202.7	NO
A.16	08/09/2009	72.30N	136.35W					9012.5	9350	337.5	NO
A.17	09/09/2009	72.29N	135.45W					9350	9360	280	NO
A.18	10/09/2009	72.29	136.25W	72.27N	136.46W	10PM	1PM	11542.4	12000	457.6	NO
A.19	11/09/2009	72.12N	136.19W	71.51N	135.54W	13:30AM	2:30AM	12000	12339	339	NO
A.20	11/09/2009	71.11N	133.12W	71.06N	131.29W	11:10AM	2:10PM	12339	12728	389	NO

Samples have been taken from 7 m water depth. Note that some of the filters are contaminated

Table 14.2. List of large volume in-situ pump samples collected for alkenones and biomarkers analysis during Leg 3a.

Station ID	Event #	PUMP #	Depth (m)	Filter QMA	MnO_2 Cart.	Volume filtered (L)		Analysis/Comments
						Flowmeter	Computer	
S1	2	1	10	x		0	25.78	sudden flow obstruction
		3	50	x		47.9	60.4	min flow reached
S2	13	1	10	x	x	0	11.46	sudden flow obstruction
		2	250	x	x	0	87.9	sudden flow obstruction
		3	500	x	x	776	857.6	
		4	750	x	x	960.5	1026.49	
		5	1000	x	x	170.7	183.69	sudden pressure release
		6	1500	x	x	53.6	48.84	sudden flow obstruction
L1	20	1	10	x	x	0	11.46	sudden flow obstruction
		2	250	x	x	0	87.9	sudden flow obstruction
		3	500	x	x	776	857.6	
		4	750	x	x	960.5	1026.49	
		5	1000	x	x	170.7	183.69	sudden pressure release
		6	1500	x	x	53.6	48.84	sudden flow obstruction
L2	47	1	25	x	x	0	3.71	Sudden flow obstruction
		2	250	x	x	863.73	938.58	
		3	400	x	x	778.3	862.01	
		4	800	x	x	686	800.21	low batteries
		6	1200	x	x	0	1.12	Sudden pressure release
L1.1	65	1	75 (Chl max)	x	x	531.6	562	min flow reached; filter ripped
		2	250	x	x	612.36	901	filter ripped
		3	400	x	x	814.6	879	
		4	600	x	x	782.8	927	low batteries
		5	800	x	x	996.1	1020	filter ripped
		6	1000	x	x	0	0	stopped by user

15 Carbon system analysis (GEOTRACES) – Legs 3a and 4a

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15.1 Introduction

The ocean's exchange of carbon dioxide with the atmosphere is governed by the biogeochemical cycling of carbon and physical processes throughout the water column, which determine the concentration of dissolved inorganic carbon (DIC) in surface waters. Of the four relevant carbon system parameters, a minimum of two are needed to calculate the others and fully describe carbonate chemistry.

15.2 Methodology

Seawater samples (500 ml) were collected from the Rosette at several depths throughout the water column for pH and total alkalinity (TA) determination. In Leg 4a, due to the presence of a group analysing for mercury, the samples were not spiked with $HgCl_2$ but stored in the dark at 4°C and analyzed within 6 hours of sampling.

Total alkalinity was measured onboard using an automated titrator (Titralab 865) from Radiometer Analytical and a Red Rod® combination pH electrode (pHC2001) in continuous titrant addition mode. Raw titration data were processed with a proprietary algorithm specifically designed for shallow end-point detection. The dilute HCl (~3.10^{-2} N) titrant was calibrated at the beginning and end of each day using certified reference materials (CRM Batch #92) provided by A. Dickson of the Scripps Institute of Oceanography (La Jolla, USA). All TA samples were analyzed in duplicates or triplicates.

Water samples for pH measurements were taken from the same bottles directly after TA samples. pH samples were collected in plastic bottles and analyzed immediately using a HP 8453 spectrophotometer. pH will be calculated using the absorbance measurements obtained from the coloration of water samples with m-cresol purple (Byrne and Breland 1989). All pH samples were analyzed in duplicates or triplicates.

Samples for $\delta^{18}O$ seawater were taken on the same Niskin bottles in 15 ml plastic tubes. Care was taken that there were no air bubble inside the tube. Then, the tubes were sealed with Parafilm for further analysis.

Samples for analyses of stable carbon isotopes ($^{13}C/^{12}C$) in dissolved inorganic carbon (^{13}C-DIC) were drawn in duplicate after other carbonate system parameters by affixing a Tygon tube to the Niskin spigot, flushing and removing all bubbles from the tubing, then filling 30 mL amber glass sampling vials. Samples were filled from the bottom and allowed to overflow by 2 volumes, ensuring all bubbles have been removed. Once the tubing was slowly removed (leaving no headspace), 20 µL saturated $HgCl_2$ was added to each sample and it was capped with a screw cap fitted with a conical insert. Samples will be analyzed for stable carbon isotope signatures at the UQAM-GEOTOP lab in Montreal, QC.

Leg 3a – 27 August to 12 September 2009 – Beaufort Sea

pH and alkalinity measurements were performed on each sample of the water column at Stations S1, S2, L1, L2, L3 and L1.1 immediately after sampling (Table 15.1). DIC samples were also collected for Dr. H. Thomas (Dalhousie University). They were not analyzed on board, but poisoned with mercury chloride ($HgCl_2$) and stored in the refrigerated container at 5°C and then stored in the cold room in the aft lab at the end of the cruise until the ship is back in Quebec City.

Samples for analyses of stable carbon isotopes ($^{13}C/^{12}C$) in dissolved inorganic carbon (DIC) were also collected in conjunction with carbonate system parameters (DIC, TALK, pH) at each of the biological casts and geochemistry casts, as outlined in Table 15.1.

Table 15.1. Summary of samples taken for DIC, alkalinity, pH and ^{13}C-DIC determination during Leg 3a.

Station	Event # Hydrocast #	Bottle	Depth (m)	^{13}C-DIC	DIC – Alk - pH
S1	1 - 1	24	4	?	
	Biology	23	4		xx
		17	10	?	xx
		11	25	?	xx
		5	50	?	xx
S2	10 - 10	24	2	xx	xx
	Biology	21	3	xx	
		20	10	xx	xx
		17	15	xx	
		16	25	xx	xx
		13	45	xx	
		12	50	xx	xx
		6	75		
		5	75	xx	xx
		2	100		
		1	100	xx	xx
S2	11 - 11	11	125		
	Geochem	9	150	xx	xx
		6	175		
		4	200	xx	xx
L1	16 - 14	21	22		
	Biology	20	22	xx	xx
		17	50		
		16	50	xx	xx
		13	85		
L1 (cont'd)		12	85	xx	xx
		9	126		

Station	Event # Hydrocast #	Bottle	Depth (m)	^{13}C-DIC	DIC – Alk - pH
		8	126	xx	xx
		5	150		
		4	150	xx	xx
		3	200	xx	xx
		1	200		
L1	18 - 15	24	2	xx	xx
	Geochem	22	10	xx	xx
		21	250	xx	xx
		19	300	xx	xx
		17	400	xx	xx
		15	500	xx	xx
		13	600	xx	xx
		11	800	xx	xx
		9	1000	xx	xx
		7	1200	xx	xx
		5	1400	xx	xx
		3	1700	xx	xx
L2	38 - 24	20	2.7	?	xx
	Biology	16	10	?	xx
		12	30	?	xx
		8	55	?	xx
		4	100	?	xx
		3	125	?	xx
L2	46 - 31	24	150	xx	xx
	Geochem	22	200	xx	xx
		20	250	xx	xx
		19	300	xx	xx
		17	400	xx	xx
		15	500	xx	xx
		14	600	xx	xx
		12	800	xx	xx
		11	1000	xx	xx
		9	1200	xx	xx
		8	1400	xx	xx
		7	1600	xx	xx
		6	1800	xx	xx
		5	2000	xx	xx
		4	2250	xx	xx
		3	2500	xx	xx
		2	2750	xx	xx
		1	3000	xx	xx
L3	54 - 33	24	3.1		
	Biology	21	3.1	xx	xx
		20	10		
		16	10	xx	xx
		15	32		
		12	32	xx	xx
		11	60		
L3 (cont'd)		8	60	xx	xx
		7	115		

Station	Event # Hydrocast #	Bottle	Depth (m)	^{13}C-DIC	DIC – Alk - pH
		4	115	xx	xx
		3	140	xx	xx
L3	56 - 34	24	150	xx	xx
	Geochem	22	200	xx	xx
		20	250	xx	xx
		19	300	xx	xx
		17	400	xx	xx
		15	500	xx	xx
		14	600	xx	xx
		12	800	xx	xx
		11	1000	xx	xx
		9	1200	xx	xx
		8	1400	xx	xx
		7	1600	xx	xx
		6	1800	xx	xx
		5	2000	xx	xx
		4	2250	xx	xx
		3	2500	xx	xx
		2	2750	xx	xx
		1	3000	xx	xx
L1.1	63 - 37	24	3		
	Biology	21	3	xx	xx
		20	10		
		16	10	xx	xx
		15	25		
		12	25	xx	xx
		11	70		
		8	70	xx	xx
		7	115		
		4	115	xx	xx
		3	140	xx	xx
L1.1	66 - 38	24	175	xx	xx
	Geochem	22	200	xx	xx
		20	250	xx	xx
		19	300	xx	xx
		17	350	xx	xx
		16	400	xx	xx
		14	450	xx	xx
		13	500	xx	xx
		12	600	xx	xx
		10	800	xx	xx
		9	1000	xx	xx
		6	1400	xx	xx
		5	1600	xx	xx
		4	1800	xx	xx
		3	2000	xx	xx
		2	2250	xx	xx
		1	2500	xx	xx

Leg 4a – 8 October to 6 November – Beaufort Sea, NW Passage, Baffin Bay

During ArcticNet Leg 4a, a total of 207 samples were collected at 16 stations and analyzed onboard for total alkalinity (TA) and pH. Samples for ^{13}C-DIC analysis were taken only at 3 different stations: 334, 323 and 109 (Table 15.2).

Table 15.2. Summary of sampling stations for carbonate system analyses during Leg 4a.

Station	Latitude N	Longitude W	Cast #	Date	Samples taken
437	71° 47.070	126° 29.206	0904-003	12/10/2009	TA, pH & $\delta^{18}O$
408	71° 18.437	127° 35.183	0904-007	13/10/2009	TA, pH & $\delta^{18}O$
412	71° 33.835	126° 55.498	0904-015	14/10/2009	TA, pH & $\delta^{18}O$
405	70° 39.769	123° 00.252	0904-023	15/10/2009	TA, pH & $\delta^{18}O$
450	72° 05.567	119° 47.482	0904-026	17/10/2009	TA, pH & $\delta^{18}O$
308	74° 06.145	108° 49.718	0904-027	19/10/2009	TA, pH & $\delta^{18}O$
334	74° 17.812	102° 44.940	0904-029	22/10/2009	TA, pH, $\delta^{18}O$ & ^{13}C-DIC
304	74° 18.727	091° 20.016	0904-030	23/10/2009	TA, pH & $\delta^{18}O$
323	74° 6.978	080° 40.681	0904-038	25/10/2009	TA, pH, $\delta^{18}O$ & ^{13}C-DIC
103	76° 21.235	076° 32.227	0904-041	26/10/2009	TA, pH & $\delta^{18}O$
105	76° 14.830	075° 50.580	0904-043	27/10/2009	TA, pH & $\delta^{18}O$
109	76° 17.227	074° 06.940	0904-048	27/10/2009	TA, pH, $\delta^{18}O$ & ^{13}C-DIC
111	76° 17.700	073° 12.628	0904-051	28/10/2009	TA, pH & $\delta^{18}O$
115	76° 20.017	071° 11.738	0904-057	29/10/2009	TA, pH & $\delta^{18}O$
136	74° 45.458	073° 33.466	0904-060	30/10/2009	TA, pH & $\delta^{18}O$
141	71° 23.950	070° 09.295	0904-065	02/11/2009	TA, pH & $\delta^{18}O$

16 Major and trace gases (GEOTRACES) – Leg 3a

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16.1 Methodology

16.1.1 Water column sampling

Samples for major and minor dissolved gases (N_2, Ar, O_2, CO_2, N_2O, CH_4) were collected in the water column during the biology and geochemistry casts carried out at each station, as outlined in Table 16.1. Samples were drawn from Niskin bottles using Tygon tubes attached to the Niskin spigot. Gas samples were the first samples drawn from each Niskin bottle once the Rosette was brought into the Rosette shack. Niskin bottles were checked for leaks from the spigot and from the bottom O-rings and any leaks were recorded. Once the leak check was completed, a Tygon tube was fixed to the Niskin spigot and rinsed with Niskin water, removing all the bubbles from the tubing. Glass serum bottles (250 mL) were then filled by placing the tubing at the bottom of the bottle and allowing it to slowly overfill by 2 volumes before removing the tubing (with no headspace remaining) and adding 40 – 60 µL of saturated $HgCl_2$ before capping with a rubber stopper and metal crimp seal. Dissolved gas samples were stored in the 4°C cooler while on board the ship and will be analyzed for dissolved gas concentrations using the GC-MS at UBC.

Table 16.1. Summary of samples taken for major and trace gases measurements in the water column during Leg 3a.

Station	Event # Hydrocast #	Bottle	Depth (m)	Gases
S1	1 - 1	24	4	?
	Biology	23	4	
		17	10	?
		11	25	?
		5	50	?
S2	10 - 10	24	2	
	Biology	21	3	x
		20	10	
		17	15	x
		16	25	
		13	45	x
		12	50	
		6	75	x
		5	75	
		2	100	x
		1	100	
S2	11 - 11	11	125	x
	Geochem	9	150	x

Station	Event # Hydrocast #	Bottle	Depth (m)	Gases
		6	175	x
		4	200	x
L1	16 - 14	21	22	x
	Biology	20	22	
		17	50	x
		16	50	
		13	85	x
		12	85	
		9	126	x
		8	126	
		5	150	x
		4	150	
		3	200	
		1	200	x
L1	18 - 15	24	2	
	Geochem	22	10	
		21	250	x
		19	300	x
		17	400	x
		15	500	x
		13	600	x
		11	800	x
		9	1000	x
		7	1200	
		5	1400	x
		3	1700	x
L2	38 - 24	20	2.7	?
	Biology	16	10	?
		12	30	?
		8	55	?
		4	100	?
		3	125	?
L2	46 - 31	24	150	x
	Geochem	22	200	x
		20	250	x
		19	300	x
		17	400	x
		15	500	x
		14	600	x
		12	800	x
		11	1000	x
		9	1200	x
		8	1400	x
		7	1600	x
		6	1800	x
		5	2000	x
		4	2250	x
		3	2500	x
		2	2750	x
		1	3000	x
L3	54 - 33	24	3.1	x
	Biology	21	3.1	
		20	10	x
		16	10	

Station	Event # Hydrocast #	Bottle	Depth (m)	Gases
		15	32	x
		12	32	
		11	60	x
		8	60	
		7	115	x
		4	115	
		3	140	x
L3	56 - 34	24	150	x
	Geochem	22	200	x
		20	250	x
		19	300	x
		17	400	x
		15	500	x
		14	600	x
		12	800	x
		11	1000	x
		9	1200	x
		8	1400	x
		7	1600	x
		6	1800	x
		5	2000	x
		4	2250	x
		3	2500	x
		2	2750	x
		1	3000	x
L1.1	63 - 37	24	3	x
	Biology	21	3	
		20	10	x
		16	10	
		15	25	x
		12	25	
		11	70	x
		8	70	
		7	115	x
		4	115	
		3	140	x
L1.1	66 - 38	24	175	x
	Geochem	22	200	x
		20	250	x
		19	300	x
		17	350	x
		16	400	x
		14	450	x
		13	500	
		12	600	x
		10	800	x
		9	1000	x
		6	1400	x
		5	1600	x
		4	1800	x
		3	2000	x
		2	2250	x
		1	2500	x

16.1.2 Underway sampling

Underway data were collected from 30 August to 11 September between latitudes 70°N and 75°N and between longitudes 125°W and 139°W. Samples were taken during transit to L1, from L1 to L2 and from L3 to L4. Due to ice breaking between L2 and L3, underway seawater flows dropped to 0 between ~14:50 UTC and 16:25 UTC and between 01:21 UTC and 12:44 UTC on 6 September, and underway data collection stopped during these times.

Dissolved gasses (H_2O, N_2, O_2, Ar, DMS, CO_2) were measured by a membrane inlet mass spectrometer (MIMS). Gas samples were extracted using a sampling cuvette and silicone membrane and then ionized by the quadrupole mass spectrometer. The mass/charge ratio of each gas was measured every 30 seconds during continuous flow analysis. Ion current measurements were calibrated to absolute concentrations for DMS and an atmospheric saturation ratio of ΔO_2/Ar. During surface sea water sampling the vacuum ranged from ~$5e^{-6}$ to ~$8e^{-6}$ torr. CO_2 concentrations will later be calibrated against the underway pCO_2 equilibrator aboard the ship.

17 Large volume in-situ pumps (GEOTRACES) – Leg 3a

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17.1 Methodology

17.1.1 Sampling

Six large volume in-situ pumps (McLane) were deployed simultaneously at different depths to obtain samples of suspended marine particles (Table 17.1). Two types of filters were used:

- Supor 0.8 µm pore size to measure ^{230}Th, ^{231}Pa, ^{234}Th, Ca, Al, Si, P.
- QMA 0.8 µm pore size to measure POC, PON, ^{234}Th and alkenones.

During the QMA casts, two cartridges of MnO_2-impregnated fibers were also mounted in series to measure $^{228}Ra/^{226}Ra$ (E. Sternberg, Dalhousie U.). Supor casts were also performed to collect particles for silicon isotopes measurements (D. Varela, U. Victoria).

Table 17.1. List of samples obtained with in-situ large volume pumps during the GEOTRACES campaign on Leg 3a.

Stn ID	Event #	Pump #	Depth (m)	Filter used			Volume filtered (L)		Analysis/ Comments
				QMA	Supor	MnO_2 cart.	Flowmeter	Computer	
S1	2 (alkenone	1	10	x			0	25.78	sudden flow obstruction
	only)	3	50	x			47.9	60.4	min flow reached
S2	13	1	10	x		x	0	17.64	sudden flow obstruction
		2	50	x		x	108.5	495.1	min flow reached
	(alkenone	3	100	x		x	166.5	209.98	min flow reached
	and Ra	4	150	x		x	946.2	995.49	
	only)	5	200	x		x	352.6	386.22	sudden pressure release
L1	20	1	10	x		x	0	11.46	sudden flow obstruction
		2	250	x		x	0	87.9	sudden flow obstruction
		3	500	x		x	776	857.6	
		4	750	x		x	960.5	1026.49	
		5	1000	x		x	170.7	183.69	sudden pressure release
L1	22	1	10		x		0	0	cancelled due to winch problems
		2	250		x		0	0	
		3	500		x		0	0	
		4	750		x		0	0	
		5	1000		x		0	0	

Stn ID	Event #	Pump #	Depth (m)	Filter used			Volume filtered (L)		Analysis/ Comments
				QMA	Supor	MnO_2 cart.	Flowmeter	Computer	
		6	1500		x		0	0	
L1	26 (Si isotopes)	1	25		x		1187.2	1114.34	
		2	100		x		285.3	1089.93	
		3	250		x		1021.3	1044.42	
		4	400		x		1370.8	1233.52	
		6	800		x		78.3	832	sudden flow obstruction
L2	37	1	25		x		211.8	223.29	Sudden pressure release
		2	250		x		1005.1	1039.71	
		3	400		x		1008.3	1036.09	
		4	800		x		822.5	923.99	low batteries
		6	1200		x		1.6	1.59	Sudden pressure release
L2	47	1	25	x		x	0	3.71	Sudden flow obstruction
		2	250	x		x	863.73	938.58	
		3	400	x		x	778.3	862.01	
		4	800	x		x	686	800.21	low batteries
		6	1200	x		x	0	1.12	Sudden pressure release
L2	50 (Si isotopes)	1	25		x		0	1.42	sudden flow obstruction
		2	100		x		41.58	149.01	sudden pressure release
		3	250		x		923.6	999	
		4	400		x		1030	1098.77	
		6	800		x		45.1	44.44	sudden pressure release
L3	53	1	50		x		797.8	751	
		2	250		x		720.09	748	
		3	400		x		759.4	772	
		4	700		x		731.7	774	
		5	1000		x		746.5	761	
		6	1300		x		0	0	forgot to program pump
L1.1	60	1	Chl max (75)		x		464.4	482	min flow reached
		2	250		x		745	770	
		3	400		x		767	779	
		4	600		x		746.6	785	
		5	800		x		25.3	25.1	sudden pressure release
		6	1000		x		17.5	23.74	sudden pressure release
L1.1	65	1	Chl max (75)	x		x	531.6	562	min flow reached; filter ripped
		2	250	x		x	612.36	901	filter ripped
		3	400	x		x	814.6	879	
		4	600	x		x	782.8	927	low batteries
		5	800	x		x	996.1	1020	filter ripped
		6	1000	x		x	0	0	stopped by user
L1.1	73 (Si isotopes)	1	Chl max (75)		x		558.4	569	
		2	100		x		637.7	690	
		3	250		x		720.8	749	
		4	400		x		732.4	773	
		5	800		x		782.1	776	
		6	1000		x		1.1	1.1	sudden flow obstruction

17.1.2 Sample processing

Supor filters: A punch was taken from the filter to measure ^{234}Th by beta counting on board or later at IOS. The remainder was stored frozen and dried a few days later. The other elements and isotopes will be measured at UBC.

QMA: A punch was taken from the filter to measure ^{234}Th by beta counting on board or later at IOS. The remainder was stored frozen at -80°C to measure alkenones (M. Kienast, Dalhousie U.).

18 Dissolved and particulate ^{234}Th (GEOTRACES) – Leg 3a

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18.1 Introduction

Dissolved and particulate ^{234}Th were measured at 4 stations to quantify the export flux of organic carbon from surface to deep water. ^{234}Th was also measured on punches of filters (QMA and Supor) obtained with the large volume in-situ pumps. Combining ^{234}Th and ^{230}Th data provides constraints on particle dynamics in the water column. Comparing ^{234}Th data obtained with different filter types also provide a means of quantifying their relative filtration efficiency.

18.2 Methodology

18.2.1 Rosette sampling

Water for particulate and total thorium samples were collected from Niskin bottles – generally emptying the designated Niskin into a collapsible carboy, about 8-10 L per Niskin. This water was then kept cold and dark until separated into particulate and total aliquots.

<u>Particulate Thorium</u>

Four to six litres of water, well shaken, measured by graduated cylinder, one litre at a time, were filtered through a pre-combusted 25 mm Tissue Quartz filter, using a vacuum pump with max 5 psi suction. At the end, the grad cylinder and filter tower were rinsed with ~50-60 mL DmQ water, to wash any stray particles down the sides, and rinse out salts. The filters were then placed in a 53°C oven to dry, before mounting and beta counting.

<u>Total Thorium</u>

Two litres of water, well shaken and measured by grad cylinder, were placed into a clean, pre-rinsed 2 L bottle for treatment. Each sample was acidified with 10 mL of 1:1 (6 M) HCl, environmental grade, then shaken, and a pre-weighed Thorium-230 spike (1 g of 10 dpm) added and allowed to sit for ~12 hours. Room temperature during this time varied from about 8-20°C. At the end of this time the samples were neutralized to pH 8.1-8.3 (using pH paper) by the addition of ~5.6 mL of concentrated NH_4OH. 125 µL of $KMnO_4$, 3 g/L, was added, mixed, then 125 µL of $MnCl_2$, 8 g/L, added and the bottle well shaken. The bottles were then placed in an 80°C water bath for two hours, a maximum of 5 at a time. Afterwards the sample were allowed to come to room temperature, about 4-6 hours, then were filtered through 25 mm pre-combusted TQ filters, again at max 5 psi suction. The bottles and filter towers were rinsed with ~50-60mL DmQ water. The filters were then placed in a 53°C oven to dry, before mounting and beta counting.

18.2.2 *In situ pumps*

Six large volume in-situ pumps (McLane) were deployed simultaneously at different depths to obtain samples of suspended marine particles. Two types of filters were used:

- Supor 0.8 μm pore size to measure ^{230}Th, ^{231}Pa, ^{234}Th, Ca, Al, Si, P. A punch was taken from the filter to measure ^{234}Th by beta counting on board or later at DFO-IOS. The remainder was stored frozen and dried a few days later. The other elements and isotopes will be measured at UBC.
- QMA 0.8μm pore size to measure POC, PON, ^{234}Th and alkenones. A punch was taken from the filter to measure ^{234}Th by beta counting on board or later at IOS. The remainder was stored frozen at -80°C to measure alkenones (Markus Kienast, Dalhousie U.)

Pump filters, whether Supor or QMA, were sampled by punching a 25 mm hole randomly, except avoiding any torn spots, through the filters. The filters were then placed on filter holders, and with the vacuum on, very gently rinsed with ~20mL DmQ to wash off salts. The filter towers were not used, as the filters did not extend completely to the edges. Once rinsed the filters were placed in a 53°C oven to dry, before mounting and beta counting.

18.2.3 *Beta counting*

The Malina group (Leg 2b) graciously left their Riso counter on board, set up in the forward starboard control container, with gases on, and a background already running but without any slides in position. As soon a new 5 mm lift slide was made, a new background was started with it and the Malina sample holder slide in place, and ran it for about 76 hours before samples came on line. Samples were read to a moderate error level, <5% or <±0.03 cpm, in order to speed them along. About 40% were read onboard, with the rest transferred to the DFO-IOS counter as soon as possible.

The gas line to the beta counter was crimped at one point, which resulted in the program shutting down. Gas flow was restored and the system purged, all ran smoothly again afterwards.

Table 18.1. List of particulate and total Thorium samples taken from the Rosette or in situ pumps during Leg 3a.

Station	Event#	Sample Type	Source	Sample ID -						Comments
				- if Rosette, ID=Niskin#, if Pump, ID=Pump#						
L1	16	Total	Niskin	20	16	12	8	4	2	
		Particulate	Niskin	20	16	12	8	4	2	
	18	Total	Niskin	23	22	20	16	12		
		Particulate	Niskin	23	22	20	16	12A,12D		12A&D are doubled up, one to give blank
										(see under filter blanks below)
	20	QMA punch	Pump	2	3A,3B	4	5	6		#1 not sampled, as no pump flow
L2	38	Total	Niskin	20	16	12	8	4	3	
		Particulate	Niskin	20	16	12	8	4	3	
	41	Total	Niskin	5A,5B	6A,6B					1500m calibration cast for Th:U ratio
		Particulate	Niskin	5	6	5&6				5&6 is combination of leftover water
	42	Total	Niskin	23A,23B	21	18	16	13		
		Particulate	Niskin	23	21	18	16	13		
	37	Supor punch	Pump	1	2	3	4	6		#6 is filter blank, as no pump flow
	47	QMA punch	Pump	1A,1B	2	3	4	6		#1&#6 are filter blanks, as no pump flow
L3	54	Total	Niskin	21	16	12	8	4	3	
		Particulate	Niskin	21	16	12	8	4	3	
	56	Total	Niskin	23	21	18	16	13		
		Particulate	Niskin	23	21	18	16	13		
	53	Supor punch	Pump	1	2	3	4	5	6	#6 is filter blank, as no pump flow
L1.1	63	Total	Niskin	21	16	12	8	4	3	
		Particulate	Niskin	21	16	12	8	4	3	
	65	Total	Niskin	23	21	18	15A,15B	11		
		Particulate	Niskin	23	21	18	15	11		
	60	Supor punch	Pump	1	2	3	4			#5&6 not sample, no pump flow
	64	QMA punch	Pump	1	2	3	4	5	6	#6 is filter blank, as no pump flow
	74	Supor punch	Pump	1	2	4	5	6		#6 is filter blank, as no pump flow
Blanks		Filter Blanks:	d original 25mm TQ filters:							
			060909	FB1	FB2					
			120909	-1						
		Filter Blanks:	from a large TQ filter, as ran out of precut ones:							
			120909	FB cut 1	FB cut 2	FB cut 3	FB cut 4			
		Particulate Filter Blanks, aka dip blanks: Filters soaked overnight in filtered 1500m SW, then rinsed with DmQ as per usual								
				PFB41-1	PFB41-2	PFB41-3	PFB41-4			
		Particulate Filter Blanks, aka double blanks: Filters doubled on filter tower, however, particulates on upper filter not evenly								
		dispersed, and so only the one blank done.								
				P1812D						
		Total Filter Blanks: used 2L DmQ per blank and followed complete total Thorium method.								
			100909	TB A	TB B	TB C	TB D			
		Supor and QMA punches: See notes above for individual casts. For numerous pumps, there was no flow rate, so these filters were								
		often sampled to use as blanks.								

18.3 Comments and recommendations

Sampling went well, although there was some delay in accessing the Rosettes while gas sampling was done. Processing samples was generally smooth, although sometimes samples took a long time to filter. A few samples were filtered after hours of delay due to the extreme ship vibration and motion in the container on the foredeck, when icebreaking was underway – with any more than ~25mL in the filtration towers, the water would often jump out. A few lead bricks around the beta counter also had to be pushed back into place during these conditions. A major potential problem was averted by building onboard a 5-mm lift slide out of Plexiglas for the beta counter, replacing the IOS one that was lost with the missing baggage. Also many thanks to all who helped out with pipettes and gloves etc. to replace my missing gear.

At the end of the cruise, the beta counter was packed for shipping back to Monaco, samples packaged for return to IOS via carry-on baggage, and equipment cleaned and placed into the container for eventual shipment to IOS.

19 Dissolved ^{230}Th and ^{231}Pa & ^{129}I (GEOTRACES) – Leg 3a

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19.1 Introduction

Dissolved ^{230}Th and ^{231}Pa were measured over the entire water column to document recent changes in deep water circulation and particle scavenging. Samples for measuring ^{129}I (J. N. Smith; DFO-BIO) were taken simultaneously to confirm the changes in circulation deduced from dissolved ^{230}Th and ^{231}Pa.

19.2 Methodology

For dissolved ^{231}Pa and ^{230}Th, 20 L samples were collected using the Rosette by closing two Niskin bottles per depth. Seawater was quickly drained from the Rosette and brought to the laboratory for filtration through an Acropak cartridge (0.45 µm) using a peristaltic pump and stored in a disposable cubitainer. The samples were then acidified to pH 2 with concentrated HCl and spiked with pre-weighed quantities of ^{233}Pa, ^{229}Th and $FeCl_3$ [aliquots of standard solutions precipitated with Fe hydroxide]. Acidified samples were left to equilibrate for 12 to 24 hours and their pH adjusted to 8-9 to precipitate Fe hydroxide and scavenge ^{231}Pa, ^{233}Pa, ^{230}Th and ^{229}Th. The precipitates were let to settle to the bottom of the cubitainer over 12 to 24 hours and recovered by suction with a peristaltic pump into a 1L plastic beaker for final settling and centrifugation into a 50 ml centrifuge tube for transport to UBC

Table 19.1. List of stations where ^{230}Th, ^{231}Pa and ^{129}I were conducted during the GEOTRACES cruise in Leg 3a.

Station ID	Latitude N	Longitude W	Bottom depth (m)	Salinity*	I-129	Pa/Th*
L1	71°06	139°10	2000	12	12	12
L2	74°30	137°00	3300	12	12	12
L3	75°17	137°30	3485	12	12	12
L1.1	72°31	136°40.8	2530	9	9	9

* Salinity and Pa/Th samples taken in duplicates, one in each of the 2 Niskins closed at each depth.

20 Dissolved Ra isotopes (GEOTRACES) – Leg 3a

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20.1 Introduction

This project focuses on carbon exchange between the shelf and the open ocean. Within the framework of the GEOTRACES program, its aim is to use the radium (Ra) isotopes to quantify this exchange in the Beaufort Sea.

20.2 Methodology

Seawater samples were collected using in-situ pumps and the ship's Rosette. The seawater collected with the Rosette was filtered onboard on an acrylic fiber coated with MnO_2 and the same fiber was used with the in situ pumps. The fibers will be analyzed in the lab for the long-lived Ra isotopes (^{226}Ra and ^{228}Ra) using gamma spectrometry, and when possible for the short-lived Ra isotopes (^{223}Ra and ^{224}Ra) using an alpha counter (Table 20.1). Alpha counting of the short-lived isotopes was started during the cruise.

Table 20.1. Depths sampled at each station using the Rosette or the in situ pumps for the determination of dissolved Radium isotopes during Leg 3a.

Station ID	S1	S1.1	S1.2	S2	L1	L2	L1.1
Rosette samples							
Depths (m)	10 [b]	10 [b]	10 [b]	10 [b]	10 [c]	10 [c]	10 [c]
	50 [b]	100 [b]	100 [b]	100 [b]	100 [c]	50 [d]	75 [d]
				150 [d]	250 [c]	100 [c]	100 [c]
				200 [d]	500 [d]	250 [d]	250 [d]
					750 [d]	400 [d]	400 [d]
					1000 [a]	700 [d]	600 [d]
					1500 [c]	1000 [d]	800 [d]
							1000 [d]
In situ pumps							
Depths (m)				10 [e]	10 [e]	25 [e]	75
				50	250 [e]	250	250
				100 [f]	500	400	400
				150	750	800	600
				200	1000 [f]	1200 [e]	800
					1500 [f]		1000 [e]

[a] cubitainer leaked, sample lost.
[b] samples to be analyzed for ^{223}Ra, ^{224}Ra, ^{226}Ra and ^{228}Ra (~ 270 L sampled per depth). A first count with the alpha counter was performed onboard for these samples.
[c] samples to be analyzed for ^{226}Ra and ^{228}Ra (100-140 L sampled per depth).
[d] In black: samples to be analyzed for ^{226}Ra (10-12 L sampled per depth).
[e] pump did not work.
[f] less than 180 L pumped, probably not enough to get a signal.

21 Trace metals (GEOTRACES) – Leg 3a

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21.1 Introduction

The overarching goal of the GEOTRACES research program was to constrain the effect of climate change on the productivity, carbon sequestration and trace gas emission in the Arctic Ocean by investigating key trace elements and isotopes which act as micronutrients (Fe, Cu, Zn, Cd) or tracers of sources and processes (Al, Ba, Ga, Mn, isotopes of Nd, Cr, Th, Pa) that impact the carbon and nutrient cycles in the Beaufort Sea.

21.2 Methodology

Trace metal sampling was performed using a trace metal clean Rosette (12 x 12 L Go Flo's on a powder coated frame, equipped with a CTD and O_2 sensor – modified to use Mg anodes instead of Zn anodes). Samples were filtered directly from the Go Flo bottles, using Pall AcroPak 500 0.2 µm capsule filters, into pre-cleaned bottles, which were rinsed 3-4 times with sample before filling. Samples for Fe-II were analyzed on board, using a flow injection system (E. Ramirez and J. Cullen, UVic) – all other analyses will be performed back in shore-based laboratories, at UVic (for total dissolved Fe, Cu, Cd, Zn) and UBC (for total dissolved Al, Mn, Ga, Pb, and for Pb isotopes). Filtered samples to be stored were acidified with 1 ml concentrated SeaStar HCl per 500 ml within 12 hours of collection (~pH = 1.7) with the exception of Fe-II which were preserved with 75 µl of 6 M SeaStar HCl per 250 ml bottle (~pH = 6) at the time of collection. Samples (125 ml) were also collected, unfiltered, for M. Saito (WHOI, Marine Chemistry and Geochemistry) for subsequent Co analyses. These samples were stored in a 4ºC refrigerator. Nutrient samples and salinity samples were also drawn from each GO-Flo (unfiltered) at the end of the sample collection, and analyzed onboard (Salinity by GEOTRACES personnel, nutrients by J. Gagnon (U. Laval/ArcticNet).

The samples collected for analysis at UBC will be concentrated and separated from the seawater matrix using the NOBIAS Chelate-PA1resin (Sohrin et al. 2008) and analyzed by ICP-MS. Pb isotopes will be analyzed on a multi-collector ICP-MS after further purifying the column eluant using an anion exchange resin. Samples will be analyzed at UVic using a combination of methods including multi-element analysis by ICP-MS after preconcentration (Sorhrin et al. 2008), and flow injection analysis with colorimetric and chemiluminescent detection (e.g. Lohan et al. 2008).

A subset of samples were analyzed for Fe(II) immediately (10-15 min) after collection on the ship using chemiluminescent detection with Luminol (Hansard and Landing 2009).

Table 21.1. List of stations where samples were collected for trace metals analyses using the Trace Metals Rosette during leg 3a (GEOTRACES). Numbers under each analysis represent the number of depths sampled on each cast.

Stn ID	Date in 2009 (UTC)	Time UTC	Latitude N	Longitude W	Cast #	Cast depth (m)	Number of depths sampled							
							TM (U Vic)	TM (UBC)	Fe(II) (U Vic)	Pb isotopes	CO (WHOI)	Cr isotopes	Nutrients	Salinity
L1	02-sept	0107	71°06.373	139°18.250	24	400	12	12	12		12		12	12
L1	02-sept	1257	71°06.268	139°20.623	28	1750				12				12
L1	02-sept	2138	71°06.218	139°15.839	32	1800	10	10	12		12	2	12	12
L1.5	03-sept	1617	73°19.254	139°23.562	33	1000	12	12	12		12		12	12
L2	04-sept	0452	74°39.755	137°20.998	35	2950	12	12	12	11	12		12	12
L2	04-sept	1736	74°35.620	137°07.338	39	700	12	12	12				12	12
L2	05-sept	2032	74°27.260	136°19.710	48	2750						12		12
L2	06-sept	0746	74°22.900	136°09.500	51	1100	1	3		12	12		12	12
L3	07-sept	2342	75°19.240	137°37.900	55	1200	12	12	12		12		12	12
L1.1	09-sept	0441	72°30.000	136°36.000	59	360	12	12	12	6	12		12	12
L1.1	09-sept		72°30.700	136°46.400	64	2400						12		12
L1.1	10-sept	0600	72°32.400	136°55.400	67	2400	12	12		6	12		12	12
S4	11-sept	1830	71°11.000	132°57.000	78	275	12	12	12	6	12		12	12

22 Cr and Nd isotopes (GEOTRACES) – Leg 3a

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22.1 Introduction

Reduction of soluble Cr(VI) to insoluble Cr(III) is associated with mass-dependent isotopic fractionation with the preferential reduction of the lighter isotopes. This might enable isotopic studies to better understand the processes behind Cr redox changes, to improve the understanding of the oceanic Cr cycle and to develop Cr isotopes as an ocean paleo-redox proxy.

The Nd isotope signature of ocean water appears to reflect continental sources without being altered by biological fractionation. If true, Nd isotopic compositions of ocean waters could thus provide a powerful tool as tracer for water masses and ocean circulation. However, to date the application of Nd isotopes as a circulation tracer and paleocirculation proxy has been hindered by a poor understanding of the processes whereby seawater acquires it Nd isotopic composition. Because Pacific and Atlantic seawater have very different Nd isotopic composition, following the Nd isotopic composition of Pacific waters as they transit trough the Arctic could reveal these processes.

22.2 Methodology

22.2.1 Cr isotopes

During Leg 3a (Geotraces), a transect was conducted from the shelf region to the deep Canada Basin with depth profiles at each station. The samples were taken either from the CTD-Rosette or the Trace Metal (TM) Rosette, drawn through 0.45 µm Supor-Filters in pre-cleaned 20 L-cubitainers after having rinsed them with the sample itself. The samples were then kept frozen (-10°C) at natural pH until processed in the home lab. For each sample, salinity was determined on board using standard method. Sample amounts, locations and depths are listed in Table 22.1.

Table 22.1. Sample list for Cr isotope analyses in Leg 3a.

Cr sample no.	Station ID	Event #	Amount [L]	Depth [m]	Rosette*
1	S1	3	10	10	Ship
2		5	10	50	Ship
3	S1.1	6	10	100	Ship

Cr sample no.	Station ID	Event #	Amount [L]	Depth [m]	Rosette*
4		7	10	10	Ship
5	S1.2	8	10	100	Ship
6		9	10	10	Ship
7	S2	12	10	100	Ship
8		14	10	10	Ship
9	L1	29	20	10	Ship
10			20	50	Ship
11			20	100	Ship
12			20	200	Ship
13			20	250	Ship
14			20	300	Ship
15			20	400	Ship
16			20	600	Ship
17			20	800	Ship
18			20	1000	Ship
19			20	1500	Ship
20			20	1700	Ship
21			5	1698.5	TM
22			11	9.6	TM
23	L2	48	11	9.9	TM
24			11	50.5	TM
25			11	120.3	TM
226			11	201.1	TM
27			11	350.2	TM
28			11	600.5	TM
29			11	999.8	TM
30			11	1499.5	TM
31			11	2000.1	TM
32			11	2500.5	TM
33			11	2751.3	TM
34	L1.1	64	11	10.6	TM
35			11	50.2	TM
36			11	100.1	TM
37			11	200.6	TM
38			11	250.1	TM
39			11	300.1	TM
40			11	400.2	TM
41			11	599.6	TM
42			11	1000.2	TM
43			11	1500.5	TM
44			11	2000.2	TM
45			11	2400.1	TM

* Ship refers to the Amundsen's CTD-Rosette and TM to the Trace Metal Rosette.

22.2.2 Nd isotopes

Water samples were taken by the ship's CTD-Rosette at 3 stations along the transect at various depths (Table 22.2). About 20 L (where available) were drained and filtered through an Acropak cartridge (0.45 µm) into either cubitainers or jerrycans that were pre-rinsed with the sample and acidified with HCl (6N or conc.) to pH 2.

Table 22.2. Sample list for Nd isotope analyses in Leg 3a.

Nd sample no.	Station ID	Event #	Depth [m]	Amount [L]
1	L1	21	10	20
2			50	20
3			100	20
4			200	20
5			250	20
6			300	20
7			400	20
8			600	20
9			800	20
10			1000	20
11			1500	20
12			1700	20
13	L2	41	10	21
14			50	23
15			100	23
16			180	21
17			250	23
18			350	23
19			600	21
20			1000	23
21			1500	21
22			2000	11.5
23			2500	23
24			3000	11.5
25	L1.1	73	10	23
26			50	23
27			100	23
28			200	23
29			250	23
30			300	23
31			400	23
32			600	23
33			800	11.5
34			1000	23
35			1500	23
36			2000	23

23 Trace metal-biota interactions (GEOTRACES) – Leg 3a

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23.1 Methodology

The phytoplankton community composition in the water column was established at each of the following stations: S1 (event #1), S2 (event #10), L1 (event #16), L2 (event #38), L3 (event #54) and L1.1 (event # 63), using different methods:

- HPLC pigments
- Phytoplankton microscopic identification
- Flow cytometry phytoplankton & bacteria numbers
- Total chlorophyll GF/F and size-fractionated Chl a (5 μm, at the 50% of incident irradiance).

The photosynthetic efficiency (Fv/Fm) and photosynthesis vs. irradiance (P-E) curves of Arctic plankton communities was established in the water column at stations L1, L2, L3 and L1.1 using FiRe. These data will be compared with the primary productivity measurements using ^{13}C spikes conducted by D. Varela's team (U. Victoria).

Nutrient concentrations (Si, NO_3^-, NO_2^- and PO_4^{3-}) were measured in the water column at each station (S1, S2, L1, L2, L3, L1.1). The size-fractionated Fe:Cd:C quotas of plankton were determined using radiotracers in the mixed layer at Station S2 (seawater collected with in-situ trace metal clean pump, event #15), Station L1 (seawater collected with in-situ trace metal clean pump, event #19), and Station L2 (seawater collected with Trace Metal Rosette, event # 39, mixed seawater from 8, 25 and 40 m). Samples were also collected to measure trace metal ratios (using ICPMS) in particles, rinsed with or without oxalate wash, from the water column at 4 depths (40, 70, 150 and 250 m) at Station L1.1 (event #62).

To determine whether plankton communities in the Arctic (L1) were co-limited by Fe light and/or nitrate, a grow-out incubation experiment was set up with three light levels (50, 10, 1% of Io), 4 Fe levels (1 nM Fe addition as well as 3 concentrations of the siderophore DFB). The bottles were also enriched with 10 μM NO_3^-, given that the in-situ NO_3^- concentrations were ~0.5 μM. Control bottles had no NO_3^- addition. Incubations were sampled on day 0, 2, 4, 6, and 8. The parameters measured were HPLC pigments, Chla GF/F & size-fractionated, flow cytometry bacteria and phytoplankton, nutrients, Fe:Cd:C ratios, Fe uptake rates (FeEDTA & FeDFB), photosynthetic efficiency (Fv/Fm) and photosynthesis vs. irradiance curves. In addition, R. Rivkin's group (Memorial University) measured bacterial productivity on each sampling date.

Samples (~250 L) were also taken for genomics & proteomic analyses at L2 from 10 m and 59 m (Chl a maximum) and at L1.1 from 10, 65 (Chl a max), and 600 m. The seawater was pre-filtered through a 200 µm Nitex membrane and then was filtered, in series, onto Supor-100 membrane filters of 3 µm and 0.1 µm porosities. The plankton composition was characterized by measuring the following parameters: HPLC pigments, Chla GF/F & 5 µm, bacteria and phytoplankton flow cytometry, phytoplankton microscopic identification, nutrients, photosynthetic efficiency (Fv/Fm) and photosynthesis vs. irradiance curves. In addition, R. Rivkin's group measured bacterial productivity on each sampling date. This work was conducted in collaboration with R. Rivkin (Memorial University) and A. Allen (Venter Institute).

Table 23.1. Summary of samples collected for trace metals-biota interactions measurements and experiments during Leg 3a.

Stn ID	Date in 2009	Time	Cast# or type	Depth (m)	% Io	Chl a max (m)	HPLC pigments	Chl a GF/F	Chl a 5 µm	Flow bact	Flow phyto	Nutrients	Phyto ID	Fv/Fm	P-E curve	Fe:Cd:C quotas Fe uptake	Grow out incubations	Genomics Proteomics
S1	29-Aug	18:30	1	5	50	60	X	X	X	X	X	X	X					
				15	10		X	X		X	X	X						
				35	1		X	X		X	X	X						
				50	0.1		X	X		X	X	X						
S2	30-Aug	12:00	10	3	50	45	X	X	X	X	X	X	X					
				15	10		X	X		X	X	X						
				25				X		X	X	X						
				45	1		X	X		X	X	X						
				50				X		X	X	X						
				75	0.1		X	X		X	X	X						
S2	31-Aug	01:30	TM pump	29			X	X	X	X	X	X	X	X	X	X		
L1	31-Aug	16:00	14	22	50	60	X	X	X	X	X	X	X					
				50	10		X	X		X	X	X						
				85	1		X	X		X	X	X						
				126	0.1		X	X		X	X	X						
				150			X	X		X	X	X						
				200			X	X		X	X	X						
L1	31-Aug	22:30	TM pump	29			X	X	X	X	X	X	X	X	X		X	
L2	04-Sep	08:30	24	2.7		55	X	X		X	X	X		X	X			
				10	50		X	X	X	X	X	X	X	X	X			
				30	10		X	X		X	X	X		X	X			
				55	1		X	X		X	X	X		X	X			
				100	0.1		X	X		X	X	X		X	X			
L2	04-Sep			40 - 20- 8			X	X	X	X	X	X	X	X	X	X		

Stn ID	Date in 2009	Time	Cast# or type	Depth (m)	% Io	Chl a max (m)	HPLC pigments	Chl a GF/F	Chl a 5 μm	Flow bact	Flow phyto	Nutrients	Phyto ID	Fv/Fm	P-E curve	Fe:Cd:C quotas Fe uptake	Grow out incubations	Genomics Proteomics
L2	04-Sep	22:00	Underway	10			X	X	X	X	X	X	X	X	X			X
				59		59	X	X	X	X	X	X	X	X	X			X
L3	07-Sep	16:00		3.1		60	X	X		X	X	X						
				10	50		X	X	X	X	X	X	X	X	X			
				32	10		X	X		X	X	X		X	X			
				60	1		X	X		X	X	X		X	X			
				115	0.1		X	X		X	X	X						
L1.1	10-Sep			40														
				70														
				90														
				150														
				200														
				250														
L1.1	10-Sep		Underway	10			X	X	X	X	X	X	X	X	X			X
				65		65	X	X	X	X	X	X	X	X	X			X
				600			X	X	X	X	X	X	X	X	X			X

24 Microbial mediation of carbon and trace element cycling (GEOTRACES) – Leg 3a

Project leader: Richard Rivkin[1] (rrivkin@mun.ca)
Cruise participants Leg 3a: Richard Rivkin[1], Michelle Hale[1], Adam Hamilton[1] and Jane Tucker[1]
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24.1 Introduction

The goal of this project was to characterize the microbial community and determine its role in the cycling of carbon and trace elements. Sampling depths were selected to represent light depths and major water mass layers.

24.2 Methodology

Five classes of parameters were measured:

Biotic stocks (7 measurements): Bacterial Abundance by Acridine Orange Direct Count (BA-AO), Bacterial Abundance by Flow Cytometry (BA-FCM), Pico-Phytoplankton Abundance by Flow Cytometry (PICO), Nano-Phytoplankton Abundance by Flow Cytometry (NANO), Phytoplankton Abundance by Flow Cytometry (PHYTO), Heterotrophic Flagellate Abundance by Microscopy (FLAG), and Microzooplankton Abundance by Microscopy (MICZ)

Biodiversity (4 measurements): Bacterial Community Structure by Fluorescence In Situ Hybirdization (FISH), Bacterial Community Structure by Culturing on Media(CULT), Bacterial Community Structure by DNA analysis (DNA), and Community Metagenomics by Sequencing (METAGEN).

Rate processes: Bacterial Production by Leucine Uptake (BP), Community Respiration by Oxygen Uptake (RESP), Microzooplankton Grazing on Bacteria and Phytoplankton by Dilution Assay (MICZ-GRAZ), Microzooplankton Mediated Cycling of Fe, Zn, Cu, Cr, Cd, Mn by Modified Dilution Assay (MICZ-CYCL), and Effect of Fe, Cu, Zn Enrichment on Growth of Phytoplankton and Bacteria by Dilution Culture (MET-ENRICH).

Dissolved and particulate organic pools: Particulate Organic Carbon by Elemental Analysis (POC), Particulate Organic Nitrogen by Elemental Analysis (PON), Dissolved Organic Carbon by High Temperature Oxidation (DOC), and Dissolved Organic Nitrogen by High Temperature Oxidation (DON).

Natural abundances of stable isotopes in organic materials: Dissolved Organic Carbon-13 by Mass Spectrometry (DOC-13), Dissolved Organic Nitrogen-15 by Mass Spectrometry (DON-15), Particulate Organic Carbon-13 by Mass Spectrometry (POC-13), Particulate Organic Nitrogen 15 by Mass Spectrometry (PON-15), Carbon 13 in Phospho-Lipid Fatty Acids by GC-MS (PLFA).

Table 24.1. Summary of samples taken for microbial cycling of carbon and trace metals measurements during Leg 3a.

				PARAMETERS																						
STATION	DEPTH	BA-AO	BA-FCM	PICO	NANO	PHYTO	FLAG	MICZ	FISH	CULT	DNA	METAGEN	BP	RESP	MICZ-GRAZ	MICZ-CYCL	MICZ-ENRICH	POC	PON	DOC	DON	DOC-13	DON-15	POC-13	PON-15	PLFA
S-1	5	X	X	X	X	X	X	X	X	X	X		X					X	X	X	X	X	X	X	X	X
	15	X	X	X	X	X			X				X					X	X	X	X					
	35	X	X	X	X	X	X	X	X	X	X		X					X	X	X	X	X	X	X	X	X
	50	X	X	X	X	X							X					X	X	X	X					
S-2	3	X	X	X	X	X	X	X	X				X					X	X	X	X	X	X	X	X	X
	15	X	X	X	X	X							X					X	X							
	45	X	X	X	X	X	X	X	X				X					X	X	X	X	X	X	X	X	X
	75	X	X	X	X	X							X					X	X							
	100	X	X	X	X	X	X	X	X				X					X	X	X	X					
	125	X	X	X	X	X							X					X	X							
	150	X	X	X	X	X	X	X	X				X					X	X	X	X					
	175	X	X	X	X	X							X					X	X							
	200	X	X	X	X	X	X	X	X				X					X	X	X	X					
L-1	10	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X
	22	X	X	X	X	X	X	X	X	X	X		X					X	X	X	X					
	50	X	X	X	X	X							X	X				X	X							
	85	X	X	X	X	X	X	X	X	X	X		X					X	X	X	X					
	100	X	X	X	X	X							X	X						X	X	X	X	X	X	X
	126	X	X	X	X	X							X					X	X							
	150	X	X	X	X	X							X					X	X	X	X					
	200	X	X	X	X	X	X	X	X				X					X	X	X	X					
	250	X	X	X	X	X							X	X				X	X							
	300	X	X	X	X	X							X													
	600	X	X	X	X	X							X	X				X	X	X	X	X	X	X	X	X
	800	X	X	X	X	X							X													
	1000	X	X	X	X	X							X	X				X	X							
	1400	X	X	X	X	X							X													
	1700	X	X	X	X	X							X													
L-2	3	X	X	X	X	X							X					X	X	X	X	X	X	X	X	X
	10	X	X	X	X	X	X	X	X	X	X	X	X	X				X	X							
	30	X	X	X	X	X							X					X	X	X	X					
	55	X	X	X	X	X	X	X	X	X	X	X	X					X	X							
	60	X	X	X	X	X							X	X	X	X	X					X	X	X	X	X
	100	X	X	X	X	X							X	X				X	X	X	X	X	X	X	X	X
	125	X	X	X	X	X	X	X	X	X	X		X					X	X	X	X					
	250	X	X	X	X	X							X	X				X	X							
	300	X	X	X	X	X	X	X					X							X	X					
	600	X	X	X	X	X	X	X					X	X				X	X	X	X	X	X	X	X	X
	1000	X	X	X	X	X	X	X					X					X	X	X	X					
	1400	X	X	X	X	X							X							X	X					
	1800	X	X	X	X	X							X													
	2250	X	X	X	X	X	X	X					X							X	X					
	3000	X	X	X	X	X							X													
L-3	3	X	X	X	X	X							X					X	X							
NOT	10	X	X	X	X	X	X	X	X				X					X	X	X	X					
COMPLET	32	X	X	X	X	X							X					X	X							
	60	X	X	X	X	X	X	X	X				X					X	X	X	X					
	115	X	X	X	X	X							X					X	X	X	X					
	140	X	X	X	X	X	X	X	X				X					X	X	X	X					
	200	X	X	X	X	X							X							X	X					
	300	X	X	X	X	X	X	X	X				X							X	X					
	600	X	X	X	X	X	X	X	X				X							X	X					
	1000	X	X	X	X	X	X	X	X				X							X	X					
	1400	X	X	X	X	X							X							X	X					
	1800	X	X	X	X	X							X													
	2250	X	X	X	X	X	X	X	X				X							X	X					
	3000	X	X	X	X	X							X													
L-1.1	3	X	X	X	X	X							X													
	10	X	X	X	X	X	X	X	X	X	X	X	X	X				X	X	X	X					
	25	X	X	X	X	X							X					X	X							
	70	X	X	X	X	X	X	X	X	X	X	X	X					X	X	X	X					
	75	X	X	X	X	X							X	X												
	100	X	X	X	X	X							X	X				X	X							
	115	X	X	X	X	X							X							X	X					
	140	X	X	X	X	X	X	X	X	X	X		X					X	X	X	X					
	200	X	X	X	X	X							X							X	X					
	250	X	X	X	X	X							X	X				X	X							
	300	X	X	X	X	X	X	X	X				X							X	X					
	600	X	X	X	X	X	X	X	X			x	X	X						X	X					
	1000	X	X	X	X	X	X	X	X				X	X						X	X					
	1400	X	X	X	X	X							X													
	1800	X	X	X	X	X							X													
	2250	X	X	X	X	X	X	X	X				X							X	X					

Community Respiration rates by Oxygen Uptake (RESP) were made on board. Samples for Bacterial Community Structure by Culturing on Media (CULT) and Bacterial Community Structure by DNA analysis (DNA) were transported back to Memorial University for further study. Samples for Microzooplankton Mediated Cycling of Fe, Zn, Cu, Cr, Cd, Mn by Modified Dilution Assay (MICZ-CYCL) and for the effects of Fe, Cu, Zn Enrichment on Growth of Phytoplankton and Bacteria by Dilution Culture (MET-ENRICH) were returned to the University of Portsmouth for analysis. The remainder of the samples were frozen or preserved and remained on board the *Amundsen* until its return to Quebec City in November 2009.

25 Natural variations in silicon isotopes (GEOTRACES) – Leg 3a

Project leader: Diana Varela[1] (dvarela@uvic.ca)
Cruise participants Leg 3a: Diana Varela[1] and Maria Hernandez Sanchez[1]
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25.1 Introduction

The knowledge of the biogeochemistry of marine silicon (Si) lags behind that of other nutrients mainly due to inherent limitations of the methods currently used to measure Si production and dissolution. An alternative for studying Si cycling and silica production over broader spatio-temporal scales is to use the variations in the natural abundance of Si isotopes (δ^{30}Si) in surface waters and suspended diatom silica. Surface water variations of δ^{30}Si are due to the biological fractionation of Si isotopes by diatoms, as diatoms discriminate against the heavy ^{30}Si isotope. Thus, δ^{30}Si in dissolved Si and biogenic silica increases as diatom production intensifies in surface waters. Because diatoms are one of the largest contributors to carbon fixation in most marine systems, it is critical to understand their effects on nutrient biogeochemistry in past and present oceans.

25.2 Methodology

Seawater samples were obtained for the measurement of δ^{30}Si in dissolved Si (δ^{30}DSi) and particulate ($\delta^{30}bSiO_2$) silica. Water samples for dissolved Si were taken at various depths in the water column with the *Amundsen*'s CTD-Rosette, and particulate samples were taken both with large-volume in-situ pumps at selected stations and with an underway continuous pumping system located in the engine room, which recovered water from 7 m depth; typically filtering 100 to 300 L (Figure 25.1). Samples were also obtained for biogenic Si ($bSiO_2$) and dissolved Si concentrations at the same depths as those sampled for δ^{30}DSi.

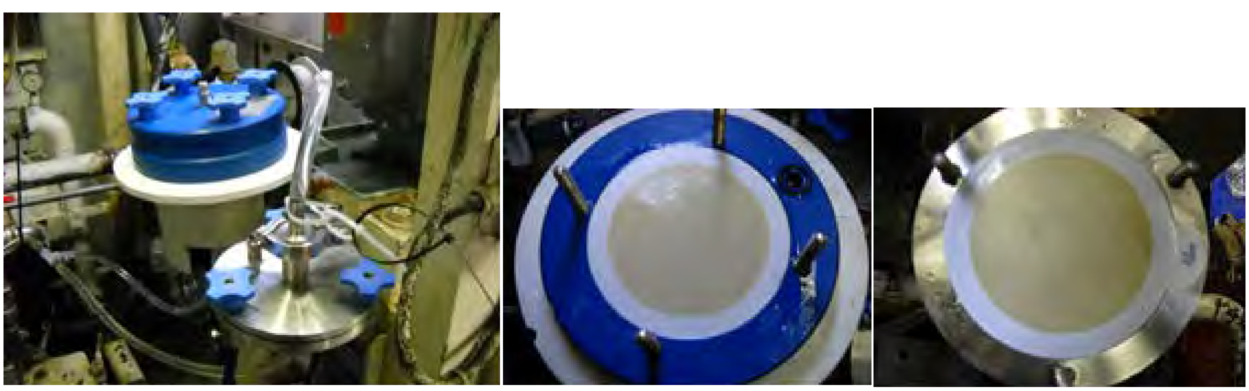

Figure 25.1. Left: Underway filtration unit in the engine room. Middle: Underway filtration setup for biomarker analyses (GF/F filters). Right: Underway filtration setup for Si isotopes (Supor filters).

Water samples for δ^{30}DSi were filtered (0.6 µm PC) and the filtrate was stored for further analysis ashore. Samples for biogenic Si ($bSiO_2$) concentrations were also filtered (0.6 µm PC) and filters were dried and stored for further analysis ashore. Filters (Supor) from the underwater pumps and underway system were dried and stored for further analysis ashore (Table 25.1).

Table 25.1. List of samples taken for the measurement of silicon isotopes in the dissolved fraction (δ^{30}DSi) and biogenic silica concentrations ([$bSiO_2$]) at each station during Leg 3a.

Station ID	Event #	Depth (m)	[$bSiO_2$] (L)	δ^{30}DSi (L)	Bottle #
S1	1	5	2	4	21/22
		15	2	4	13/14
		35	2	4	8
		100	2	4	2
S2		3	2	4	22
		15	2	4	18
		45	2	4	14
		75	2	4	10
		100	2	4	3
S2	4	125	2	2	11
		150	2	2	9
		175	2	2	6
		200	2	2	4
L1	16	22	2	4	22
		50	2	4	18
		85	2	4	14
		126	2	4	10
		150	2	4	6
		200	2	4	2
L1	18	2	2	4	23
		250	2	4	21
		300	2	4	19
		400	2	4	17
		500	2	4	13
		800	2	4	11
		1000	2	4	9
		1200	2	4	7
		1399	2	4	5
		1699	2	4	3
L1	25	10	2	4	21
L2	38	2.7	2	4	22
		10	2	4	18
		30	2	4	14
		54.6	2	4	10
		100	2	4	6
		125	2	4	2
L2	40	10		4	20
L2	42	150	2	2	24
		200	2	2	22
		250	2	2	20

Station ID	Event #	Depth (m)	[$bSiO_2$] (L)	δ^{30}DSi (L)	Bottle #
L2 (cont'd)		300	2	2	19
		400	2	2	17
		500	2	2	15
		600	2	2	14
		800	2	2	12
		1000	2	2	11
		1200	2	2	9
		1400	2	2	8
		1600	2	2	7
		1800	2	2	6
		2000	2	2	5
		2250	2	2	4
		2500	2	2	3
		2750	2	2	2
		3000	2	2	1
L3	52	3.1	2	4	23
		10	2	4	19
		32	2	4	14
		60	2	4	10
		115	2	4	6
		140	2	4	2
L3	56	150	2	4	24
		200	2	4	22
		300	2	4	20
		400	2	4	19
		500	2	4	17
		600	2	4	15
		800	2	4	14
		1000	2	4	12
		1200	2	4	11
		1400	2	4	9
		1600	2	4	8
		1800	2	4	7
		2000	2	4	6
		2250	2	4	5
		2500	2	4	4
		2750	2	4	3
		3000	2	4	2
					1
L1.1	63	3	2	4	23
		10	2	4	19
		25	2	4	14
		70	2	4	10
		115	2	4	6
		140	2	4	2
L1.1	65	175	2	2	24
		200	2	2	22
		250	2	2	20
		300	2	2	19
		350	2	2	17

Station ID	Event #	Depth (m)	[$bSiO_2$] (L)	δ^{30}DSi (L)	Bottle #
L1.1(cont'd)		400	2	2	16
		450	2	2	14
		500	2	2	13
		600	2	2	12
		800	2	2	10
		1000	2	2	9
		1200	2	2	7
		1400	2	2	6
		1600	2	2	5
		1800	2	2	4
		2000	2	2	3
		2250	2	2	2
		2500	2	2	1

Table 25.2. List of underway samples taken for silicon isotopes measurements in the particulate fraction ($\delta^{30}bSiO_2$) collected during Leg 3a.

Sample ID	Date in 2009	Start Latitude N	Start Longitude W	End Latitude N	End Longitude W	Start time	End time	Reading start	Reading end	Vol filtered (l)	Conta mination
A1	29/08	69°17.40	137°35.40	70°00.00	138°51.60			270	300	30	YES
A2	29/08	69°17.40	137°35.40	70°54.00	138°51.60			300	343	43	YES
A3	29/08	69°30.00	138°12.00	71°02.40	139°51.00	08:50	10:30	343	380	37	YES
A4	31/08	70°25.80	138°26.40	71°03.00	138°57.60	07:45	11:00	403	592	189	NO
A5	31/08	71°06.00	138°51.00			10:00	11:45	592.6	618.5	25.9	YES
A6	31/08	71°02.40	139°04.20	71°24.60	138°18.00	11:45	13:20	318	670	52	YES
A7	02/09	71°04.20	139°10.80	72°30.00	139°16.80	09:45	11:40	5594.9	5976.4	381.5	NO
A8	02/09	71°09.00	139°06.60	74°13.20	138°16.80	16:20	18:40	6405	6794.1	389.1	NO
A9	02/09	72°16.20	139°11.40			23:00	01:05	6815	7026.4	211.4	NO
A10	03/09	73°33.60	139°24.00			12:55	15:15	7062.6	7389	326.4	NO
A11	03/09	74°23.40	137°13.20			19:05	21:10	7394.9	7754.4	359.5	NO
A12	04/09	74°21.00	137°04.20	74°13.20	135°04.20	12:40	03:15	7758.2	8209.5	451.3	NO
A13	05/09	74°14.40	136°15.60	74°16.80	133°00.00	01:30	03:30	8215.8	8595.2	379.4	NO
A14*	06/09	74°13.20	135°35.40	74°18.00	134°21.00	01:45	03:20	8619	8718.6	99.6	NO
A15	06/09	75°21.60	133°13.20			14:05	16:20	8724.5	8999.3	274.8	NO
A17*	06/09	74°16.80	133°21.60			21:30	23:30	8999.5	9132	132.5	NO
A18.L3	07/09	75°11.40	137°22.20	74°06.60	136°26.40			9136.7	9462.2	325.5	NO
A19.L3	07/09	75°09.60	137°26.40	72°22.20	136°30.00	14:30	16:15	9462.3	9802.8	360.5	NO
A20	08/09	74°17.40	136°35.40					9802.5	10163.2	360.7	NO
A21	08/09	72°28.20	135°13.80			13:30	15:30	10163	10321.2	158.2	NO
A22	08/09	72°18.00	136°21.00					10321.2	10726	404.8	NO
A23	09/09	71°17.40	136°21.00	72°07.20	136°11.40			10726.8	11031.5	304.7	NO
A24	09/09	72°48.00	136°27.00	71°06.60	133°07.20			11031.5	11461.5	430	NO
A25	10/09	72°16.20	136°27.60	70°00.00	138°51.60	22:30	00:30	11462.2	11754.5	292	NO
A26	11/09	71°10.20	134°19.80	70°54.00	138°51.60	09:00	11:00	11754	12109	355	NO

26 Primary productivity (GEOTRACES) – Leg 3a

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26.1 Methodology

On-deck experiments were performed for the measurement of net and new (NO_3-driven) primary (phytoplankton) productivity and the composition of the phytoplankton assemblages was analyzed with the use of a FlowCam. Triplicate samples were obtained at 4 depths in the euphotic zone, at 50%, 10%, 1% and 0.1% of incident surface irradiance. Water samples were double-labeled with $^{15}NO_3$ and ^{13}C-bicarbonate and subsequently incubated in on-deck acrylic tanks with flowing surface seawater (to maintain samples at surface water temperatures) for 24 hours. Samples were filtered (0.7 µm GFF), and filters were dried and stored for further analysis ashore. FlowCam analysis of the particle distribution, which included autotrophic and non-autotrophic microorganisms, was performed at the same 4 depths. The samples were also size-fractionated at 50% irradiance to determine the contribution s of the <5 µm and >5 µm size fraction to primary productivity. Finally, samples were also size-fractionated for biogenic silica concentrations at the same depth (50% irradiance).

Table 26.1. List of stations where primary productivity incubation experiments were conducted in Leg 3a.

Station ID	Cast#	Irradiance (% of surface)	Depth sampled (m)
S1	1	50	5
		10	15
		1	35
		0.1	100
S2	10	50	3
		10	15
		1	45
		0.1	75
L1	16	50	22
		10	50
		1	85
		0.1	126
L2	38	50	10
		10	30
		1	55
		0.1	100
L3	54	50	10
		10	32
		1	60
		0.1	115
L1.1	63	50	10
		10	25
		1	70
		0.1	115

27 Nutrients fluxes and primary producers – Legs 1b, 2a, 3a and 4a

ArcticNet Phase 2 – Project titled *Marine Biological Hotspots: Ecosystem Services and Susceptibility to Climate Change*. ArcticNet/Phase2/TremblayJE_Marine_ecosystem_services.

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27.1 Introduction

The Arctic climate displays high inter-annual variability and decadal oscillations that modulate growth conditions for marine primary producers. Much deeper perturbations recently became evident in conjunction with globally rising CO_2 levels and temperatures (ACIA 2004, Comiso 2003). The thickness and extent of Arctic sea-ice decrease rapidly (Johannessen et al. 1999, Rothrock et al. 1999) and the ice-free season is extending both in the Arctic (Laxon et al. 2003) and subarctic (Stabeno & Overland 2001). Models predict further reductions in ice cover (ACIA 2004). These changes entail a greater penetration of light into surface waters, which is expected to bolster phytoplankton production (Rysgaard et al. 1999), food web productivity and CO_2 drawdown by the ocean. At present, phytoplankton production varies by two orders of magnitude across the Canadian Arctic, but the forcing mechanisms are poorly understood and quantified.

In the Canadian Archipelago, the productivity of phytoplankton is likely to be limited by light or the supply of allochtonous nitrogen, depending on ice conditions. The supply of allochtonous nitrogen is influenced by climate-driven processes, mainly the large-scale circulation, river discharge, upwelling and regional mixing processes.

Over most of the western Arctic, and especially the Beaufort Sea, the concentrations of inorganic nitrogen (i.e. nitrate, nitrite and ammonia) at surface remain low throughout the year and the phytoplankton possibly depend on local recycling and the dissolved organic nitrogen (DON; e.g. urea, amino acids and primary amines) supplied by rivers.

A large portion of the phytoplankton biomass is typically located within subsurface chlorophyll maxima (SCM). SCM productivity is possibly in balance with the episodic supply of nitrate across the halocline and/or the supply of ammonium and nitrate by local recycling and nitrification, respectively. Despite the importance of SCM for the food web and CO_2 fluxes, little is known about their structure, turnover and susceptibility to environmental variability and change.

The main goals of this project were to:

- Establish the horizontal and vertical distributions of phytoplankton, nutrients and the influence of different processes (e.g. mixing, upwelling and biological processes) on these distributions.
- Characterize the detailed vertical structure of chlorophyll-a with respect to irradiance, nutrient supply and physical structure.

During Leg 2a, additional objectives were set in preparation for the Malina campaign (Leg 2b):

- Test the installations and adapt the sampling strategy for the Arctic environment.
- Obtain primary and nitrogen production rates at the beginning of the melting season.

27.2 Methodology

Samples for inorganic nutrients (ammonium, nitrite, nitrate, orthophosphate and orthosilicic acid) were taken at all Rosette stations to establish detailed vertical profiles. Ammonium was determined immediately after collection using modifications of the manual fluorometric method (e.g. Holmes et al. 1999). The concentrations of nitrate, nitrite, orthophosphate and orthosilicic acid were determined on fresh samples using an Autoanalyzer 3 (Bran+Luebbe) with colorimetric methods adapted from Grasshof (1999).

Chlorophyll was filtered onto GF/F filters (0.70 µm) at 6 depths (5, 10, 20, 50, 70 m and at SCM depth) and extracted with 90% Acetone for 18 hours at 4°C in the dark. The fluorescence was measured before and after acidification with a Turner Designs Model 10-AU fluorometer.

Samples for the taxa composition were taken at 5 m and at SCM depth and were stored at 4°C with acid lugol and with formaldehyde for a post-cruise analysis. Pico-nanoplankton and bacteria were sampled (5, 20, 50 m and at SCM depth) and fixed with 25% glutaraldehyde for post-cruise analysis.

$^{13}C/^{15}N$ production and natural abundances of $\delta^{13}C/\delta^{15}N$ in particulate organic matter were conducted on Leg 2a in preparation for the Malina cruise (Leg 2b). Measurements of new and regenerated primary production and of nitrogen assimilation (NH_4, NO_3 and N_2) were made at different depths in the euphotic zone using a double isotopic marking technique (^{13}C and ^{15}N). Particulate organic matter was characterized in terms of the natural abundance of carbon and nitrogen isotopes ($\delta^{13}C/\delta^{15}N$).

Particulate organic carbon and total organic phosphorus were filtered onto burned GF/F filters (0.70 µm) at 2 depths (5 m, SCM depth) and dried for a post-cruise analysis. Biogenic silica was filtered on polycarbonate filters (0.60 µm) and were stored at -20°C for post-cruise analysis as well.

27.2.1 Leg 1b – 30 June to 16 July 2009 – Victoria to Sachs Harbour

Samples for nutrients were taken in coordination with the Malina teams sampling from the ship's water intake. The samples were preserved for analysis on Leg 2a.

27.2.2 Leg 2a – 16 July to 30 July 2009 – Beaufort Sea

A total of 21 stations and Rosette casts were sampled during Leg 2a between 18 July and 27 July (Table 27.1). $^{13}C/^{15}N$ samples were collected at 17 stations, alternating profiles of production rate measurements and profiles of POM $\delta^{13}C/\delta^{15}N$ contents (Table 27.1). Production rates of ^{13}C-$^{15}NH_4$ and ^{13}C-$^{15}NO_3$ were performed at 6/7 depths per station while production of ^{13}C-$^{15}N_2$ were conducted at the surface (Table 27.2). Ammonium measurements (109 samples) were made at 6/7 depths per station and TOM/POM were determined at 10-12 depths per station for a total of 115 TOM samples and 99 POM samples (Table 27.2).

Table 27.1. Lists of sampling stations and measurements during Leg 2a.

Station ID	Cast#	Date	Nuts	NH4	Chl a	Taxo	Pico/Nano	$^{13}C/^{15}N$ production	POM $\delta^{13}C/\delta^{15}N$
1	2	18-07-09	X	X				Test	Test
2	3	18-07-09	X	X	X	X	X		
11	5	19-07-09	X						
3	6	19-07-09	X		X				
14	7	20-07-09	X	X	X	X	X	X	X
15	8	20-07-09	X						X
17	9	20-07-09	X	X	X	X	X	X	
4	10	21-07-09	X	X	X	X	X		X
10	11	21-07-09	X		X	X		X	
23	13	22-07-09	X	X	X	X	X		
22	14	22-07-09	X						X
21	15	22-07-09	X	X	X	X	X	X	
18	16	23-07-09	X	X	X	X	X		X
8	17	23-07-09	X		X	X		X	
20	18	23-07-07	X	X	X	X	X		X
16	19	24-07-09	X	X	X	X	X	X	
6	20	25-07-09	X						X
7	21	25-07-09	X	X	X	X	X	X	
9	22	26-07-09	X					X	
13	23	27-07-09	X		X	X			X
12	24	27-07-09	X	X	X	X	X	X	

A total of 41 samples were collected (5 depths between the surface and chlorophyll maximum) for the determination of POM $\delta^{13}C/\delta^{15}N$ contents (Table 27.2). Ammonium measurements were made onboard while dissolved inorganic matter (DIM), total organic matter (TOM) and particulate organic matter (POM) will be made post-cruise in the laboratory using a AA3 AXFLOW autoanalyzer. Incorporation rate measurements using

$^{13}C/^{15}N$ tracers and $\delta^{13}C/\delta^{15}N$ content of POM will be made on a SERCON mass spectrometer.

Regenerated production measurements at 6 or 7 depths between the surface and the chlorophyll maximum were conducted during deck incubations (Figure 27.1), for a total of 127 rate experiments, and ammonium regeneration rate experiments were measured 59 times.

Figure 27.1. Incubation basins flowing with seawater and simulating different light levels (100%, 50%, 25%, 15%, 8%, 3%, 1%) were used for production rate experiments during Leg 2a.

Table 27.2. Number of depths sampled on each cast for carbon and nitrogen isotopic measurements and rate experiments during Leg 2a.

Cast#	Ammonium	Total organic matter (TOM)	Nuts	Particulate organic matter (POM)	Production rate $^{13}C/^{15}N_2$	Production rate $^{13}C/^{15}NO_3$	Production rate $^{13}C/^{15}NH_4$	Regeneration rate $^{15}NH_4$	POM content $d^{13}C/d^{15}N$
2	10	12	12	6					5
7	12	12	12	6	1	6	6	6	
8									4
9	12	12	12	6	1	6	6	6	
10									5
11	10	12	12	12	1	6	6	6	
13									7
15	12	12	12	12	1	7	7	7	
16									5
17	12	12	12	14	1	6	6	6	
18									5
19	10	12	14	14	1	7	7	7	
20									5
21	12	12	18	15	1	7	7	7	
22	12	12	12	7	1	7	7	7	
23									5
24	7	7	7	7	1	7	7	7	
TOTAL	**109**	**115**	**123**	**99**	**9**	**59**	**59**	**59**	**41**

27.2.3 Leg 3a – 27 August to 12 September 2009 – Beaufort Sea

In addition to nutrient determination in support of the various Geotraces teams (Table 27.3), samples were collected to examine natural variations in nitrogen isotopes of nitrate (NO_3), collaboration with D. Sigman (Princeton University, USA). Seawater samples were collected with a syringe and filtered through a GFF filter. These samples were used for nutrient analysis and 60 ml aliquots were stored at -20°C for d^{15}N-nitrate analysis.

Table 27.3. Number of depths sampled on each cast for nutrient measurements during Leg 3a.

Station ID	Event #	Cast type	NO2	NO3+NO2	Si	PO4
S1	1	Shallow Bio	4	4	4	4
S2	10	Shallow Bio	7	7	7	7
S2	11	Deep Geochem	4	4	4	4
L1	14	Shallow Bio	6	6	6	6
L1	15	Deep Geochem	10	10	10	10
L1	19	Incubation	3	3	3	3
L1	24	10m	1	1	1	1
L1	24	Trace metals	12	12	12	12
L1	32	Trace metals	12	12	12	12
L1.5	33	Trace metals	12	12	12	12
L2	35	Trace metals	12	12	12	12
L2	38	Shallow Bio	6	6	6	6
L2	46	Deep Geochem	17	17	17	17
L2	39		12	12	12	12
L2	51		12	12	12	12
L2	54	Shallow Bio	6	6	6	6
L2		Proteomics	4	4	4	4
L3	55		12	12	12	12
L3	56	Deep Geochem	18	18	18	18
L1.1	59		12	12	12	12
	62	Particles Trace metals	6	6	6	6
L1.1	63	Shallow Bio	6	6	6	6
L1.1	66	Deep Geochem	17	17	17	17
L1.1	67		12	12	12	12
S4	78		12	12	12	12
S4		Ice	6	6	6	6
S4	75-76	Proteomics	2	2	2	2
S4	68-71	Proteomics	4	4	4	4

27.2.4 Leg 4a – 8 October to 6 November – Beaufort Sea, NW Passage, Baffin Bay

Vertical profile of nutrient concentrations were conducted at 26 stations during Leg 4a (Table 27.4) located in the Northwest Passage and Baffin Bay.

Table 27.4. List of sampling stations and measurements taken during Leg 4a.

Date	Station	CTD Cast #	Type
2009-10-12	437	cast 003	Nutrients + Ammonium + Urea
2009-10-13	408	cast 007	Nutrients + Ammonium + Urea
2009-10-14	416	cast 011	Nutrients
2009-10-14	414	cast 013	Nutrients
2009-10-14	412	cast 015	Nutrients
2009-10-14	410	cast 017	Nutrients
2009-10-15	405	cast 023	Nutrients + Ammonium + Urea
2009-10-17	450	cast 026	Nutrients
2009-10-19	308	cast 027	Nutrients + Ammonium + Urea
2009-10-22	334	cast 029	Nutrients
2009-10-23	304	cast 030	Nutrients + Ammonium + Urea
2009-10-24	330	cast 032	Nutrients
2009-10-25	325	cast 033	Nutrients
2009-10-25	323	cast 038	Nutrients + Ammonium + Urea
2009-10-26	300	cast 039	Nutrients
2009-10-26	322	cast 040	Nutrients
2009-10-27	103	cast 041	Nutrients + Ammonium + Urea
2009-10-27	105	cast 043	Nutrients + Ammonium + Urea
2009-10-28	107	cast 046	Nutrients
2009-10-28	109	cast 048	Nutrients + Ammonium + Urea
2009-10-28	110	cast 050	Nutrients
2009-10-28	111	cast 051	Nutrients + Ammonium + Urea
2009-10-29	113	cast 054	Nutrients
2009-10-29	115	cast 057	Nutrients + Ammonium + Urea
2009-10-30	136	cast 060	Nutrients + Ammonium + Urea
2009-11-02	141	cast 065	Nutrients + Ammonium + Urea

Additionally, nutrient assimilation rates by phytoplankton were assessed during deck incubations on 9 occasions in Leg 4a (Table 27.5). For these experiments, phytoplankton community collected from the chlorophyll maximum was incubated with nutrient enrichments and at two light intensities. Incubations were conducted on deck in basins kept at sea surface temperature (1.5-2°C) for 48 hours. Subsamples for nutrient analyses, chlorophyll and taxonomic composition were taken every 6 hours, except for ammonia which were taken only at 0 h and 12 h.

Table 27.5. Stations where incubations experiments were conducted to determine nutrient assimilation rates by phytoplankton during Leg 4a.

Date	Station	CTD/Cast
2009-10-12	437	cast 003
2009-10-13	408	cast 007
2009-10-15	405	cast 023
2009-10-19	308	cast 027
2009-10-23	304	cast 030
2009-10-25	323	cast 038
2009-10-27	105	cast 043
2009-10-28	111	cast 051
2009-10-29	115	cast 057

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28 Microbial diversity in the Canadian Arctic using molecular tools – Leg 4a

ArcticNet Phase 2 – Project titled *Marine Biological Hotspots: Ecosystem Services and Susceptibility to Climate Change*. ArcticNet/Phase2/TremblayJE_Marine_ecosystem_services

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28.1 Introduction

Microbial communities, from all three domains of life, form the basis of marine food webs and play an important role in all biogeochemical cycles. While these communities are highly diverse, the majority of organisms cannot be cultured, and are virtually impossible to distinguish morphologically. Molecular tools must therefore be used to describe their genetic and functional diversity. Clone libraries, denaturing gradient gel electrophoresis, qPCR and fluorescent *in situ* hybridization are all examples of such tools. The goal of this project for Leg 4a, while transiting through the Canadian Arctic, was to collect samples for DNA- and RNA-based analyses as well as conventional and epifluorescent microscopy. These samples will be analyzed in the laboratory at Université Laval.

28.2 Methodology

28.2.1 General overview

In October 2009, seawater was collected from 4-8 depths using the CTD-Rosette system onboard the CCGS *Amundsen*. To capture regional variability, the sampling plan included 4 stations in the western Arctic, 5 stations in the Canadian Archipelago, including Prince of Wales Strait, Viscount Melville Sound and Lancaster Sound, 5 stations along a transect between Ellesmere Island and Greenland, one station in mid-Baffin Bay, and one station in Scott Inlet, Baffin Island (Table 28.1).

Sampling depths were chosen based on characteristics of the water column as profiled by the downcast of the CTD. The surface and bottom were always sampled, along with up to six other depths of interest such as the nitracline, O_2 minimum, deep chlorophyll maximum, or Atlantic and Pacific water masses.

PCR-based molecular techniques can miss rare but interesting species. One method to boost abundance of rare heterotrophic organisms consists in incubating the seawater in darkness at in situ temperatures before processing (Massana et al. 2006). Where time permitted, duplicate seawater samples from selected depths were incubated for 18-36 hours before processing.

28.2.2 *DNA and RNA*

Samples for DNA and RNA were collected by filtering seawater onto a 3 μm polycarbonate filter and a 0.2 μm Sterivex cartridge (Fisher Scientific) using a peristaltic pump. This method allowed separating the large and small size fractions of the microbial community.

The filtering apparatus allowed four depths to be sampled for RNA at each station. 4 litres were filtered at 4ºC to prevent degradation of the fragile RNA molecule. Filters were stored in RLT buffer (Qiagen) with ß-mercaptoethanol, flash-frozen in liquid nitrogen, and then stored at -80ºC.

Up to eight depths were sampled for DNA at each station. 6 litres of water were filtered at room temperature. Filters were stored in lysis buffer (50 mM tris, 40 mM EDTA and 0.75 M sucrose) at -80ºC.

28.2.3 *Chlorophyll a*

While other teams onboard the *Amundsen* collected water column samples for Chlorophyll *a*, the depths they sampled were not always the same. Therefore, it was decided to collect separate chlorophyll samples from each depth at every station. 500 ml of seawater was filtered through a glass fibre filter and stored in darkness at -20ºC. In addition, the same quantity of water was pre-filtered through a 3 μm polycarbonate filter before filtering onto a glass fibre filter, in order to sample only the <3 μm size fraction of the photosynthetic community. Chlorophyll *a* will be extracted with ethanol and quantified at Université Laval.

28.2.4 *Epifluorescent microscopy*

Slides were made for epifluorescent microscopy at each station and depth sampled. These slides will be used to estimate bacterial and eukaryote abundance. Seawater was fixed with 2.5% glutaralehyde and processed within 24 hours of sampling. For eukaryotic organisms, 50 ml of fixed sample was filtered through a 0.8 μm black polycarbonate filter and stained with DAPI, a nucleic acid stain. This filter was mounted on slide using a drop of immersion oil and stored in darkness at -20ºC. An identical procedure was followed for bacteria, except that 15 ml were filtered onto a 0.2 μm black polycarbonate filter.

28.2.5 *Fluorescent in situ Hybridization (FISH)*

FISH is a technique that uses fluorescent-labelled nucleic acid probes to identify a specific phylogenetic group of organisms under the microscope. Samples for FISH were collected in duplicate for eukaryotes and bacteria at each station and depth sampled. Seawater was fixed with 3.7% formaldehyde and processed within 24 hours of sampling. For eukaryotic organisms, 90 ml of fixed sample was filtered onto a 0.8 μm polycarbonate filter. For bacteria, 10 ml was filtered onto a 0.2 µm polycarbonate filter. Filters were air-dried and stored at -20ºC.

28.2.6 Conventional light microscopy

At each station and depth sampled, 225 ml of seawater was collected and fixed using FNU fixative (1 % paraformaldehyde, 0.1 % glutaraldehyde). At Université Laval, these samples will be allowed to sediment in Utermöhl chambers and larger organisms, such as diatoms and dinoflagellates, will be identified to the highest possible taxonomic resolution on an inverted microscope.

28.2.7 Culturing effort

Raw seawater was collected from the surface at Stations 136 and 141 and kept in dim light at 4ºC. These samples will be used to try to establish monoclonal cultures of bacterial and eukaryote strains.

Table 28.1. Number of depths sampled for microbial diversity assessments at each cast and station visited during Leg 4a.

Region	Station ID	Cast #	Depths sampled	Incubations (Y/N)
Western Arctic	437	4	7	Y
	408	8	7	N
	405	21	8	N
	450	26	4	N
Prince of Wales Strait	308	28	7	Y
Viscount Melville Sound	334	29	4	N
Lancaster Sound	304	31	4	Y
	323	35	8	N
Northern Baffin Bay Transect	103	42	4	N
	105	44	4	N
	109	49	4	N
	111	52	4	N
	115	58	8	N
Mid-Baffin Bay	136	61	4	N
Scott Inlet	141	64	8	N

29 Phytoplankton and primary production – Legs 4a and 4b

ArcticNet Phase 2 – Project titled *Marine Biological Hotspots: Ecosystem Services and Susceptibility to Climate Change*. ArcticNet/Phase2/TremblayJE_Marine_ecosystem_services
ArcticNet Phase 2 – Project titled *Understanding and Responding to the Effects of Climate Change and Modernization in Nunatsiavut.* ArcticNet/Phase2/Reimer_Nunatsiavut_nuluak

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29.1 Introduction

Primary production plays a central role in the ocean as it supplies organic matter to higher trophic levels including invertebrates, fishes, marine mammals and polar bears. This component of the ecosystem is extremely vulnerable to climate and environmental variability. Marine ecosystems in polar regions are particularly sensitive to any changes in primary production due to their low number of trophic links. Phytoplankton is also a key factor in ocean biogeochemistry as it participates in the transformation of ca. 50% of the annual atmospheric CO_2 into organic carbon via the biological pump. Thus, any modification of phytoplankton production and community structure will play a critical role in the response of the ocean to climate change. The ArcticNet Expedition is therefore offering a great opportunity to cover a wide environmental gradient through the 3000 nautical miles of transit from Beaufort Sea to Baffin Bay.

The general objectives of this research project were (1) to determine the temporal variability of phytoplankton production, biomass and abundance, and (2) to determine the role of environmental factors on the phytoplankton dynamics of the designated Arctic Ocean hot spots.

In Leg 4b, the team also participated in the School on Board program, led by L. Barber, and gave a talk on the importance of studying primary production in Arctic ecosystems. The team also led a workshop in the measurement of Chl *a* concentrations during which the 10 students had to sample, filtrate, extract Chl *a* pigments, read the fluorescence and calculate the Chl *a* concentration of two fjords (Nachvak, Anaktalak). Finally, they had to compare these fjord ecosystems based on the physics (CTD data, D. Boisvert) and the biology (Chl *a* measurements; benthic data, M. Gauthier).

29.2 Methodology

29.2.1 Leg 4a – 8 October to 6 November – Beaufort Sea, NW Passage, Baffin Bay

The following measurements were made during Legs 4a and 4b:

- Incident irradiance with a LI-COR 2 pi sensor (continuous readings).
- Uunderwater irradiance profile using a PNF-300 probe.
- Transparency of the seawater with a Secchi disk (Holme 1970).
- Concentrations of dissolved organic carbon (DOC) and total organic carbon (TOC) with a Shimadzu TOC-5000 analyzer (Whitehead et al. 2000).
- Concentrations of chlorophyll *a* and pheopigments for 3 size-classes (>0.7 µm, >5 µm, >20 µm) using a Turner Designs fluorometer (Knap et al. 1996).
- Concentrations of pigments by HPLC (Knap et al. 1996).
- Concentrations of particulate organic carbon (POC) and nitrogen (PON) with a CHN analyzer (Knap et al. 1996).
- Phytoplankton abundance and taxonomic composition by inverted microscopy (Lund et al. 1958).
- Abundance of pico- and nano-phytoplankton and heterotrophic bacteria using flow cytometry.
- Photosynthesis-irradiance curves using the ^{14}C assimilation method (Babin et al. 1994).
- In Leg 4a only, Concentrations of DOC and DON at all sampling depths (Whitehead et al. 2000).

During Leg 4a, sampling was conducted from 11 October till 06 November at 16 stations located along a west-to-east transect from the Beaufort Sea to Baffin Bay. Detailed sampling activities are summarized in Table 29.1.

Incident downwelling irradiance (photosynthetically active radiation, PAR, 400-700 nm) was continuously recorded at 10 min intervals using a Li-COR 2 π quantum sensor (LI-190 SA) located on the monkey island. At each station, the sea-ice coverage was visually estimated. Light profiles and water transparency were measured in the water column at every station with a PNF-300 and a Secchi disk to determine the photic depths, except where ice cover prohibited its deployment or when the ship arrived on station at night.

At each station, water samples were collected from 12-L Niskin bottles attached to the Rosette equipped with a CTD (conductivity-temperature-depth) probe, an underwater PAR sensor, an *in situ* fluorometer and a nitrate sensor. These water samples were collected at 7 discrete optical depths (100, 50, 30, 15, 5, 1 and 0.2 % of surface PAR), including the depth of maximum chlorophyll fluorescence, 2-4 depths between the base of Z_{eu} and 100 m. Higher resolution vertical profiles were obtained for dissolved organic carbon and nitrogen (DOC and DON) following the nutrients profile sampling. Subsamples for subsequent analyses were drawn from the Niskin bottles into acid-washed Nalgene bottles (Knap et al. 1996).

Subamples of 200 ml for the identification and enumeration of phytoplankton cells were collected at 50% and 15% of surface PAR and the depth of maximum chlorophyll *a* fluorescence. They were preserved in acidic Lugol and formaldehyde solutions (Parsons et al. 1984) and stored in the dark at 4°C until analysis. Samples will be identified in laboratory.

Subsamples of 5 ml for DOC/TOC concentration measurements were collected at 50% and 15% of surface PAR, maximum chlorophyll *a* fluorescence and 100 m. Subsamples of 20 ml for DOC/DON concentration measurements were collected at 5 m, 10 m, 20 m, 30 m, 40 m, 50 m, 60 m, 80 m, 100 m, 120 m, 140 m, 160 m, 180 m, 200 m, 250 m, 300 m then every 100 m to the bottom. In Baffin Bay, depths were changed to 5 m, 10 m, 20 m, 30 m, 40 m, 50 m, 60 m, 70 m, 80 m, 100 m, 125 m, 150 m, 200 m, 250 m, 300 m then every 100 m to the bottom. Samples were taken with a syringe directly from the Niskin bottles then acidified with phosphoric acid and stored in the dark at 4°C until laboratory analysis.

Subsamples of 5 ml for the abundance of pico- and nanophytoplankton and heterotrophic bacteria were collected at 50%, 30%, 5% and 1% of surface PAR, at the maximum chlorophyll *a* fluorescence and at 100 m. Subsamples were fixed with glutaraldehyde, frozen in liquid nitrogen and kept at -80°C until laboratory analysis.

Subsamples of 3 to 4 L for high performance liquid chromatography (HPLC) were collected at 50% of surface PAR and\or at the maximum chlorophyll *a* fluorescence. Subsamples were frozen in liquid nitrogen and kept at -80°C until laboratory analysis.

Subsamples of 1 L for POC/PON measurements were collected at 50% and 15% of surface PAR, maximum chlorophyll *a* fluorescence and 100 m. Subsamples were dried at 60°C for 24 hours and stored out of humidity until laboratory analysis.

For size-fractionated chlorophyll *a* (chl *a*) determination, 500-ml subsample were filtered through 25 mm Whatman GF/F fiber glass filters (total phytoplankton biomass: $B_T \geq 0.7$ µm), 25 mm Poretics 5 µm polycarbonate membrane filters (biomass of large phytoplankton: $B_L \geq 5$ µm) and subsamples of 1 l through 20 µm Nitex filter. Susamples were collected at 7 discrete optical depths (100, 50, 30, 15, 5, 1 and 0.2 % of surface PAR), including the depth of maximum chl *a* fluorescence, 60, 70, 80 and 100 m. When a light profile could not be achieved prior to the Rosette cast, surface, 10, 30, 40, 60, 70, 80, 100 m were sampled. Concentrations of chl *a* were measured on board the ship with a Turner Designs TD-700 fluorometer, after 18 h of pigment extraction in 90% acetone at 4°C in the dark (acidification method of Parsons et al. 1984).

For short term photosynthesis-irradiance (P-E) curve experiments, 850 ml subsamples were collected at 2 depths (50% surface irradiance, and maximum chlorophyll fluorescence) to estimate photosynthetic parameters, such as maximum productivity (P_m), the irradiance at which P_m is reached (I_k), and photosynthetic efficiency (α)

Table 29.1. Summary of stations sampled for phytoplankton and primary production parameters during Leg 4a.

Station ID	DOC/DON	DOC/TOC	HPLC	Pico/Nano/ Bact	Cells	Chl a	POC/PON	P-E curves
437	X	X	X	X	X	X	X	X
408	X	X	X	X	X	X	X	X
405	X	X	X	X	X	X	X	X
450	X	X	X	X	X	X	X	X
308	X	X	X	X	X	X	X	X
334	X X X	X	X	X	X	X	X	X
304	X X	X	X	X	X	X	X	X
330	X X	X	X	X	X	X	X	X
323	X X	X	X	X	X	X	X	X
103	X	X	X	X	X	X	X	X
105	X	X	X	X	X	X	X	
109	X	X	X	X	X	X	X	X
111	X	X	X	X	X	X	X	
113	X	X	X	X	X	X	X	
115	X	X	X	X	X	X	X	X
136	X	X	X	X	X	X	X	
141	X	X	X	X	X	X	X	X

29.2.2 Leg 4b – 6 November to 18 November – Labrador fjords

During Leg 4b, sampling was conducted from 8 November until 13 November at 9 stations, one in the Hudson Strait and 8 in the four Labrador fjords (Nachvak, Saglek, Okak, Anaktalak; Table 29.3).

CTD profiles were taken at numerous stations in each fjord. Preliminary observation of CTD profiles revealed very high productivity (fluorescence) levels at the mouth of Saglek fjord. Water samples were collected from the Rosette to examine nutrients, contaminants, dissolved organic carbon, particulate organic carbon and nitrogen, primary production, phytoplankton biomass for trophodynamics and contaminants and phytoplankton taxonomy. Sampling depths were chosen to provide representative sampling of the entire water column at each station (Table 29.2).

Table 29.2. Nutrients and phytoplankton parameters measured with the depths sampled during Leg 4b.

Parameter	Depths (m below surface or % of incident irradiance)
Phytoplankton for trophodynamics & contaminants	Fluor. max
Nutrients	Bottom, every 50 m to 200, every 25 m to 100, every 20m to 80, 70, 60, 50, 40, 30, 20, 10, 5
Phytoplankton taxonomy	50%, 15%, fluor. Max

Parameter	Depths (m below surface or % of incident irradiance)
TOC, DOC & POC/PON	50%, 15%, fluor. max, 100 m
Chl a	100%, 50%, 30%, 15%, 5%, 1%, 0.2% (including fluor. max)
HPLC-Pigments	50%, fluor. Max
Pico/Nano/Bacteria	50%, 30%, 5%, 1%, chl. max, 100 m
Primary production (mouth of each fjord)	100%, 50%, 30%, 15%, 5%, 1%, 0.2%

Table 29.3. Stations visited and number of depths sampled for phytoplankton parameters during Leg 4b.

Station	Latitude N	Longitude W	Cast □	Date (M/D/Y)	Chl *a*	POC/ PON	DOC/ TOC	HPLC	Cell	Pico/ Nano/ Bact	DCMU	P&I curves
352	61°15.868	064°44.962	66	11/7/2009	7	5	4	0	0	5	0	0
600	59°05.208	063°25.745	68	11/8/2009	8	5	4	1	3	5	0	2
602	59°03.145	063°52.312	70	11/9/2009	7	4	4	2	3	6	2	0
604*	58°59.582	063°53.701	71	11/9/2009	6	0	0	0	0	0	0	0
615	58°05.208	063°25.745	76	11/9/2009	8	4	4	1	3	6	2	0
617	58°31.265	062°50.413	78	11/10/2009	9	3	2	1	2	5	1	1
633	57°39.199	061°53.490	79	11/11/2009	7	4	4	1	2	6	1	1
630	57°28.336	062°26.521	82	11/11/2009	5	3	3	2	3	5	1	0
620	56°23.807	061°12.977	85	11/12/2009	7	3	4	1	2	5	0	1
623*	56°26.839	061°56.413	88	11/13/2009	5	0	0	0	0	0	0	0
624	56°25.234	061°04.360	89	11/13/2009	6	3	3	1	2	4	0	0

*Station sampled as a School on Board workshop.

29.3 Preliminary results (Leg 4b)

The phytoplankton biomass generally showed higher value at the deeper mouth of the fjord where the water column directly mixed up with the Labrador Sea than at their geographical end. The entrance of Saglek fjord (Station 617) presented the highest phytoplankton biomass and it was dominated by large cells (>5 µm). The fall phytoplankton biomass of the studied Labrador fjords was dominated by small cells (0.7-5 µm), except for Station 617. These results will be further analysed in relation with other variables and environmental parameters.

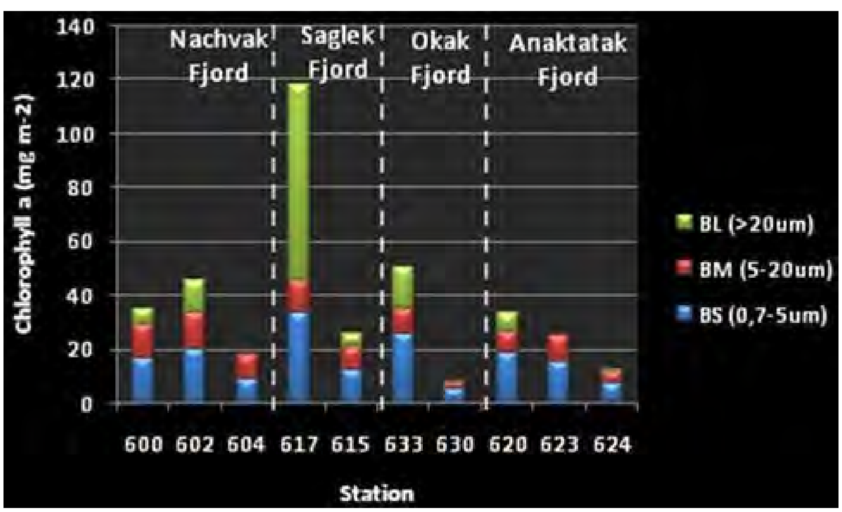

Figure 29.1. Integrated chlorophyll a concentrations from the first 100 m from 4 Labrador fjords collected in Leg 4b between November 11-13 2009.

29.4 Comments and recommendations

The Li-Cor instrument used in Legs 4a and 4b for measuring irradiance was installed on the monkey island to avoid ice formation over the sensor.

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30 Zooplankton and ichtyoplankton – Legs 2a, 4a, 4b and BaySys

ArcticNet Phase 2 – Project titled *Marine Biological Hotspots: Ecosystem Services and Susceptibility to Climate Change*. ArcticNet/Phase2/TremblayJE_Marine_ecosystem_services
ArcticNet Phase 2 – Project titled *Understanding and Responding to the Effects of Climate Change and Modernization in Nunatsiavut.* ArcticNet/Phase2/Reimer_Nunatsiavut_nuluak
ArcticNet Phase 2 – Project titled *Freshwater-Marine Coupling in the Hudson Bay IRIS*. ArcticNet/Phase2/Barber_Freshwater-marine_coupling

Project leaders: Louis Fortier[1] (louis.fortier@bio.ulaval.ca) and Ken Reimer[2] (reimer-k@rmc.ca)
Cruise participants Leg 2a: Louis Fortier[1], Louis Létourneau[1] and Virginie Galindo[1]
Cruise participants Leg 4a: Maxime Geoffroy[1], Hélen Cloutier[1] and Cyril Aubry[1]
Cruise participants Leg 4b: Maxime Geoffroy[1], Hélen Cloutier[1], Tanya Brown[2] and Esteban Estrada[2]
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30.1 Introduction

30.1.1 Leg 2a – 16 July to 30 July 2009 – Beaufort Sea

The objectives of the zooplankton program for Leg 2a were (1) to sample the overall mesozooplankton assemblage over the entire water column, and (2) to sample the ichthyoplankton community (focusing on the dominant species Arctic cod) in the surface (0-40 m) layer, at all 21 stations of Imperial Oil's Ajurak lease block sampling grid.

30.1.2 Leg 4a – 8 October to 6 November – Beaufort Sea, NW Passage, Baffin Bay
Leg 4b – 6 November to 18 November – Labrador fjords

The primary objectives of the zooplankton program for Legs 4a and 4b were to:

- Sample the overall mesozooplankton assemblage over the entire water column
- Sample the ichthyoplankton and nekton community in the surface (0-90 m) layer, with a focus on the dominant species Arctic cod.

The resulting sample sets will allow the assessment of zooplankton abundance by species and developmental stages for each station and permit to increase the size of Arctic cod larval dataset (length-at-age) based on otoliths analysis.

In Leg 4a, sampling was performed at as many stations as possible but heavy ice conditions and winds limited opportunities of instruments deployments in certain areas.

Secondary field objectives for that leg also included the use of zooplankton samples to:

- Assess the biomass and respiration rates of the zooplankton community by the Electron Transfer System (ETS) activity at specific stations
- Sort and weigh main macro-zooplankton taxa from selected samples and compare them with equivalent samples from Leg 2a in order to estimate stage-specific biomass in summer and early fall.

30.1.3 BaySys – 27 July to 5 August 2009 – Hudson Bay

The main objectives of the zooplankton research project during the BaySys cruise were to sample zooplankton for taxonomic identification used in ecological studies, to sample live fish for marking experiment, and to prepare the sediment traps to be deployed on the moorings.

The marking experiment consisted in immersing fish in a fluorescent chemical for a short period, which leaves a mark in their otoliths (ear bones) and then to rear the fish for a few days. This technique allows for validation of the daily deposition of increment (growth ring) in the otolith of the fish, a pre-requisite to test for each species before using otolith for ageing fish in ecological studies.

30.2 Methodology

30.2.1 Zooplankton assemblages

The zooplankton assemblage integrated over the entire water column was collected at all 21 biophysical stations in the Ajurak block during Leg 2a, at 13 stations during Leg 4a (Table 30.1) and at 8 stations in Leg 4b (Table 30.2) by deploying the 5-Net Vertical Sampler (5NVS or Monster Net; Figure 30.1) from 10 m above the seafloor to the surface at a retrieval rate of 40 m min^{-1}. The 5NVS carried four 1-m^2 aperture nets (three with 200-µm mesh and one with 500 µm mesh), and one 50-µm mesh cylindrical net of 0.1 m diameter, for the collection of the entire mesozooplankton size spectrum. Two of the three 200 µm mesh sample were preserved in formalin and the third one was provided to the Contaminant team (G. Stern, DFO-FWI). The 50 µm mesh sample (copepod eggs and nauplii) and the 500 µm mesh sample (macrozooplankton including jellies) were preserved in formalin. Flow meters were installed on each net for abundance measurements.

For Leg 4a, one 200 µm mesh sample was used live for respiration experiments. To derive respiration from the activity of the Electron Transfer System (ETS), a ratio of respiration on ETS activity is required. Seven incubations (Table 30.1) were carried out to measure oxygen consumption of zooplankton assemblages and selected copepods species from the live tow in sealed chambers.

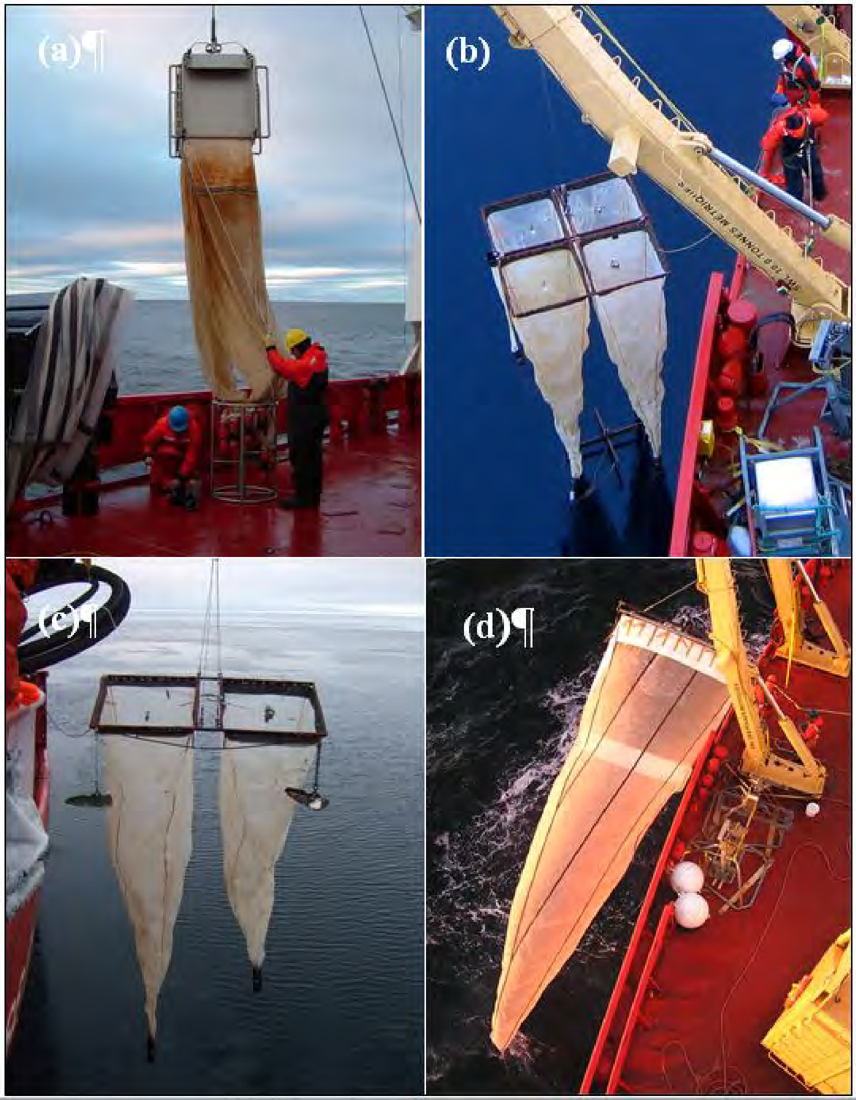

Figure 30.1. Zooplankton and fish sampling gear used on the *Amundsen*: (a) Hydrobios; (b) 4 x 1-m^2 5NVS or Monster net; (c) 2 x 1-m^2 DSN orTucker net (also used on the *Pierre Radisson*, BaySys cruise); (d) Rectangular Midwater Trawl (RMT).

During Leg 4a, the *Hydrobios* (Figure 30.1) was also used for specific multi-depth plankton sampling (Table 30.1). The *Hydrobios* is equipped with nine 200 µm-mesh nets (opening 0.5 m^2) and with a CTD to record water column properties while collecting biological samples. Note that the CTD pressure gauge was not working and depth was then calculated using the cable payout of the winch. When deploying, downward winch speed was 30 m min^{-1} and the speed up was 40 m min^{-1}. At 10 stations (Table 30.1), the content of each net was divided: 50% for taxonomy (preserved in 4% buffered formaldehyde), 25% for biomass estimates and 25% for ETS analysis, while at one station (Station 136), the net collection was only preserved in formaldehyde for taxonomic analysis. For biomass estimates, the sub-sample was fractionated with sieves in >1000 µm and <1000 µm size classes; these fractions were preserved at -20°C. Sub-samples for zooplankton population

ETS activity assays were also sieved through the same two size fractions and incubated at 4˚C.

30.2.2 Ichtyoplankton and mesozooplankton assemblages

The ichthyoplankton and mesozooplankton assemblages in the surface layer were sampled with the Double Square Net sampler (DSN or Tucker Net; Figure 30.1), a rectangular metal frame carrying side by side two 6-m long, 1-m^2 mouth aperture, 750-µm mesh, square-conical nets, and usually towed by the ship at 20 m min^{-1} and 2-3 knots. One 750 µm mesh was replaced by a 500 µm mesh net for the last 3 stations of Leg 2a and throughout Leg 4a and Leg 4b. A third smaller 50-µm mesh cylindrical net of 0.1 m diameter was also attached to the frame.

In Leg 4a, at four stations where wind and ice conditions where favorable (Table 30.1), a Rectangular Midwater Trawl (RMT; Figure 30.1) with an opening of 9 m^2 fitted with a 1600 µm mesh-net has been deployed for nekton sampling. When towed, ship speed was 2-3 knots while winch speed down was 30 m min^{-1} and 20 m min^{-1} up. The zooplankton (minus fish larvae) was split with one half provided fresh to the Contaminant team and the other half preserved at -20ºC.

Table 30.1. Summary of sampling activities and field experiments for zooplankton and ichtyoplankton during Leg 4a.

Date in 2009	Station ID	Latitude N	Longitude W	Depth (m)	TuckerNet	RMT	MonsterNet	Hydrobios	Respiration / ETS	ETS	Copepods Dry Weight
10-12	437	71º 47.04	126º 29.36	317	X		X		X		
10-13	408	71º 18.59	127º 35.54	202	X	X	X	X		X	X
10-15	405	70º 39.83	122º 59.23	565	X	X	X	X	X	X	X
10-17	450	72º 05.33	119º 47.98	95			X		X		
10-20	308	74º 06.17	108º 49.82	545			X	X	X	X	X
10-24	304	74º 18.81	091º 22.51	335				X		X	
10-25	323	74º 09.36	080º 30.18	792			X		X		
10-27	103	76º 19.45	076º 19.31	202			X	X		X	
10-27	105	76º 09.91	075º 57.89	355	X		X	X		X	X
10-28	109	76º 17.07	074º 06.36	452	X	X	X	XX		XX	
10-28	111	76º 17.60	073º 11.31	560			X		X		
10-29	115	76º 20.75	071º 13.16	652	X	X	X	XX		XX	X
10-30	136	74º 43.37	073º 26.21	800			X	X			
11-02	141	71º 22.43	070º 06.29	265			X		X		
TOTAL					**6**	**4**	**13**	**11**	**7**	**10**	**5**

Table 30.2. Summary of sampling activities and field experiments of the zooplankton group during Leg4b.

Date (UTC)	Station ID	Fjord	Latitude N	Longitude W	Depth (m)	Tucker	Monster	RMT	Hydrobios
2009-11-08	600	Nachvak	59º 05.275	63º 26.009	204	x	x		x
2009-11-08	602	Nachvak	59º 03.131	63º 52.226	150	x	x		x
2009-11-09	615	Saglek	58º 19.405	63º 32.436	137	x	x		x
2009-11-10	617	Saglek	58º 30.000	62º 41.375	136	x	x		x
2009-11-11	633	Okak	57º 36.360	61º 53.525	178	x	x	x	x
2009-11-11	630	Okak	57º 28.278	62º 26.573	50	x	x	x	x
2009-11-12	620	Anaktalak	56º 23.800	61º 13.120	93	x	x	x	x
2009-11-13	624	Anaktalak	56º 25.230	62º 04.279	68	x	x	x	x

During the BaySys cruise, on two occasions, a 1-m diameter conical frame equipped with a 500-µm mesh net (ringnet) was deployed from the barge (Stations Z-1 and Z-2). The ringnet was lowered to the desired depth and towed for 5 minutes at a speed of 2 knots before being manually hauled onboard. Zooplankton samples were taken at many stations (Table 30.3) but the presence of sea ice did not allow to sample the other stations of the original sampling grid. One additional tow was made to collect food for the captive fish (HB01).

Table 30.3. Summary of sampling activities of the zooplankton group during the BaySys cruise in Hudson Bay.

Station	Date	Latitude N	Longitude W	Gear	Taxonomy samples	Number of fish
702	27/07/09	55° 24.481	77° 55.678	DSN	2	1
Z-1	28/07/09	55° 16.685	77° 49.438	Ringnet	1	0
Z-2	28/07/09	55° 16.685	77° 49.438	Ringnet	1	0
703	29/07/09	54° 40.808	79° 58.258	DSN	2	6
HB01	30/07/09	57° 05.039	81° 55.233	DSN	0	0
707	01/08/09	59° 58.348	91° 58.843	DSN	2	0
713	03/08/09	57° 42.147	90° 52.475	DSN	2	1
706	04/08/09	58° 46.232	91° 31.205	DSN	2	0
707	04/08/09	59° 57.845	91° 57.846	DSN	2	0

Sample processing – Legs 2a, 4a and 4b

The zooplankton (minus fish larvae) from one of the 750-µm mesh net was provided fresh to the Contaminant teams (G. Stern, DFO-FWI) and/or to Imperial Oil. The zooplankton (minus fish larvae) from the other 500-µm mesh net was preserved in formalin for further analysis of the macrozooplankton assemblage in the layer occupied by fish larvae.

All fish from the two nets were sorted at sea, most of them alive for incubation in the environmental chamber of the zooplankton laboratory. The vast majority (99.9%) of the live larvae died in the hours following sampling and were returned to the collection for preservation in ethanol. At each station, a subset of up to 25 larvae of Arctic cod per net was photographed under the stereoscopic microscope and measured (length and body height at the anus).

<u>Sample processing – BaySys</u>

Fish were removed from the zooplankton samples quickly after sampling and if alive, kept in individual jars in seawater. They were then transferred in an incubator at a temperature of 0°C with the light open 12 hours per day. Every day, the fish were fed with fresh zooplankton and the water in the jars replaced. All the fish (dead in the net or after captivity) were measured fresh and preserved in ethanol 95%. For the marking experiment, fish were immersed in a 400 mg L^{-1} oxytetracyline solution for 12 hours and then transferred in clear seawater.

Five fish (of four different species) captured at Station 703 were successfully marked and three of them survived until the end of the mission. Their otoliths will be examined in the lab.

30.2.3 Echosounder

The biomass of adult fish along the ship track was monitored continuously with the EK60 echosounder. The EK60 signal will be processed to assess fish biomass following the methodology of Benoit et al. (2008). Fish larvae, zooplankton and nekton samples separated for lipid analysis were stored in 5 ml cryovials and kept frozen at -80ºC.

In Leg 2a, no significant concentration of fish or highly scattering organisms was noted so in accordance with the original sampling plan, the Rectangular Midwater Trawl (RMT) was not deployed to capture nekton during Leg 2a.

30.2.4 Moored sediment traps

In Leg 2a, four sediment traps for the measure of vertical carbon fluxes were deployed as part of the mooring program. The traps will be recovered next year, providing information on the annual flux of carbon (including zooplankton fecal fluxes) in the Ajurak, as well as annual collections of entrapped zooplankton (swimmers), in particular migrating species such as *Calanus hyperboreus*, *Metridia longa*, *Pareuchaeta glacialis* and *Themisto libellula*.

In Leg 4a, three sediment traps were recovered and three were deployed as part of the mooring program to obtain measurements of the annual variations in the vertical carbon fluxes.

During BaySys, sediment traps sampling cups were prepared for mooring deployments. The cups were filled with 4% formaldehyde saltwater solution (S = 35), numbered and installed in the sediment trap in preparation for the mooring deployment. After a sediment trap recovery, the cups were closed and stored for future analysis. Samples from two sediment traps moored in 2007 were also recovered.

30.3 Preliminary results

30.3.1 Leg 2a – 16 July to 30 July 2009 – Beaufort Sea

Despite heavy ice conditions the team was able to complete all planned sampling save for the deployment of the horizontal tow at station Ajurak 2009-07 where ice cover reached nearly 10/10. The resulting sample sets and some preliminary results are presented below.

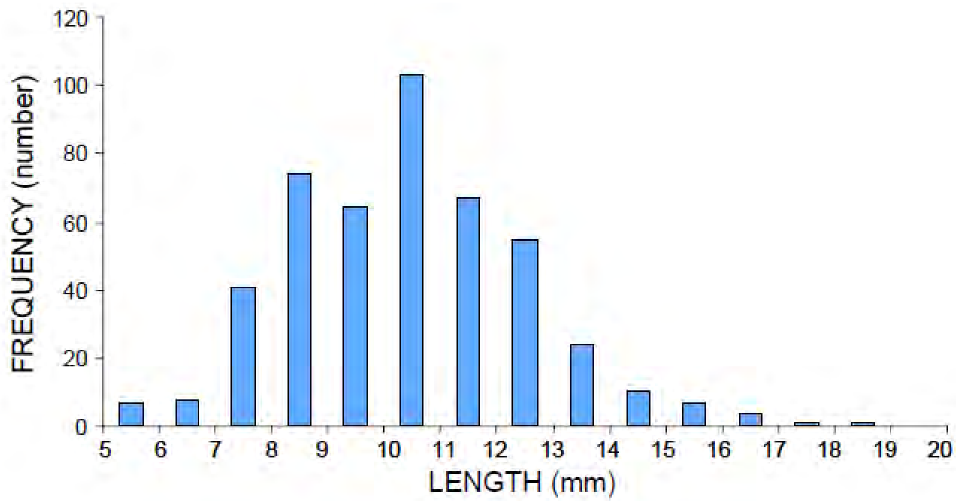

Figure 30.2. Size frequency distribution of the Arctic cod (*Boreogadus saida*) larvae measured during Leg 2a.

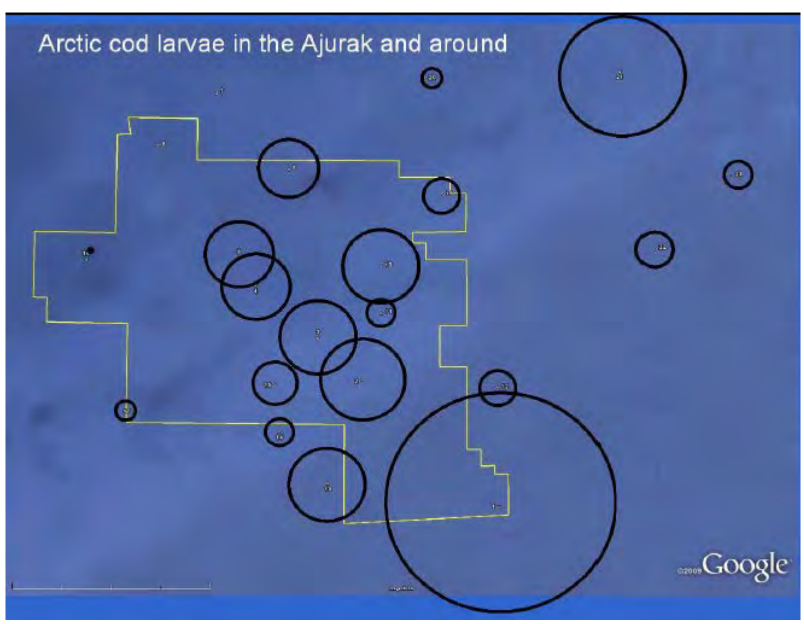

Figure 30.3. Distribution of Arctic cod larvae (*Boreogadus saida*) in the Ajurak sampling area during Leg 2a. The surface of the circle is proportional to abundance (number 100 m^{-3}). Maximum abundance was 77 larvae 100 m^{-3} and minimum abundance was 0.16 larvae 100 m^{-3}.

30.3.2 Leg 4a – 8 October to 6 November – Beaufort Sea, NW Passage, Baffin Bay

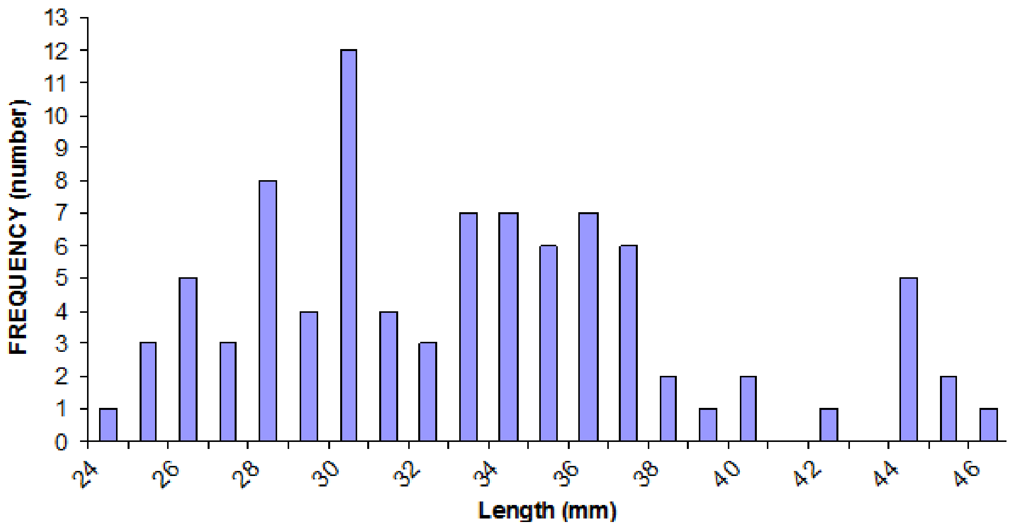

Figure 30.4. Size-frequency distribution of the Arctic cod (*Boreogadus saida*) larvae measured during Leg 4a. Note that one juvenile and one adult Arctic cod measuring 86 and 110 mm respectively were also caught.

30.3.3 Leg 4b – 6 November to 18 November – Labrador fjords

The predominant fish larvae collected belonged to the genus *Lumpenus*, especially *L. fabricii*. Another unidentified species of *Lumpenus* was also collected. Arctic cod, alligator fish and a few sculpin larvae were also caught in the fjords. Gelatinous zooplankton species were very abundant in the fjord samples, especially ctenophores. In the last two stations jellyfish (Scyphozoa) were also abundant.

30.4 Comments and recommendations

30.4.1 Leg 4a – 8 October to 6 November – Beaufort Sea, NW Passage, Baffin Bay

Problems were experienced with the Hydrobios' CTD which could not be used in Leg 4a. A spare CTD should be brought onboard on future missions. The nine zippers of the Hydrobios nets should also be changed.

The RMT required more weight on its bottom part. The Tucker Nets' depressors were added which seemed to improve trawling capacity.

Finally, the oxygen probe used for respiration experiments was unreliable. New membranes should be brought on future missions and the probe should remain in the lab instead of the container to prevent electrode oxidation.

30.4.2 Leg 4b – 6 November to 18 November – Labrador fjords

As usual, a “flush” should be asked of the bridge under ice conditions to prevent any damage to nets and samples.

Reference

Benoit et al. (2008) Journal of Geophysical Research - Oceans. doi:10.1029/2007JC004276.

31 Marine Wildlife Surveys – Legs 2a and 3b

Project leaders: ArcticNet and Imperial Oil
Cruise participants Leg 2a: Imperial Oil
Cruise participants Leg 3b: Imperial Oil

31.1 Introduction

The goal of the Marine Wildlife Program was to collect baseline information on the marine wildlife that lives in and around IOL's lease area EL446 (Ajurak). While the focus was placed on Ajurak during Legs 2a and 3b, the Marine Wildlife Program and associated surveys will be conducted throughout the 2009 Expedition in the larger Beaufort Sea area and in the eastern Arctic in partnership with ArcticNet. The data collected during these surveys is one component in a larger program that will provide comprehensive baseline information that can be used to evaluate potential effects on marine wildlife due to industrial development.

31.2 Methodology

31.2.1 Survey methods

All Marine Wildlife Observers (MWO) were trained in spotting and identifying marine mammals and seabirds. MWOs were focused observers on board the vessel to record marine wildlife that was encountered while the *Amundsen* was at sea in the summer and fall of 2009.

While the ship was moving, MWOs were stationed on either side of the bridge and scanning 180° to either port or starboard. While the ship was stationary, MWOs scanned the entire area around the ship. Each observer recorded data on electronic handheld devices (HP Ipaq) that were connected with a Bluetooth GPS (Garmin 76). Data on survey effort, environmental conditions and wildlife sightings were recorded:

1. Survey effort
    - Name of observer
    - Start and end time of survey
    - Start and end location of survey
2. Environmental conditions were recorded every half hour or as environmental conditions changed
    - Visibility
    - Swell
    - Ice cover
    - Wind speed/direction
    - Sea state
3. Wildlife sightings
    - Location on transect
    - Distance from transect (using reticle binoculars)
    - Travelling direction

- Number of individuals
- Size/age
- Behavior (diving, feeding, reaction to ship, etc.)

31.2.2 Bird surveys

Dedicated seabird surveys were completed every two hours. Observers looked forward from the vessel, scanning for birds at a 90° angle from either the port or starboard side of the ship. The transect width was 300 m from the side of the vessel. All birds observed in this transect, whether flying or on the water, were recorded. Birds seen outside the transect were recorded and noted as "not in transect".

<u>Stationary platform</u>

When the ship was stationary, surveys were done using instantaneous counts, or "snapshots" of birds within the area. A total of six single scans was done within a 30 minute period (once every 5 minutes), and all birds observed within the scan area (within 300 metres) were recorded.

<u>Moving platform</u>

When the ship was moving along a transect or route, three observation periods of 10 minutes each were conducted, during which observation were only focused on birds.

<u>Birds in flight</u>

Flying birds were not recorded continuously throughout the survey, as this would overestimate bird density. Observers used a routine of 'snapshot' counts to record flying birds during the observation period. The number of snapshots done depended on the speed of the platform. For example, if the vessel traveled at an average speed of 4.5 knots, snapshots happened every 2 minutes. During each snapshot, flying birds were recorded as "in transect" only if they were above the 300 m strip transect AND seen when the snapshot was being done.

In addition to the environmental variables recorded for the marine wildlife surveys, data on dedicated seabird survey effort and seabird observations were recorded:

1. Start and end time
2. Coordinates at start of observation period
3. Species
4. Number of individuals
5. Grouping observations: Record groups of birds as one sighting (same subform), if they behave as a group and have the same morphological and behavioural characteristics (e.g., all adults in breeding plumage flying in the same direction). Record other individuals from the group that have different characteristics (e.g., juveniles) in the next row.
6. Behaviour (flying, on sea, and/or feeding)
7. Age (adult plumage, juvenile, immature plumage)
8. Adult (adult plumage)

9. Juvenile (first coat of true feathers acquired before leaving nest)
10. Immature (first fall or winter plumage that replaces juvenile plumage and may continue in a series that includes first-spring plumage, but is not the complete adult plumage).
11. Plumage of adults (breeding, non-breeding, moult, sex)

31.3 Preliminary results

31.3.1 Leg 2a – 16 July to 30 July 2009 – Beaufort Sea

During Leg 2a, Marine Wildlife surveys were completed from 18-28 July 2009 for a total of 166 hours of MWO effort. Low visibility due to heavy fog resulted in poor sightability for the first 5 days of the survey.

Preliminary results for marine wildlife sightings are presented in Table 31.1. Results indicate the number of sightings and do not account for the number of individuals spotted per sighting, or for the possibility of re-sighting the same individual or group at different times.

Table 31.1. Summary of sightings during wildlife surveys on Leg 2a.

			Birds						Seals			Whales	Bears
Date in 2009	**MWO effort (hours)**	**Sightability**	**Eider**	**Gull**	**Jaegar**	**Northern Fulmar**	**Loon**	**Kittiwake**	**ringed seal**	**bearded seal**	**unidentified**	**bowhead whale**	**polar bear**
18-Jul	14	Poor											
19-Jul	14	Poor		2									
20-Jul	14	Poor		1					1				
21-Jul	14	Poor		3								1	
22-Jul	14	Poor	1						2				
23-Jul	14	High	2	3	1								
24-Jul	14	good			1				5				
25-Jul	14	good		1	1				1				6
26-Jul	16	High	4	6	2	2	1						
27-Jul	24	High	2	4	2		1	1	6	1	2		1
28-Jul	14	High	3	4				1					
Total sightings			12	24	7	2	2	2	15	1	2	1	7

*does not include opportunitic sightings
**does not acocunt for number of individuals per sighting

Figure 31.1. The first polar bear was spotted on 25 July, after a full week of surveying in less than optimal foggy conditions. This bear was first spotted by the ship-based observers but was photographed from the helicopter on its return from an ice patrol. Six bears were spotted that day. (Photo: Martin Fortier/ArcticNet).

31.3.2 Leg 3b – 12 September to 8 October 2009 – Beaufort Sea

Marine wildlife surveys for Leg 3b were completed from 13 September to 5 October 2009 for a total of approximately 212 hours of MWO observation effort. Preliminary results for marine wildlife sightings are presented in Table 31.2.

Table 31.2. Summary of wildlife observations for each day of Leg 3b.

			Birds*						Mammals		
Date in 2009	**Observation time (hours)**	**Sightability**	**Pomarine Jaeger**	**Glaucous Gull or Northern Fulmar**	**Black- legged kittiwake**	**Pacific Loon**	**Seaducks**	**Landbirds**	**Bearded Seal**	**Ring Seal**	**Bowhead whale**
13 Sep	16.51	Very Poor to Moderate	1			5	1		3	3	4
14 Sep	12.11	Moderate to High		6		2	2				
15 Sep	10.43	Very Poor to High		4			1				
16 Sep	12.10	High to Very High		4		3					
17 Sep	11.08	Moderate to Very High		2							
18 Sep	0.51	Poor		2							
19 Sep	11.01	Poor to Moderate		3	1	3	2			1	
20 Sep	10.24	Moderate to High		3						1	
21 Sep	11.40	Moderate to High		4	1	1	2			1	
22 Sep	10.17	Moderate		3		1	2	2			1
23 Sep	10.38	Moderate		1		1					

Date in 2009	Observation time (hours)	Sightability	Birds*						Mammals		
			Pomarine Jaeger	Glaucous Gull or Northern Fulmar	Black- legged kittiwake	Pacific Loon	Seaducks	Landbirds	Bearded Seal	Ring Seal	Bowhead whale
24 Sep	8.49	Moderate		4			1				
25 Sep	9.00	Moderate to High				1					
26 Sep	9.56	Moderate to Very High								6	
27 Sep	7.57	Very Poor to Very High		1							
28 Sep	9.55	Moderate to Very High		2	1						
29 Sep	9.54	Moderate to Very High		1			1				
30 Sep	10.00	Moderate to Very High								19	4
01 Oct	8.33	Moderate to Very High		2							
02 Oct	9.46	Moderate to Very High								5	2
03 Oct	7.53	Poor to Moderate		2			1				
04 Oct	8.43	Moderate		2				1			
05 Oct	9.31	Moderate		3				2			
Total			**1**	**49**	**3**	**17**	**13**	**5**	**3**	**36**	**11**

*Does not include incidental bird observations. Seaducks include Common and King Eider, Thick-billed Murre and Long-tailed Duck. Landbirds include owls and songbirds.

Results indicate the number of sightings and do not account for incidental or opportunistic bird observations, the number of individuals spotted per sighting, or the possibility of resighting the same individual or group at different times.

There were a couple of noteworthy marine mammal observations. One was an aggregation of feeding ring seals (and Glaucous Gulls) recorded on 26 September at 70°37.7815' N 135°59.2243' W. A second mammal concentration was recorded on 2 October, this was a group (Figure 31.2) of five bowhead whales observed at 70°31.7471' N 135°16.7996' W. Based on behavioral cues the whales were feeding.

Figure 31.2. A bowhead whale blow seen from the *Amundsen* during Leg 3b.

32 Bioacoustics research program – Legs 2a and 3b

ArcticNet Phase 2 – Project titled *Impacts of Global Warming on Arctic Marine Mammals*. ArcticNet/Phase2/Ferguson_Marine_mammals.

Project leaders: ArcticNet and Imperial Oil
Cruise participants Leg 2a: Imperial Oil
Cruise participants Leg 3b: Imperial Oil

32.1 Introduction

ArcticNet has deployed passive hydrophones on its annual sub-surface oceanographic moorings in the Amundsen Gulf and Mackenzie Shelf region since 2002. These hydrophones allow an assessment of marine mammal frequentation in the region over an entire annual cycle, even in important early spring, late fall and winter seasons that are not usually covered by seasonal hydroacoustics programs. The limited number of ArcticNet hydrophones and the large study area imposed limitations on data analysis and did not allow to track and specifically locate individual whales.

Starting in 2008, Imperial Oil initiated a seasonal and regional Bioacoustics Research Program involving the deployment of an array of marine autonomous recording units (MARUs) to record sounds of marine mammals, with a particular focus on bowhead whales (*Balaena mysticetus*). The array was located in and around the Ajurak exploration lease area. This successful program was continued in 2009 with the deployment of the MARUs in Ajurak during Legs 2a and 3b.

The specific objectives were to:

- Compare present deployment with 2008 Deployment in Ajurak for the purposes of collecting multi-year data and obtaining data for the month of August which was previously not obtained for logistical reasons.
- Assess the daily presence of bowhead whale sounds in each day of data and their hourly presence in 50% of the hours of data from the Ajurak site;
- Assess the relative levels of bowhead whale acoustic activity in the region by determining the number of calls in the first minute of 50% of the hours in each of the days during which bowhead whale sounds were found;
- Acoustically locate and track individual bowhead; attempt to determine whether vocalizing whales in the Ajurak area are moving through or remaining in the area;
- Estimate the number of calling bowhead whales responsible for the located, and compare estimated numbers of vocalizing whales present in the Ajurak area on selected days;
- Compare hourly whale presence and rates of calling between periods with and without seismic airgun activity in the Ajurak array.

Additional goals for the project included refinement of software for automated processing of such recordings and development of protocols for efficient data management and analysis. Summertime data collected through the Imperial Oil program will be complemented with annual hydroacoustics data collected by ArcticNet.

32.2 Methodology

32.2.1 Recording

A *marine autonomous recording unit (MARU)* is a digital audio recording system contained in a positively buoyant 17” glass sphere that is deployed on the bottom of the ocean for periods of weeks to months. The MARU can be programmed to record on any desired daily schedule and deployed in a remote environment where it is held in place by an anchor. A hydrophone mounted outside the sphere is the mechanism for acquiring sounds which are recorded and stored in a binary digital audio format on an internal hard disk. At the conclusion of a deployment, the MARU is sent an acoustic command to release itself from its anchor and float to the surface for recovery. After the recovery, the MARU data are extracted, converted into audio files and stored on a server for analysis. The unit is then refurbished (batteries replaced, disk erased, etc.) in preparation for a subsequent deployment. Data recorded by a MARU are thus accessible only after the device is retrieved.

When multiple MARUs are deployed in an array configuration, all units are synchronized at the start and end of the deployment, and the extracted data are merged into synchronized, multichannel audio files. Because the locations of the recorders and the speed of sound underwater are known, estimates of the locations of whales vocalizing in and near the array can be computed based on differences among recorders in the arrival times of individual whale sounds, provided that the sound is recorded on three or more units. When a whale vocalizes repeatedly while moving, the location estimates can be linked into tracks.

32.2.2 2009 deployment (Leg 2a)

Twelve MARUs were deployed in an array separated from their nearest neighbours by distance of 7 nautical miles. Before deployment, each MARU was diagnostically tested to determine correct functioning of the unit, including internal pressure and acoustic communication systems. The MARUs were also acoustically synchronized by placing them in a circle and creating a loud impulsive noise that are used to align the data after recovery (Figure 32.1).

Figure 32.1. Synchronization of the Marine Autonomous Recording Units (MARUs) on the deck of the *Amundsen* before deployment during Leg 2a.

Once synchronized the MARUs were deployed by attaching anchors via a 2 m long rope and lowering them over the side of the vessel using the A-frame. Care was taken not to damage the burn wire which is used to release the MARU's on recovery whereupon they will float to the surface.

Figure 32.2. Deployment of a MARU in the Ajurak block during Leg 2a.

Table 32.1. Time and locations of the MARU deployments in the Ajurak lease block during Leg 2a.

Loc ID	Waypoint ID	MARU #	Deployment time	Desired latitude N	Desired longitude W	Deployment latitude N	Deployment longitude W	Depth (m)
LF01	3	185	7/26/2009 13:40	70°45.156	136°38.280	70°45.113	136°38.279	1204
LF02	2	75	7/26/2009 12:40	70°45.156	136°16.884	70°45.124	136°16.162	618
LF03	1	80	7/26/2009 10:08	70°45.156	135°55.638	70°45.171	135°55.657	642
LF04	8	155	7/27/2009 5:05	70°45.156	135°34.464	70°33.141	135°13.456	395
LF05	11	156	7/27/2009 21:05	70°32.940	135°13.428	70°45.170	135°34.355	60
LF06	4	184	7/26/2009 14:42	70°39.090	136°27.726	70°39.068	136°27.786	830
LF07	5	163	7/26/2009 16:53	70°39.090	136°06.474	70°38.957	136°6.676	401
LF08	10	178	7/27/2009 19:09	70°39.090	135°45.228	70°39.354	135°45.589	465
LF09	9	188	7/27/2009 14:30	70°39.090	135°23.838	70°38.321	135°22.220	71
LF10	12	198	7/28/2009 0:09	70°45.132	135°14.142	70°45.236	135°13.932	87
LF11	6	200	7/26/2009 18:48	70°32.928	135°55.974	70°33.097	135°55.960	70
LF12	7	201	7/27/2009 1:38	70°32.958	135°34.464	70°32.857	135°35.332	66
First Deployment			7/26/2009 10:08					
Last Deployment			7/28/2009 0:09					
Total duration*			38:01:21					

*Including sampling at 2 biophysical stations

An acoustic 'Hello' signal was sent to each buoy as it floated on the surface. On the reception of a responding acoustic 'Hello', the MARUs were released to sink to the bottom, and the time, depth and GPS locations were recorded. This process was repeated until all 12 buoys were deployed at their respective locations. The deployments were a success, although full success can only be assessed upon recovery in Leg 3b and subsequent extraction of the data back at the lab.

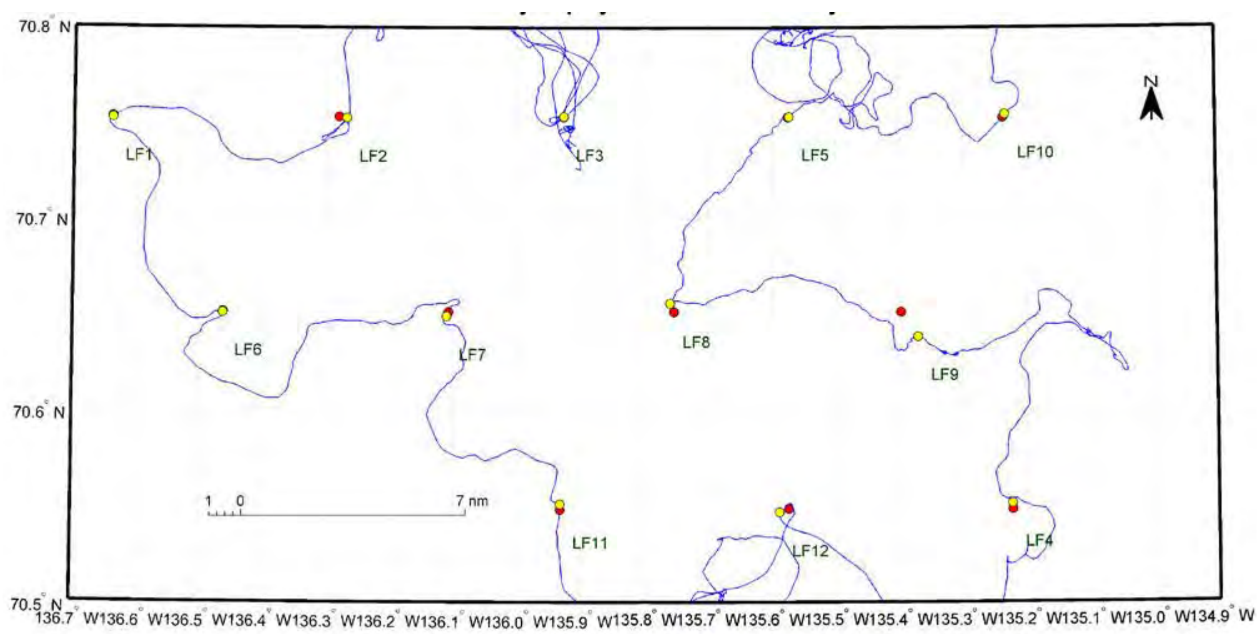

Figure 32.3. Map of locations of the 12 MARUs deployed in the Ajurak lease block during Leg 2a.

32.2.3 2009 retrieval (Leg 3b)

Twelve MARUs were deployed (Figure 32.3) in an array separated from their nearest neighbours by a distance of 7 nautical miles during Leg 2a between 26 and 28 July. The MARUs were recovered during Leg 3b by activating a burn-wire release. An underwater speaker and a hydrophone hung from the *Amundsen* were used to interact with the moored MARUs. Each MARU serial number recognizes a pair of commands encoded in an audio file. Initially, the "Hello" file is played to awaken the communication system on the MARU to which the MARU responds with an audible coded message. Once communication is established, a "Burn" file is played, and the MARU responds. The "Burn" command must be heard by the MARU twice in the span of five minutes to activate the release system.

Figure 32.4. Left: Retrieving the MARU from the foredeck during Leg 3b, and right: time synchronization of MARU buoys on the flight deck of the *Amundsen*.

Following recovery of the MARUs, it is necessary to do a post-recovery time synchronization. This allows a correction of the time drift in the internal clock of each individual MARU, such that any sounds heard by more than one of the MARUs can be triangulated in position. The post-recovery time synchronization was carried out in an identical way to the pre-deployment time synchronization; the MARUs were placed in a circle and a series of loud, distinguishable noises were created at a precisely noted time. Figure 32.4 shows the MARUs clustered on the ship's helicopter deck for post-recovery time synchronization. The loud noise was created using a length of aluminum pipe and a hammer.

It was believed at the time that a result of the sea state, the high ambient noise level of the *Amundsen*, and the depth of the mooring, the initial attempt to communicate with the MARU at position LF01 was unsuccessful. Scheduling of other ship-board activities precluded the possibility of another attempt at recovery for several days. As a result, the decision was made to do an initial time synchronization of the 11 recovered MARUs. The advantage of doing a time synchronization as soon as possible after recovery is to disconnect the power to the data recording hard drive, thereby parking it in a secure condition. Otherwise, there is a possibility that excessive jarring can damage the disk, making it difficult to recover data. Following the initial synchronization, 10 of the 11 MARUs were disabled and stowed. The 11th MARU was left powered in case the 12th MARU was recovered successfully prior to the completion of the leg. A second time synchronization with only these two MARUs would then subsequently allow complete synchronization amongst the set of 12.

Another attempt was made to recover the MARU at LF01 in the morning of 1 October. Each MARU was programmed to automatically release at a specific hour on 1 October, and the ship was on station at the expected release time for this MARU. During the expected hour or more that it would take to rise to the surface, attempts were made to interact with it using the hydrophone and speaker without success. The ship remained on station for 1 hour and twenty minutes following the scheduled release time before giving up. Details of each of the MARU moorings including depth, locations, and recovery times are listed in Table 32.2.

Table 32.2. Deployment and recovery parameters of the MARU buoys deployed in 2009 in the Ajurak block.

Location ID	MARU #	Recovery - On Surface Time (UTC)	Latitude N	Longitude W	Depth (m)	Time to reach surface (min)	Post-recovery Time Sync [1]	Disable Time (UTC)
LF01	185	Not Recovered	70° 45.113	136° 38.279	1204	N/A	N/A	N/A
LF02	75	23-09-09 17:33	70° 45.124	136° 16.162	618	23	Yes	25-09-09 19:14:00
LF03	80	23-09-09 19:04	70° 45.171	135° 55.657	642	24	Yes	25-09-09 19:14:00
LF04	155	23-09-09 20:21	70° 45.17	135° 34.355	395	12	Yes	25-09-09 19:14:00

Location ID	MARU #	Recovery - On Surface Time (UTC)	Latitude N	Longitude W	Depth (m)	Time to reach surface (min)	Post-recovery Time Sync [1]	Disable Time (UTC)
LF05	156	22-09-09 18:25	70° 33.141	135° 13.456	60	10	Yes	25-09-09 19:14:00
LF06	184	23-09-09 00:45	70° 39.068	136° 27.786	830	38	Yes	2-10-09 20:12:00
LF07	163	22-09-09 03:13	70° 38.957	136° 6.676	401	18	Yes	25-09-09 19:14:00
LF08	178	22-09-09 20:45	70° 39.354	135° 45.589	465	13	Yes	25-09-09 19:14:00
LF09	188	22-09-09 19:43	70° 38.321	135° 22.22	71	7	Yes	25-09-09 19:14:00
LF10	198	23-09-09 21:21	70° 45.236	135° 13.932	87	6	Yes	25-09-09 19:14:00
LF11	200	22-09-09 15:32	70° 33.097	135° 55.958	70	8	Yes	25-09-09 19:14:00
LF12	201	22-09-09 16:54	70° 32.857	135° 35.332	66	NR [2]	Yes	25-09-09 19:14:00

[1] Time Sync initiated at 25-Sep-09 19:01:00 (UTC)
[2] Not recorded

32.3 Preliminary results

As the MARU's have yet to be recovered and analyzed, examples of data from the 2008 deployment are shown in Figure 32.5 to 31.8.

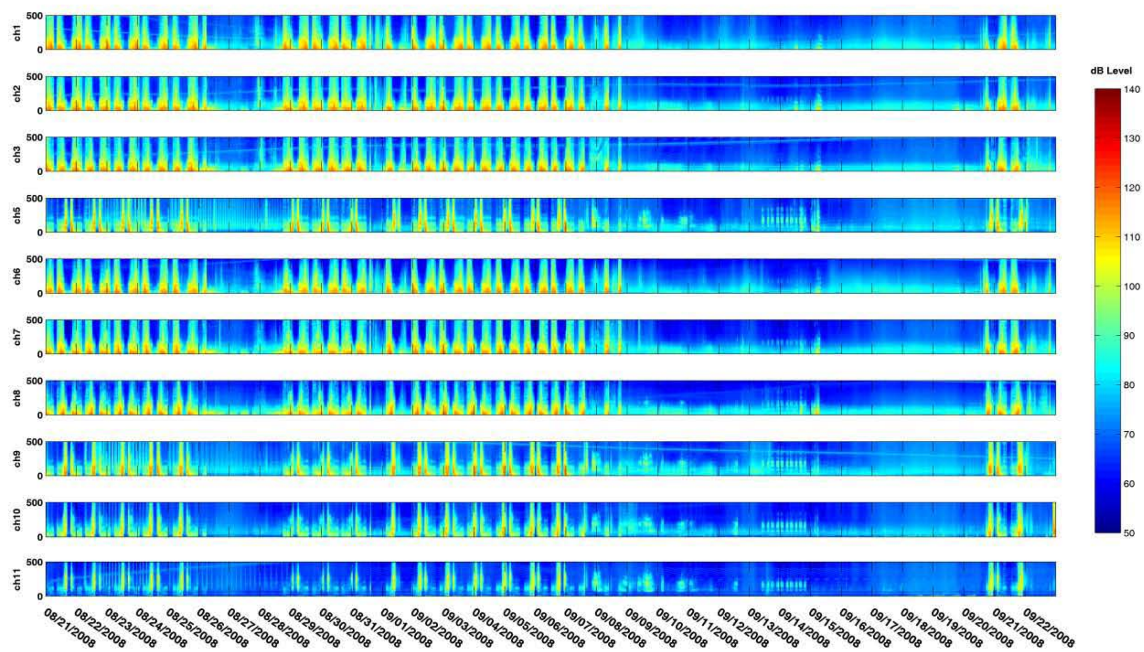

Figure 32.5. Acoustic spectrograms for all of the MARU's deployed in the Ajurak block for the 2008 season. The x-axis denotes frequency and the y-axis denotes time. The color bar indicates the noise levels in dB re: 1μPa. Note that the regular red peaks are due to seismic profiling.

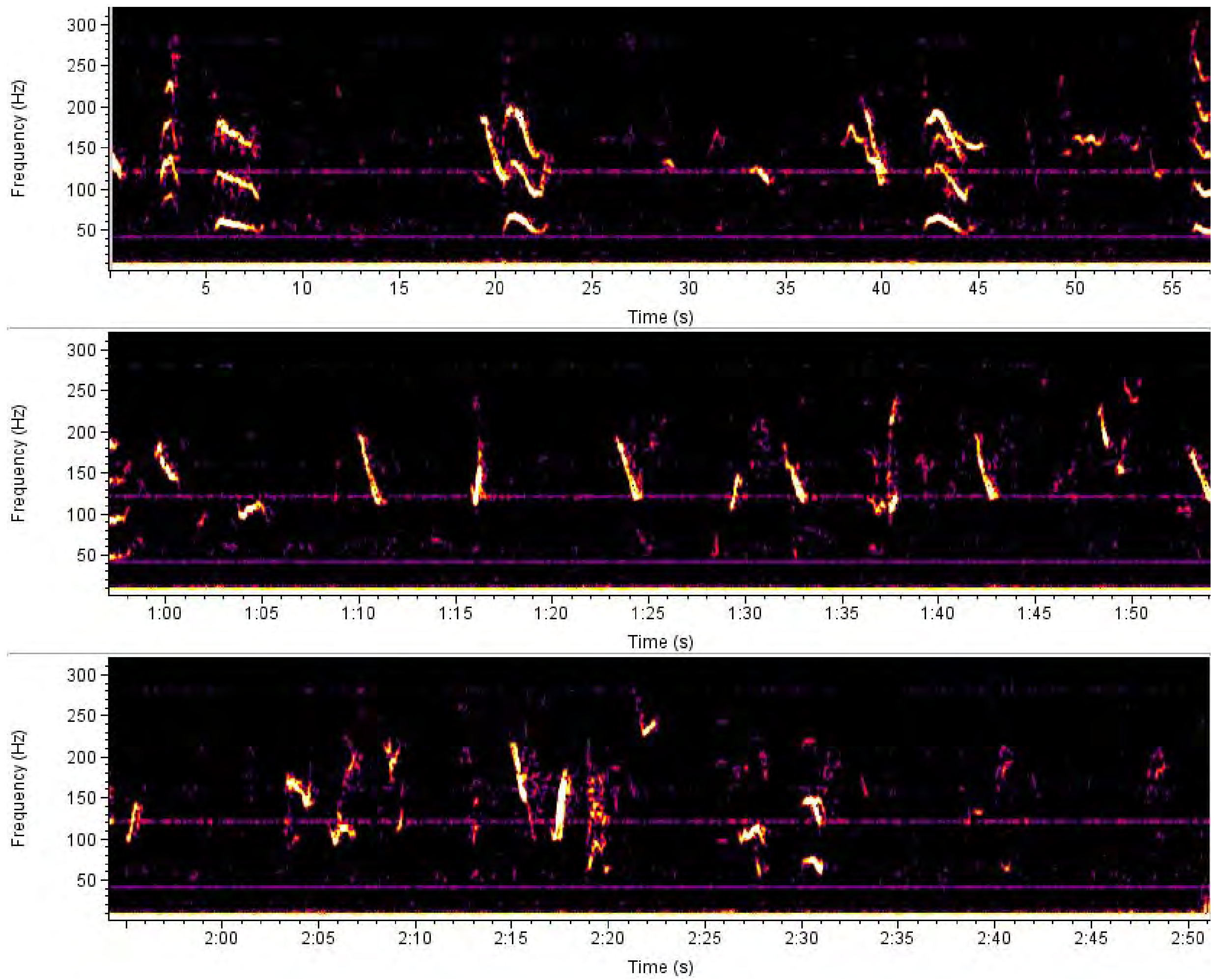

Figure 32.6. Spectrogram at much smaller timescale showing the presence of bowhead whale (*Balaena mysticetus*) vocalizations (lighter yellowish lines).

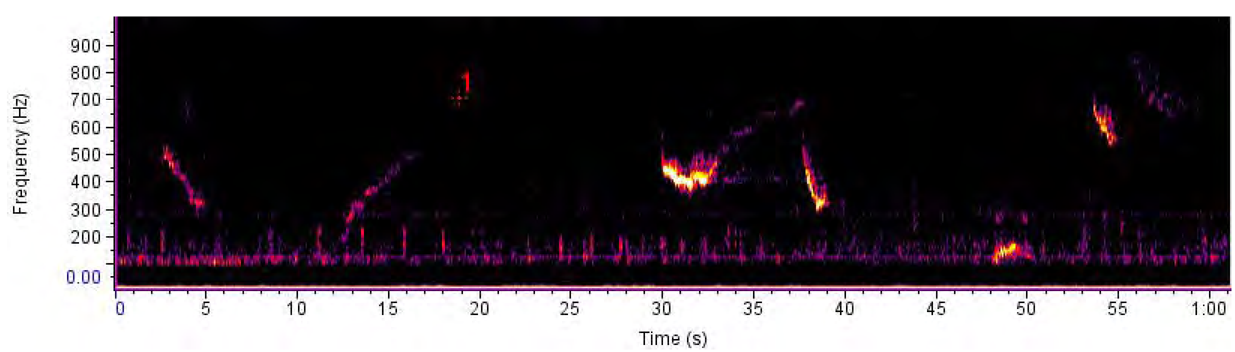

Figure 32.7. Example of a bearded seal (*Erignathus barbatus*) recorded on one MARU in the Array.

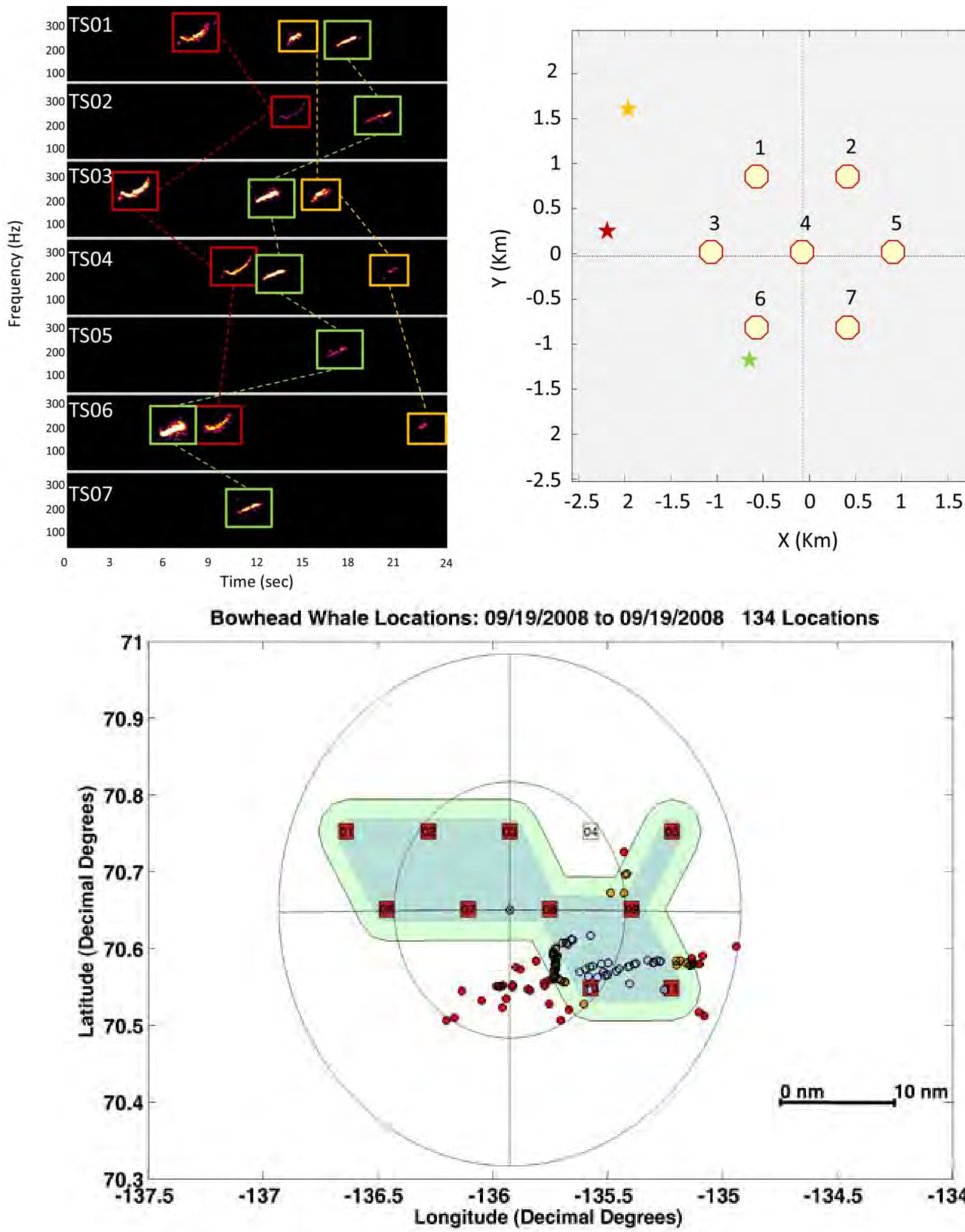

Figure 32.8. Bowhead whale calls analysis in multiple channels, to pinpoint time of arrivals and calculate the time delays to each MARU. By combining the geometry and the knowledge of acoustic propagation, the location of the calls can be determined.

33 Contaminants sampling program – Legs 1, 2a and 3b

ArcticNet Phase 2 – Project titled *Effects of Climate Change on Contaminant Cycling in the Coastal and Marine Ecosystems*. ArcticNet/Phase2/Stern_Contaminants.

Project leaders: Gary Stern[1,2] (Gary.Stern@dfo-mpo.gc.ca) and Imperial Oil (Legs 2a and 3b)
Cruise participants Leg 1: Jeffrey Latonas[2] and Debbie Armstrong[2]
Cruise participants Leg 2a: Imperial Oil, Alexis Burt[1,2], Marcos Lemes[2], Amanda Chaulk[2] and Marc Cadieux[2]
Cruise participant Leg 3a: Monika Pucko[2]
Cruise participant Leg 3b: Imperial Oil, Joscelyn N.-L. Bailey[1,2] and Joanne Delaronde[1]
[1] Fisheries and Oceans Canada (DFO), Freshwater Institute (FWI), 501 University Crescent, Winnipeg, MB, R3T 2N6, Canada.
[2] University of Manitoba, Centre for Earth Observation Science (CEOS), Wallace Building, 125 Dysart Rd, Winnipeg, MB, R3T 2N2, Canada.

33.1 Introduction

Contaminants pose a potential hazard to Arctic fish and marine mammal health, and ultimately to northerners that consume the tissues of these animals as part of their traditional diets. It is therefore imperative to better understand how climate variability in physical forcing and the biogeochemical response to this primary forcing will affect, among others, contaminant transport processes and cycling in marine environments.

33.1.1 Leg 2a – 16 July to 30 July 2009 – Beaufort Sea

The contaminants program was jointly designed and conducted by ArcticNet and Imperial Oil to collect sediment, water column and biological samples for laboratory analysis. The Imperial Oil-led component focuses on petroleum hydrocarbons, metals, sediment particle size distribution, total organic carbon, total suspended solids as well as radiometric dating. The ArcticNet-led component contributes mercury and methyl mercury analyses. Many of the ArcticNet analyses were performed onboard using the *Amundsen*'s Portable In-situ Laboratory for Mercury Speciation (PILMS) lab.

33.1.2 Leg 3a – 27 August to 12 September 2009 – Beaufort Sea

The contaminants program focused on Hexachlorocyclohexane (HCH) compounds in sea ice and in the atmosphere during Leg 3a. Technical HCH is a mixture of several isomers, the most abundant being α-HCH (60-70%), γ-HCH (5-12%) and β-HCH (10-15%). Technical HCH and pure γ-HCH (lindane, pesticide active isomer) have been used for over 50 years and are now ubiquitous in water throughout the northern hemisphere with the highest levels found in the surface water layers near pack ice in the Arctic Ocean. Technical HCH was banned or heavily restricted by China, the former Soviet Union and India between the mid-1980s and 1990. Concentrations of α-HCH in Arctic air responded quickly to these large-scale usage changes and declined by an order of magnitude from the early 1980s to mid-1990s in steps that closely matched global usage and emission estimates.

Sampling during Leg 3a was a supplement to the ice sampling campaign for HCHs conducted during the Circumpolar Flaw Lead (CFL) System Study 2007-2008. The main objective was to collect meltpond samples, air samples, and top 1 m cores of different summer ice types (old ice, first-year ice) to discuss potent contribution of air-meltpond water exchange (dry or wet) to higher levels of HCHs in the old ice.

33.1.3 Leg 4a – 8 October to 6 November – Beaufort Sea, NW Passage, Baffin Bay

Mercury (Hg) has long been known as a potent neurotoxin, and has emerged as a contaminant of great concern in the Arctic because of its presence at high concentrations in traditional food animals of Inuit people. Although global Hg emissions are declining, marine mammals in certain areas in the Canadian and West Greenland Arctic have exhibited increasing Hg concentrations during the past three decades, but with unexplained deviations in trends. For example, increasing Hg has been observed in the liver of beluga from the Beaufort Sea since 1982, peaking in 1996, and declining by about half up to 2005. There are also regional differences in Hg trends, which so far remain unexplained. The Lancaster Sound – North Water – northern Davis Strait region of the eastern Arctic is a locus of increasing biological Hg, with significant increases occurring across a range of species including beluga, ringed seal, narwhal, seabirds and polar bears.

The biomagnification of Hg throughout the aquatic foodweb is well documented; however, the cyclical behaviour of Hg in the upper ocean – atmosphere, and how abiotic Hg interacts with the marine foodweb, is not well understood. These interactions are occurring against a backdrop of rapid polar climate change, which has the potential to drastically alter Hg biogeochemical cycling and biological uptake. There is also an interest in the role of changing oceanic and terrestrial inputs/exports of Hg via glaciers and rivers into or out of specific geographical regions such as the North Water polynya, which is a biological "hot spot" for marine mammals.

<u>**Seabed sediments as archives of aquatic primary productivity**</u>

Recent studies on Arctic lake sediments have provided evidence that climate change is shifting patterns of contaminant exposure in the Arctic by, for example, altering aquatic primary production (Outridge et al. 2007). However, little is known about the mechanisms or consequences of change in Arctic marine systems. However, processes involving organic carbon in the upper ocean will likely have a large impact on marine Hg dynamics. The organic carbon cycle of marine systems is at the heart of the predicted impacts of Arctic climate change, and many of the key processes that control contaminants involve the organic carbon cycle.

J. N.-L. Bailey's PhD thesis focuses on the question of how past climate change has affected marine primary productivity and the associated scavenging of Hg from the Arctic

Ocean's euphotic zone. The project aims to gain insight into the relative importance of terrestrial vs. marine sources (primary production) of suspended particulate organic and inorganic matter in seawater, the transport and modification the organic matter undergoes after it is created or enters the ocean, the rate of Hg removal by SPOM or inorganic SPM scavenging from the upper ocean into seabed sediments, and how these processes may be modified by predicted climate change. Seabed sediments will be studied during Leg 4a as recorders of Hg – SPOM interactions in the water column over historical periods of time. Vertically fluxing Hg and SPOM (also inorganic SPM) enters sediments and, with some degree of *in situ* recycling and resuspension through horizontal transport (turbidity flows), biomixing (surface mixed layer) and diagenesis, down-core changes in sedimentary organic matter and Hg should reflect the history of these parameters in seawater, especially the euphotic zone. Thus, this work will draw on insights into nutrient and productivity studies in seawater overlying the study sites, from other parts of the ArcticNet research program.

33.2 Methodology – Imperial Oil sampling

33.2.1 Seawater sampling

Seawater samples were taken at 9 sites at two water depths, approximately 10 m and 42 m below the surface. These samples were collected using a Redi-Flow submersible pump and new, cleaned TFE lined tubing. The tubing was flushed between depths to ensure water was sampled only from the target depth.

At the beginning of each sample, 20 L of water was collected in a stainless steel container for later sub-sampling in the laboratory.

<u>Solid Phase Extraction (SPE)</u>

At each depth, the Infiltrex sampler ran a 20 L sample through a cartridge filter then a column of XAD resin. The flow was maintained at 1 L/min or less to maximize the water's exposure to the XAD resin and to prevent channelling of the water through the resin in the column. One XAD column and one cartridge filter were used for each water depth (2 of each in total) to produce two aggregate samples of the total sampling block area.

<u>Dissolved Organic Carbon (DOC)</u>

The Dissolved Organic Carbon samples were processed in the laboratory. A 200 ml sub-sample was taken from the 20 L stainless steel container. The sample was run through the DOC filter apparatus and the filter was saved for further analysis. 125 ml of the filtered sample was fixed with 1ml of hydrochloric acid and a 10ml sub-sample was taken. This 10ml sample was added stations.

<u>Total Suspended Solids (TSS)</u>

The Total Suspended Solids samples were collected in the laboratory using the reserved sample water. Between 15 and 16 litres of water was filtered through a pre-weighed 1 micron glass fiber disk filter. The flow through the filter was maintained below 1L per minute to prevent the filter from blowing through. A new filter was used at each station and each water depth.

Table 33.1. Storage and shipping of seawater samples collected for contaminants analyses during Leg 2a.

Sample type	Container	Storage	Shipping
Dissolved Organic Carbon	Amber Glass Bottle	Keep Cool	Take of ship in freezer pak coolers
Susp sed filters for PHC	Wrap filters in aluminium foil	Keep Cool	Take of ship in freezer pak coolers
SPE columns	Wrap columns in bubble wrap for transit	Keep Cool	Take of ship in freezer pak coolers
TSS on 142mm filters	Wrap filters in aluminium foil	Keep Cool	Take of ship in freezer pak coolers

33.2.2 Sediment sampling

Sediment samples were collected by removing the top centimetre from the box cores taken at 13 sites, and by taking core samples at the central site. In general, the samples were taken from one half of the box core, then the remainder was used by the ArcticNet benthic team who filtered the sediment for organisms. Any standing water was carefully removed using a piece of Teflon tubing to ensure that the sediment was not disturbed or contaminated.

Surficial sediments

Using bent spatulas (stainless steel for petroleum hydrocarbons and plastic for metals) the top 1 cm was scraped off. The sample for petroleum hydrocarbons was taken first. The sample was placed in a 250 ml glass jar. For the metals, particle size distribution and total organic carbon samples, an area of approximately 8 cm x 8 cm and 1 cm deep was placed into Whirlpak bags.

At station 23, a triplicate box core sample (three separate box cores) was taken for petroleum hydrocarbons, metals, particle size distribution and total organic carbon to assess the variability between subsequent box cores.

At station 12, a triplicate subsample (three samples from the same box core) was taken for petroleum hydrocarbons, metals, particle size and total organic carbon to assess the variability between samples taken from the same box core.

At one station, a blind duplicate subsample (from the same box core) was taken for petroleum hydrocarbons, metals, particle size and total organic carbon.

Sediment core samples

At the nominal drilling location (Station 4) sediment core samples were taken. Two stainless steel tubes and two acrylic tubes were used. One SS tube was used for the hydrocarbons, one acrylic tube was used for the metals, and the other two tubes were used for radiometric dating and TOC/particle size distribution. For each core, samples were collected for 0-1, 2-3, 5-6, 10-11, 15-16, and 20-21 cm.

Table 33.2. Storage and shipping of sediment samples collected for contaminants analyses during Leg 2a.

Sample type	Container	Storage	Shipping
Petroleum HC	250 ml glass jar	Freeze	Take of ship in freezer pak coolers
Metals	Whirlpak Bag	Freeze	Take of ship in freezer pak coolers
Particle Size	Whirlpak Bag	Keep Cool	Take of ship in freezer pak coolers
Total Org Carbon	Whirlpak Bag	Freeze	Take of ship in freezer pak coolers
Radiometric dating	Whirlpak Bag	Freeze	Take of ship in freezer pak coolers

33.2.3 Biological Samples

Biological samples were collected on an opportunistic basis. They were obtained from the trawl nets and the box cores. Depending on the size and type of sample, they were either placed in aluminium foil or glass jars for storage.

Table 33.3. Storage and shipping of biological samples collected for contaminants analyses during Leg 2a.

Sample type	Container	Storage	Shipping
Biota – fish – Petroleum HC	Wrap in aluminium foil	freeze	Take of ship in freezer pak coolers
Biota – benthos/amphipods et al	250 ml glass jar	freeze	Take of ship in freezer pak coolers

Table 33.4. Description and location of all samples collected for contaminants analyses during Leg 2a.

Stn	Latitude N	Longitude W	Depth (m)	Date and time (UTC)	Sample number	Analysis	Notes
0				07/17/09	IA09-000-W001	HC	Travel Blank
1	70°28.992	135°10.083	60	07/18/09 1317	IA009-001-S001	HC	
	70°28.992	135°10.083	60	07/18/09 1317	IA009-001-S002	Metals	
	70°28.992	135°10.083	60	07/18/09 1317	IA009-001-S003	Particle Size	
	70°28.992	135°10.083	60	07/18/09 1317	IA009-001-S004	TOC	
	70°29.216	135°04.187	60	07/18/09 950	IA009-001-W005	DOC filter	Deep sample, filtered 200ml
	70°29.216	135°04.187	60	07/18/09 950	IA009-001-W006	TSS	Deep sample, filtered 15.65l
1	70°29.216	135°04.187	60	07/18/09 950	IA009-001-W007	DOC filter	Shallow sample, filtered 200ml
	70°29.216	135°04.187	60	07/18/09 950	IA009-001-W008	TSS	Shallow sample, filtered 15.8l
	70°29.214	135°03.338	61	07/18/09 915	IA009-001-Z009	zooplankton	from vertical net
	70°29.494	135°08.397	61	07/18/09 1933	IA009-001-Z010	biology	from agasiz trawl
2	70°39.386	135°38.590	146	07/19/09 144	IA009-002-W001	TSS	Deep sample, filtered 16.9l
	70°39.386	135°38.590	146	07/19/09 144	IA009-002-W002	DOC filter	Deep sample, filtered 200ml
	70°39.386	135°38.590	146	07/19/09 144	IA009-002-W003	DOC filter	Shallow sample, filtered 200ml
	70°39.404	135°38.161	141	07/19/09 250	IA009-002-Z004	zooplankton	from vertical net
	70°39.386	135°38.590	146	07/19/09 144	IA009-002-W005	TSS	Shallow sample, filtered 15.6l

Stn	Latitude N	Longitude W	Depth (m)	Date and time (UTC)	Sample number	Analysis	Notes
	70°39.749	135°37.193	160	07/19/09 348	IA009-002-S006	HC	
	70°39.749	135°37.193	160	07/19/09 348	IA009-002-S007	Metals	
	70°39.749	135°37.193	160	07/19/09 348	IA009-002-S008	Particle Size	
	70°39.749	135°37.193	160	07/19/09 348	IA009-002-S009	TOC	
	70°39.749	135°37.193	160	07/19/09 348	IA009-002-S010	biology	from surface of box core
	70°40.057	135°37.259	189	07/19/09 415	IA009-002-Z011	fish	from agasiz trawl
	70°40.057	135°37.259	189	07/19/09 415	IA009-002-Z012	biology	from agasiz trawl
3	70°42.341	135°48.85	406	07/19/09 1310	IA009-003-W001	TSS	Deep sample, filtered 15.8l
	70°42.341	135°48.85	406	07/19/09 1310	IA009-003-W002	DOC filter	Deep sample, filtered 200ml
	70°42.341	135°48.85	406	07/19/09 1310	IA009-003-W003	TSS	Shallow sample, filtered 15.8l
	70°42.341	135°48.85	406	07/19/09 1310	IA009-003-W004	DOC filter	Shallow sample, filtered 200ml
	70°42.368	135°47.257	397	07/19/09 1535	IA009-003-S005	HC	
	70°42.368	135°47.257	397	07/19/09 1535	IA009-003-S006	Metals	
	70°42.368	135°47.257	397	07/19/09 1535	IA009-003-S007	Particle Size	
	70°42.368	135°47.257	397	07/19/09 1535	IA009-003-S008	TOC	
	70°42.436	135°47.112	400	07/19/09 1613	IA009-003-Z009	biology	from agasiz trawl
14	70°34.883	135°58.340	95	07/20/09 45	IA009-014-Z001	zooplankton	from vertical net
17	70°36.571	135°28.677	730	07/20/09 1257	IA009-017-W001	TSS	Deep sample, filtered 15.8l
	70°36.571	135°28.677	730	07/20/09 1257	IA009-017-W002	DOC filter	Deep sample, filtered 200ml
	70°36.571	135°28.677	730	07/20/09 1257	IA009-017-W003	DOC filter	Shallow sample, filtered 200ml
	70°36.571	135°28.677	730	07/20/09 1257	IA009-017-W004	TSS	Shallow sample, filtered 15.8l
	70°36.671	136°33.453	788	07/20/09 1641	IA009-017-S005	HC	
	70°36.671	136°33.453	788	07/20/09 1641	IA009-017-S006	Metals	
	70°36.671	136°33.453	788	07/20/09 1641	IA009-017-S007	Particle Size	
	70°36.671	136°33.453	788	07/20/09 1641	IA009-017-S008	TOC	
	70°36.728	136°32.426	777	07/20/09 1519	IA009-017-Z009	zooplankton	from vertical net
	70°38.132	136°34.823	875	07/20/09 1716	IA009-017-Z010	biology	from agasiz trawl
4	70°45.756	136°01.364	695	07/21/09 242	IA09-004-W001	TSS	Deep sample, filtered 15.8l
	70°45.756	136°01.364	695	07/21/09 242	IA09-004-W002	DOC filter	Deep sample, filtered 200ml
	70°45.756	136°01.364	695	07/21/09 242	IA09-004-W003	DOC filter	Shallow sample, filtered 200ml
	70°45.756	136°01.364	695	07/21/09 242	IA09-004-W004	TSS	Shallow sample, filtered 15.9l
	70°45.486	136°02.585	674	07/21/09 530	IA09-004-Z005	zooplankton	from vertical net
	70°45.320	136°01.906	667	07/21/09 711	IA09-004-S006	HC	Box core 1
	70°45.320	136°01.906	667	07/21/09 711	IA09-004-S007	Metals	Box core 1
	70°45.320	136°01.906	667	07/21/09 711	IA09-004-S008	Particle Size	Box core 1
	70°45.320	136°01.906	667	07/21/09 711	IA09-004-S009	TOC	Box core 1
		136°01.906	667	07/21/09 711	IA09-ABR1-001	HC	Box core 1 – blind replicate
		136°01.906	667	07/21/09 711	IA09-ABR1-002	Metals	Box core 1 – blind replicate
		136°01.906	667	07/21/09 711	IA09-ABR1-003	Particle Size	Box core 1 – blind replicate
	70°45.320	136°01.906	667	07/21/09 711	IA09-ABR1-004	TOC	Box core 1 – blind replicate
	70°45.320	136°01.889	667	07/21/09 639	IA09-004-S010	HC	Core - 0-1cm
4	70°45.320	136°01.889	667	07/21/09 639	IA09-004-S011	Metals	Core - 0-1cm
	70°45.320	136°01.889	667	07/21/09 639	IA09-004-S012	Particle Size	Core - 0-1cm
	70°45.323	136°01.889	667	07/21/09 639	IA09-004-S013	TOC	Core - 0-1cm
	70°45.323	136°01.889	667	07/21/09 639	IA09-004-S014	HC	Core - 2-3cm
	70°45.323	136°01.889	667	07/21/09 639	IA09-004-S015	Metals	Core - 2-3cm
	70°45.323	136°01.889	667	07/21/09 639	IA09-004-S016	Particle Size	Core - 2-3cm
	70°45.323	136°01.889	667	07/21/09 639	IA09-004-S017	TOC	Core - 2-3cm
	70°45.323	136°01.889	667	07/21/09 639	IA09-004-S018	HC	Core – 5-6cm
	70°45.323	136°01.889	667	07/21/09 639	IA09-004-S019	Metals	Core – 5-6cm

Stn	Latitude N	Longitude W	Depth (m)	Date and time (UTC)		Sample number	Analysis	Notes
	70°45.323	136°01.889	667	07/21/09	639	IA09-004-S020	Particle Size	Core – 5-6cm
	70°45.323	136°01.889	667	07/21/09	639	IA09-004-S021	TOC	Core – 5-6cm
	70°45.323	136°01.889	667	07/21/09	639	IA09-004-S022	HC	Core – 10-11cm
	70°45.323	136°01.889	667	07/21/09	639	IA09-004-S023	Metals	Core – 10-11cm
	70°45.323	136°01.889	667	07/21/09	639	IA09-004-S024	Particle Size	Core – 10-11cm
	70°45.323	136°01.889	667	07/21/09	639	IA09-004-S025	TOC	Core – 10-11cm
	70°45.323	136°01.889	667	07/21/09	639	IA09-004-S026	HC	Core – 15-16cm
	70°45.323	136°01.889	667	07/21/09	639	IA09-004-S027	Metals	Core – 15-16cm
	70°45.323	136°01.889	667	07/21/09	639	IA09-004-S028	Particle Size	Core – 15-16cm
	70°45.323	136°01.889	667	07/21/09	639	IA09-004-S029	TOC	Core – 15-16cm
	70°45.323	136°01.889	667	07/21/09	639	IA09-004-S030	HC	Core – 20-21cm
	70°45.323	136°01.889	667	07/21/09	639	IA09-004-S031	Metals	Core – 20-21cm
	70°45.323	136°01.889	667	07/21/09	639	IA09-004-S032	Particle Size	Core – 20-21cm
	70°45.323	136°01.889	667	07/21/09	639	IA09-004-S033	TOC	Core – 20-21cm
	70°45.323	136°01.889	667	07/21/09	639	IA09-004-S034	TOC	Core – 25-26cm
	70°45.116	136°03.645	664	07/21/09	653	IA09-004-Z035	biology	from agasiz trawl
10	70°47.489	135°33.780	421	07/21/09	1615	IA09-010-S001	HC	
	70°47.489	135°33.780	421	07/21/09	1615	IA09-010-S002	Metals	
	70°47.489	135°33.780	421	07/21/09	1615	IA09-010-S003	Particle Size	
	70°47.489	135°33.780	421	07/21/09	1615	IA09-010-S004	TOC	
	70°47.990	135°31.741	456	07/21/09	1702	IA09-010-Z005	biology	from agasiz trawl
23	70°53.603	134°15.907	80	07/22/09	246	IA09-023-S001	HC	Box core 1
	70°53.603	134°15.907	80	07/22/09	246	IA09-023-S002	Metals	Box core 1
	70°53.603	134°15.907	80	07/22/09	246	IA09-023-S003	Particle Size	Box core 1
	70°53.603	134°15.907	80	07/22/09	246	IA09-023-S004	TOC	Box core 1
	70°53.563	134°15.758	80	07/22/09	305	IA09-023-S005	HC	Box core 2
	70°53.563	134°15.758	80	07/22/09	305	IA09-023-S006	Metals	Box core 2
	70°53.563	134°15.758	80	07/22/09	305	IA09-023-S007	Particle Size	Box core 2
	70°53.563	134°15.758	80	07/22/09	305	IA09-023-S008	TOC	Box core 2
	70°53.459	134°15.672	81	07/22/09	325	IA09-023-S009	HC	Box core 3
	70°53.459	134°15.672	81	07/22/09	325	IA09-023-S010	Metals	Box core 3
	70°53.459	134°15.672	81	07/22/09	325	IA09-023-S011	Particle Size	Box core 3
	70°53.459	134°15.672	81	07/22/09	325	IA09-023-S012	TOC	Box core 3
	70°53.149	134°15.416	79	07/22/09	409	IA09-023-Z013	biology	from agasiz trawl
21	71°01.054	134°38.012	336	07/22/09	1638	IA09-021-W001	TSS	Deep sample, filtered 15.8l
	71°01.054	134°38.012	336	07/22/09	1638	IA09-021-W002	DOC filter	Deep sample, filtered 200ml
	71°01.054	134°38.012	336	07/22/09	1638	IA09-021-W003	DOC filter	Shallow sample, filtered 200ml
	71°01.054	134°38.012	336	07/22/09	1638	IA09-021-W004	TSS	Shallow sample, filtered 15.8l
	71°00.333	134°39.203	320	07/22/09	1825	IA09-021-S005	HC	
	71°00.333	134°39.203	320	07/22/09	1825	IA09-021-S006	Metals	
	71°00.333	134°39.203	320	07/22/09	1825	IA09-021-S007	Particle Size	
21	71°00.333	134°39.203	320	07/22/09	1825	IA09-021-S008	TOC	
	71°00.333	134°39.203	320	07/22/09	1825	IA09-021-Z009	biology	found on surface of box core
18	70°52.554	135°21.709	500	07/23/09	120	IA09-018-W001	TSS	Deep sample, filtered 15.8l
	70°52.554	135°21.709	500	07/23/09	120	IA09-018-W002	DOC filter	Deep sample, filtered 200ml
	70°52.554	135°21.709	500	07/23/09	120	IA09-018-W003	DOC filter	Shallow sample, filtered 200ml
	70°52.554	135°21.709	500	07/23/09	120	IA09-018-W004	TSS	Shallow sample, filtered 15.8l
	70°53.060	135°23.694	520	07/23/09	404	IA09-018-S005	HC	
	70°53.060	135°23.694	520	07/23/09	404	IA09-018-S006	Metals	
	70°53.060	135°23.694	520	07/23/09	404	IA09-018-S007	Particle Size	

Stn	Latitude N	Longitude W	Depth (m)	Date and time (UTC)		Sample number	Analysis	Notes
	70°53.060	135°23.694	520	07/23/09	404	IA09-018-S008	TOC	
16	70°47.880	136°38.990	1071	07/24/09	1822	IA09-016-Z001	biology	from box core
6	70°56.246	136°26.998	1014	07/25/09	700	IA09-006-W001	TSS	Deep sample, filtered 15.8l
	70°56.315	136°25.533	1022	07/25/09	631	IA09-006-Z002	zooplankton	from vertical net
	70°56.246	136°26.998	1014	07/25/09	700	IA09-006-W003	TSS	Shallow sample, filtered 15.8l
	70°56.246	136°26.998	1014	07/25/09	700	IA09-006-W004	DOC filter	Deep sample, filtered 200ml
	70°56.246	136°26.998	1014	07/25/09	700	IA09-006-W005	DOC filter	Shallow sample, filtered 200ml
	70°56.220	134°26.151	1020	07/25/09	835	IA09-006-S006	HC	
	70°56.220	134°26.151	1020	07/25/09	835	IA09-006-S007	Metals	
	70°56.220	134°26.151	1020	07/25/09	835	IA09-006-S008	Particle Size	
	70°56.220	134°26.151	1020	07/25/09	835	IA09-006-S009	TOC	
9	70°44.373	135°54.342	589	07/26/09	420	IA09-009-Z001	zooplankton	from vertical net
	70°44.392	135°54.547	592	07/26/09	518	IA09-009-S002	HC	
	70°44.392	135°54.547	592	07/26/09	518	IA09-009-S003	Metals	
	70°44.392	135°54.547	592	07/26/09	518	IA09-009-S004	Particle Size	
	70°44.392	135°54.547	592	07/26/09	518	IA09-009-S005	TOC	
5	70°50.011	136°05.287	814	07/26/09	1247	IA09-005-S001	HC	
	70°50.011	136°05.287	814	07/26/09	1247	IA09-005-S002	Metals	
	70°50.011	136°05.287	814	07/26/09	1247	IA09-005-S003	Particle Size	
	70°50.011	136°05.287	814	07/26/09	1247	IA09-005-S004	TOC	
13	70°30.117	135°40.627	68	07/27/09	458	IA09-013-Z001	zooplankton	from vertical net
12	70°38.248	135°05.511	62	07/27/09	1616	IA09-012-S001	HC	triplicate from one box core
	70°38.248	135°05.511	62	07/27/09	1616	IA09-012-S002	HC	triplicate from one box core
	70°38.248	135°05.511	62	07/27/09	1616	IA09-012-S003	HC	triplicate from one box core
	70°38.248	135°05.511	62	07/27/09	1616	IA09-012-S004	Metals	triplicate from one box core
	70°38.248	135°05.511	62	07/27/09	1616	IA09-012-S005	Metals	triplicate from one box core
	70°38.248	135°05.511	62	07/27/09	1616	IA09-012-S006	Metals	triplicate from one box core
	70°38.248	135°05.511	62	07/27/09	1616	IA09-012-S007	Particle Size	triplicate from one box core
	70°38.248	135°05.511	62	07/27/09	1616	IA09-012-S008	Particle Size	triplicate from one box core
12	70°38.248	135°05.511	62	07/27/09	1616	IA09-012-S009	Particle Size	triplicate from one box core
	70°38.248	135°05.511	62	07/27/09	1616	IA09-012-S010	TOC	triplicate from one box core
	70°38.248	135°05.511	62	07/27/09	1616	IA09-012-S011	TOC	triplicate from one box core
	70°38.248	135°05.511	62	07/27/09	1616	IA09-012-S012	TOC	triplicate from one box core
	70°38.205	135°05.122	62	07/27/09	1546	IA09-012-Z013	zooplankton	from vertical net
	70°38.248	135°05.511	62	07/27/09	1616	IA09-012-Z014	biology	found on surface of box core
0						IA009-000-W002	HC	Composite sample – shallow filter
						IA009-000-W003	HC	Composite sample – deep column
						IA009-000-W004	HC	Composite sample – shallow column
						IA009-000-W005	DOC	Composite sample – deep DOC
0						IA009-000-W006	DOC	Composite sample – shallow DOC
						IA009-000-W007	HC	Composite sample – deep filter

33.3 Methodology – ArcticNet sampling

33.3.1 Atmospheric sampling

<u>Leg 1a and 1b – 4 June to 16 July 2009 – Quebec City to Paulatuk (via Panama)</u>

During the voyage from Quebec City to Victoria via the Panama Canal (Leg 1a), gaseous elemental mercury (GEM) in the atmosphere was continuously measured using a Tekran 2537 instrument (Figure 33.1). The instrument was installed prior to departure in the scatterometer shed located on the port side of the flight deck. The inlet was composed of a funnel (to block spray) and a Teflon filter holder with a 2 µm filter and was positioned just outside of the scatterometer shed at the same level (Figure 33.1).

Figure 33.1. Left: Tekran 2537B Instrument used to measure atmospheric gaseous elemental mercury (GEM) located in the scatterometer shed. Right: Air sampling inlet.

Measurements began on 3 June and continued until reaching Victoria, BC, with a sample resolution of one every 5 minutes. The instrument was sensitive to contamination from sea spray thus during times where waves were large enough for the spray to reach the inlet, the instrument was turned off. There were two such events when the instrument was idle for the period between 21 June 10:30 UTC and 23 June 18:45 as well as between 27 June 18:10 UTC and 1 July 03:39.

The instrument calibration was checked twice with manual injections of a known amount of mercury from a Tekran 2505 calibration unit on 4 June as well as in a warmer climate on 10 June.

Upon arrival in Victoria, the instrument was taken down and moved into the foredeck container. Delays in getting mounts for gas tanks installed meant that sampling started again only on 13 July, north of Alaska. The sampling of GEM was continued until the end of Leg 2a.

Leg 2a – 16 July to 30 July 2009 – Beaufort Sea

During Leg 2a, gaseous elemental mercury (GEM) in the atmosphere was continuously measured as described for Leg 1, using a Tekran 2537B instrument located in the foredeck container.

Leg 3a – 27 August to 12 September 2009 – Beaufort Sea

To measure hexachlorocyclohexane (HCH) in the atmosphere, an air sampler was set up on the bow of the ship on the starboard side along with each ice sampling. Samples were collected on a polyurethane foam (PUF) following the glass-fiber filter (GFF). Air samples collection time ranged between 6 and 15 hours. Filters and PUFs were frozen at -20°C and shipped frozen back to the Freshwater Institute (FWI-DFO) for HCH contaminant analysis.

33.3.2 Sea ice and meltpond sampling

Leg 3a – 27 August to 12 September 2009 – Beaufort Sea

Ice samples (top 1 m of summer ice and surface ice from the meltponds) and meltpond water for HCH concentration and enantiomeric composition were collected. The samples for oxygen isotope composition ($\delta^{18}O$) and salinity were taken along with all samples. Melted ice samples and meltpond water (4-8 L) were pumped through a glass-fiber filter (GFF) followed by an ENV+ solid-phase extraction (SPE) cartridge using peristaltic pumps. The cartridges and GFFs were stored in -80°C and brought to the DFO (Winnipeg) for further chemical analysis.

Table 33.5. List of on-ice sampling activities and HCH samples collected from sea ice and meltpond water during Leg 3a.

Date	Station	Sample type
31-Aug-09	MYI1 (L1)	Meltpond 1 water
		Meltpond 2 water
		Meltpond 3 water
31-Aug-09 (cont'd)		Meltpond 4 water
		Meltpond 1 ice
		Meltpond 2 ice
		Meltpond 3 ice
		Meltpond 4 ice
		Ice top 1 m hummock
		Ice top 1 m meltpond
01-Sep-09	MYI1	Meltpond 5 water
		Meltpond 6 water
		Meltpond 7 water
		Meltpond 5 ice

Date	Station	Sample type
		Meltpond 6 ice
		Meltpond 7 ice
		Ice top 1 m hummock
		Ice top 1 m meltpond
02-Sep-09	MYI1	Meltpond 8 water
		Meltpond 8 ice
		Ice top 1 m hummock
		Ice top 1 m meltpond
04-Sep-09	FYI1	Ice core 1 (full -1m)
	(L2)	Ice core 2 (full -1m)
		Ice core 3 (full -1m)
05-Sep-09	MYI2	Meltpond 9 water
	(L2)	Meltpond 10 water
		Meltpond 9 ice
		Meltpond 10 ice
		Ice top 1 m hummock
		Ice top 1 m meltpond
06-Sep-09	FYI2	Ice core 1 (top 1m)
	(L3)	Blank 1
		Blank 2
		Blank 3
		Blank 4
09-Sep-09	MYI3	Meltpond 11 water
	(L1.1)	Meltpond 12 water
		Meltpond 13 water
		Meltpond 14 water
		Meltpond 11 ice
		Meltpond 12 ice
		Meltpond 13 ice
		Meltpond 14 ice
		Ice top 1 m hummock 1
		Ice top 1 m meltpond 1
		Ice top 1 m hummock 2
		Ice top 1 m meltpond 2

33.3.3 Seawater sampling

Leg 1a and 1b – 4 June to 16 July 2009 – Quebec City to Sachs Harbour (via Panama)

During Leg 1 preparations were made in the lab for the intensive sampling period starting on Leg 2a. The mercury clean lab was successfully installed on the flight deck during the mobilization of the ship in Quebec City. The operation lab was certified by a technician from Microzone before departure on 2 June. The water lines were connected en route and proper operation of the Milli-Q water filtration system was confirmed. During Leg 1b, the Tekran 2600 used for sampling mercury in liquid samples was prepared and cleaned for water sampling starting on Leg 2a.

Leg 2a – 16 July to 30 July 2009 – Beaufort Sea

During Leg 2a, samples were collected from the marine water column in the Ajurak lease block from seven locations (Table 33.6 and 32.7). Samples from the 10 m depth to the seafloor were collected with the Rosette's Niskin bottles. Supplementary 'Surface' samples from 0 to 10 m in depth were collected using a PVC Niskin water sampling bottle (General Oceanics, Miami, Florida) via the Zodiac at least one hundred meters away from the ship and within 3 hours of the Rosette collection (Figure 33.2). Within each profile, 11 to 20 different depths were sampled (including Niskin sampling), producing high resolution profiles for 'total Hg' (Hg_T). At each depth sampled for Hg_T, water was also collected for δ^8O analysis in tightly sealed glass scintillation vials. After collection of δ^8O samples, bottles were further sealed with Parafilm and stored at 4°C. Water for methyl mercury analysis was also collected at four stations (Table 33.7).

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igure 33.2. Surface sample collection using the Zodiac and a Niskin bottle.

After collection of marine water for Hg_T analysis, samples were spiked with ultra-pure 0.5% HCl (JT Baker, Phillipsburg NJ) and 0.5% BrCl and stored at 4°C. Hg_T samples were subsequently analyzed by cold vapour atomic fluorescence spectrophotometry (CVAFS) within 48 hours of collection in the Portable In Situ Laboratory for Mercury Speciation (PILMS) onboard the CCGS *Amundsen*. Analysis followed the guidelines of the US EPA Method 1631.

Table 33.6. Sampling location and date for marine water Hg_T measurements during Leg 2a.

Station	Date in 2009	Latitude N	Longitude W	Bottom depth (m)	Number of depths sampled
1B	July 18	70º28.852	135º07.460	51	10
3B	July 19	70º42.342	135º48.125	404	23
17B	July 20	70º36.535	135º29.657	730	27
23B	July 21	70º53.815	135º16.078	82	13
20B	July 23	71º00.938	135º20.742	645	25
6B	July 25	70º56.156	136º25.766	1020	25
12B	July 27	70º38.393	135º06.006	61	10

Table 33.7. Sampling location and date for marine water Methylmercury (MeHg) measurements during Leg 2a.

Station	Date in 2009	Latitude N	Longitude W	Bottom depth (m)	Number of depths sampled
3B	July 19	70º42.342	135º48.125	404	23
17B	July 20	70º36.535	135º29.657	730	27
6B	July 25	70º56.156	136º25.766	1020	25
12B	July 27	70º38.393	135º06.006	61	10

33.3.4 Biological sampling

Leg 2a – ArcticNet/IORVL – 16 July to 30 July 2009 – Beaufort Sea

Zooplankton were sampled from the whole water column using the vertical net tow (Monster Net: 1 m^2 200 µm mesh, see Figure 30.1 in Section 29) at Stations 1, 3, 17, 23, 20, 16, 6, 7, and 12. Species of interest included: *Calanus hyperboreus*, *C. glacialis*, *Paraeuchaeta glacialis*, *P. barbata*, Chaetognaths (including *Sagitta elegans*, *S. maxima*, and *Eukrohnia* sp.), *Themisto libellula*, *T. abyssorum*, *Cleone limacina*, Ostracoda, *Appendicularia* sp., Jelly fish, Amphipods, Decapods (Family Crangonidae and Mysidae). Samples collected with the net were separated to species on board and frozen at -20°C for transport to the Freshwater Institute (DFO) in Winnipeg, where they will be analyzed for mercury and methyl mercury.

Benthic invertebrates were collected from the sieved top portions of box cores (0.25 m X 0.5 m X ~0.1 m) at Stations 1, 3, 17, 23, 20, 16, 6, 7, 9, and 12. Invertebrates were also provided by members of the P. Archambault group (UQAR) from Agassiz trawls at Stations 1, 3, 17, 4, 10, 23, 8, 20, 9, and 13. Benthic taxonomists were not available, thus species identification was limited. Groups of interest included: Asteroidea (sea stars), Ophiuroidea (brittle stars), molluscs, isopods, amphipods, and polychaete worms.

Leg 4a – 8 October to 6 November – Beaufort Sea, NW Passage, Baffin Bay

The main purpose of this study in Leg 4a was to link physical and biological processes to mercury levels in the food web and to target the pelagic food web biomagnification and bioaccumulation of mercury with stable isotopes and fatty acids. Thus, all biological samples collected will be measured for total mercury and MeHg along with stable isotopes to place organisms into their associated trophic levels. These analyses will be performed at the Freshwater Institute, DFO, in Winnipeg.

Biological samples were collected at Basic and Full stations along the cruise transect: Stations 437, 408, 405, 450, 308, 323, 103, 105, 109, 111, 115, 136 and 141. These stations represent a large sampling area beginning in the Western Arctic (the south-eastern Beaufort Sea and Amundsen Gulf), throughout the Northwest Passage and finally the Eastern Arctic in Baffin Bay.

Zooplankton was collected using the vertically towed Monster Net (200 µm mesh size) designed for integrated water column sampling. When ice conditions allowed, the oblique Tucker net (750 µm mesh size) was deployed, providing water column zooplankton samples from the upper 100 m layer. The Rectangular Mid-water Trawl (1600 µm net) was deployed only at Full stations. The RMT is designed to catch larval and juvenile fish, and was used by the Université Laval zooplankton and fish team. The subsequent catch of larger zooplankton species (mostly *Themisto libellula*) were kept for contaminant studies. Immediately after collection, individual zooplankton species were sorted into plastic vials and frozen at -20°C.

33.3.5 Sediment sampling

Leg 2a – 16 July to 30 July 2009 – Beaufort Sea

Two sediment cores were taken from the box core at Stations 23B (60 m) and 20B (750 m) using a 4” diameter PVC pipe. The sediment was pushed through the core using a tight fitting plunger and scraped into Ziploc bags at 1 cm increments for the first 1-10 cm interval, and then 2 cm increments for 10-20 cm. The samples were frozen at -20°C and will be analyzed for mercury and methyl mercury in Winnipeg.

Pore water from sediment samples was collected at two stations during Leg 2a (Stations 23B (60m) and 20B (750m)) with the help of the Boxcore Team from Université Laval. Falcon tubes were pushed into the sediment core to collect the sediment every two centimetres. The tubes were rinsed and centrifuged for 40 minutes at 3200 rpm to isolate the pore water. The pore water was decanted using a pipette in the airlock of PILMS into 10 mL Teflon bottles for methyl mercury analysis and frozen immediately. The remaining was decanted into a Falcon tube and diluted 10x for total mercury analysis. Most tubes had to be centrifuged twice to extract enough pore water.

Leg 4a – 8 October to 6 November – Beaufort Sea, NW Passage, Baffin Bay

The sedimentary organic matter being studied was mostly seabed sediment retrieved by box core (see Sections 35 and 36 for details on box core operations). Sediment cores where collected in duplicate by push core from box cores retrieved from six sites in the Amundsen Gulf (Stations 408 & 437), Lancaster Sound (Stations 304 & 323), the NOW Polynya (Station 109), and Scott's Inlet (Station 141) (Table 33.8). These cores have been sliced as 0.5 cm intervals in the upper 10 cm, then at 1 cm intervals thereafter. The samples are frozen at -80°C, awaiting detailed geochemical analyses in the Geological Survey of Canada and the University of Manitoba. Various organic geochemical techniques are planned to characterize the sedimentary organic matter in the samples. Bulk properties such as organic and inorganic carbon content, nitrogen content, stable isotope ratios ($\delta^{13}C$, $\delta^{15}N$), and trace and major elements will be determined. A geochronology for the sediment cores will be established using ^{210}Pb, ^{226}Ra, and ^{137}Cs in the upper cores, and radiocarbon dating by accelerator mass spectrometry at intervals below the point of ^{210}Pb extinction (before ~1850 AD). Inorganic chemical analysis includes Hg and a suite of other trace and minor elements to aid in interpretation of the Hg profiles. Organic contaminant analyses may also be carried out depending on sediment availability and contaminant concentrations present.

Table 33.8. Sediment coring stations and core information for contaminants samples collected during Leg 4a.

	Station data				Site information					Core data	
Site #	Stn ID	Box drop #	Station type	Cores	Date in 2009 (GMT)	Time (GMT)	Latitude N	Longitude W	Depth (m)	Last slice Core A (cm)	Last slice Core B (cm)
1	408	3	Full	2	14/10	03:41	71° 17.212	127° 47.892	150.9	38-39.5	38-39
2	437	2	Full	2	13/10	02:04	71° 47.095	126° 30.224	326.4	30-31	30-31
3	304	1	Full	2	24/10	03:38	74° 19.022	091° 24.151	333.0	40-41	45-46
4	323	1	Full	2	25/10	17:07	74° 11.010	080° 37.951	780.9	41-42	37-38.5
5	109	1	Full	2	28/10	16:03	76° 17.510	074° 07.342	454.5	13-14.25	18-19
6	141	1	Full	1	02/11	00:19	71° 22.970	070° 09.273	413.0	25-26	21-22

33.4 Preliminary results

33.4.1 Atmospheric sampling

The average value for GEM for the entire Leg 1 (Quebec City to Sachs Harbour via the Panama Canal) was approximately 1.2 ng/m^3. During Leg 2a, atmospheric GEM was usually around ~1.3–1.7 ng/m^3. During deployment of the moorings (and launch of the Zodiac) and increased activity on the foredeck, concentrations were seen to increase to ~4 ng/m^3.

33.4.2 Seawater sampling

Total mercury (Hg_T) levels in the Amundsen Gulf measured during Leg 2a were very low, averaging roughly 1 pM (0.2 ng/L) throughout the water column. These values are comparable with the lowest concentrations of Hg_T observed in the global oceans (e.g., the Pacific and North Atlantic Oceans), and somewhat lower than those observed in coastal oceans and regional seas (e.g., the Baltic and the Celtic Seas, Hudson Bay).

33.4.3 Sediment sampling

Preliminary results showed a 10x dilution was not enough, samples from Station 23B were diluted a further 100X (making the dilution 1:1000) and run on the Tekran 2600 to be analyzed for total mercury. Preliminary results show the total mercury in pore water ranges from 5 ppt to 8 ppb. Both profiles showed a sub-surface peak in total mercury. Methyl mercury samples were frozen to be taken back to Winnipeg and analyzed.

34 Seabed mapping – Legs 1b, 2a, 2b, 3b, 4a and 4b

ArcticNet Phase 2 – Project titled *The Canadian Arctic Seabed: Navigation and Resource Mapping*. ArcticNet/Phase2/Hugues_Clarke_Seabed_mapping.

Project leaders: John Hughes Clarke[1] (jhc@omg.unb.ca), Steve Blasco[2] (Steve.Blasco@NRCan-RNCan.gc.ca), and Imperial Oil (Legs 2a and 3b)
Cruise participants Leg 1b: Doug Cartwright[1], Ian Church[1] and James Muggah[1]
Cruise participants Leg 2a: Imperial Oil, Jonathan Beaudoin[1] and Travis Hamilton[1]
Cruise participants Leg 2b: Jonathan Beaudoin[1] and Travis Hamilton[1]
Cruise participants Leg 3b: Imperial Oil, John Hughes Clarke[1], Ian Church[1], Reenu Toodesh[1] and James Muggah[1]
Cruise participants Leg 4a: Angus Robertson[2], Katie Blasco[2], Doug Cartwright[1] and Christine Legere[1]
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34.1 Introduction

34.1.1 Leg 1b – 30 June to 16 July 2009 – Victoria to Paulatuk

The Ocean Mapping Group was on board for Leg 1b primarily to test upgraded equipment and perform a preliminary survey in the Beaufort Sea. The Kongsberg EM302 multibeam echosounder and POS/MV motion sensor have both been recently upgraded and were tested throughout the cruise. A preliminary survey was completed in the Ajurak lease block area in the Beaufort Sea. In addition, bathymetric and sub-bottom data was collected along the entire leg from Victoria, British Columbia, to Sachs Harbour, Northwest Territories.

34.1.2 Leg 2a – 16 July to 30 July 2009 – Beaufort Sea
Leg 3b – 12 September to 8 October 2009 – Beaufort Sea

The Ocean Mapping Group was on board for Leg 2a to opportunistically collect reconnaissance bathymetric and sub-bottom data in the Ajurak lease block in preparation for a dedicated mapping effort during Leg 3b. Support for science operations was also provided when necessary, either through additional contextual mapping or real-time confirmation of depth/position of mooring equipment using the EM302 water column imaging capability (new this year to the *Amundsen*).

34.1.3 Leg 2b – 30 July to 27 August 2009 – Beaufort Sea

The Ocean Mapping Group was on board for Leg 2b to opportunistically collect reconnaissance bathymetric and sub-bottom data along the Mackenzie Shelf in support of the ArcticNet project's effort to map the Canadian Arctic waters. Support for science operations was also provided when necessary, either through additional contextual mapping or real-time confirmation of depth/position.

34.1.4 Leg 4a – 8 October to 6 November – Beaufort Sea, NW Passage, Baffin Bay Leg 4b – 6 November to 18 November – Labrador fjords

The Ocean Mapping Group's primary objective is to provide mapping and sub-bottom profile data to the ArcticNet participants. In addition this year, the group has been collecting acoustic water column imaging data for oceanography, geology and search and recover purposes.

34.2 Methodology – Seafloor mapping operations

34.2.1 Equipment onboard the CCGS Amundsen:

- Kongsberg EM302 30 kHz multibeam echosounder
- Knudsen K320R 3.5 kHz sub-bottom profiler
- Applanix POS/MV 320 motion and orientation sensor
- C&C Technologies CNAV GPS
- AML Smart Probe surface sound speed probe
- Honeywell Precision digital Barometer

<u>EM302 Multibeam Echosounder</u>

A 1° x 2° EM302, flush-mounted to the hull was used for all multibeam mapping operations. This is an upgrade from the EM300 which provides several improvements. The most important differences are: the use of frequency modulation, the ability to record full water column data and the ability to measure 2 full swaths for every ping. The use of frequency modulation (or "chirp") in the acoustic signal provides the ability to attain wider swath widths while in deeper waters as well as providing an improved range resolution. Water column data can be used to image oceanographic information, fish and other biota in the water column. Most practically, the water column capability can be used to accurately locate objects in the water such as moorings, box cores and remotely operated vehicles. The ability to measure 2 swaths per ping means that the data density is double that of the previous system (Figure 34.1).

The system utilized a swath up to +/-60°. The normal +/-70° of an EM302 is not available on the *Amundsen* due to the addition of titanium polymer ice-reinforcing windows. The receive array is mounted on the port side tilted up 6° from horizontal to accommodate the non flat hull form. This resulted in a slight curl (within specification but notable) to the outer edge of the swath on starboard side. The system utilized multiple sectors to achieve two full swaths in a single ping cycle. The pair of swaths were steered forward and back respectively to achieve an even along-track density.

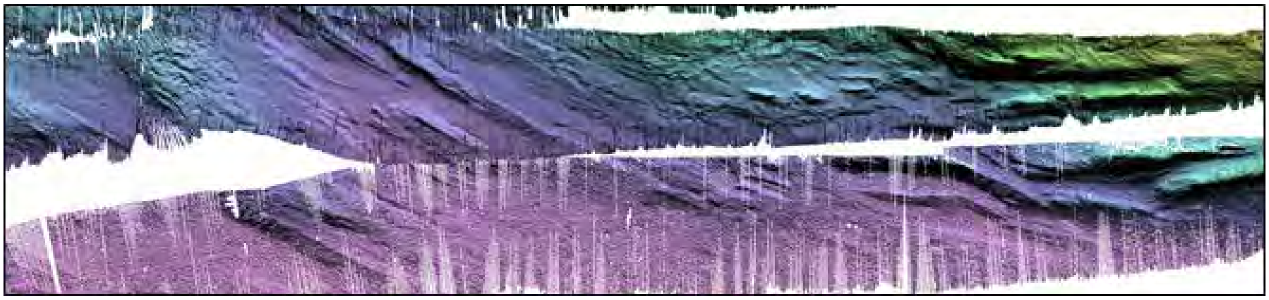

Figure 34.1. Multibeam lines illustrating difference in data density between EM300 (lower line) and EM302 (upper line) under similar sea states.

The sonar operated in 3 modes in the depth ranges seen in the area:

- Shallow Mode - 4 sectors per swath 2ms CW pulses (750Hz bandwidth) - 26.5 to 33.6 kHz
- Medium Mode - 4 sectors per swath 3ms CW pulses (500Kz bandwidth) - 26.5 to 31.3 kHz
- Deep Mode - 8 sectors per swath, 7ms CW for centre 4 sectors 25-40ms FM pulse for outer 4 sectors (all 200 Hz bandwidth) - 26.5 to 32.5 kHz

Shallow mode was used by default in less than 200 m. Deep mode was used by default for depths greater than 600 m. In poor sea states, the system was manually forced to deep mode in depths greater than 300 m to help maintain bottom tracking and swath width.

<u>Knudsen K320R 3.5 kHz Subbottom Profiler</u>

All subbottom profiling was performed using a Knudsen 320R 3.5 kHz system. It utilized a 16 element (4x4 Massa TR-1072A) array shooting through the hull (1/2 inch steel). A max ping period of 0.5 seconds was set, although with the 12ms chirp pulse used, the duty cycle limited the system to 1 Hz pinging. The K320R was synchronized to the EM302 (master). The system utilized a 2-7 kHz bandwidth. Sub bottom data was converted in real time and converted to imagery daily for data quality assurance.

Heave correction: Heave was first provided on day JD262. The heave provided from the POS was a custom lever armed solution from the IMU the 3.5 kHz location (~30 m forward and 16 m down from the RP). The Knudsen transceiver had a tendency to lose the heave string after around 24 hours. The operator had to notice this (hard in low sea states) and it required a restart of the transceiver to bring it back.

During the cruise, an increasing number of heave spikes was observed. The reason was not understood. The same serial heave data stream was logged and used by the Fugro Starfix processing package. That data was analysed for an equivalent time window and no spikes were noted. It was suspected that cause lies with the K320R transceiver. Reboots didn't help.

Draft correction: 6.7 m was used for all post processing.

Sound velocity correction: In real time, the default Arctic shelf value of 1465 m/s was used for depth estimation. This is an underestimation of the harmonic sound speed for the deeper water (1480 ms++). The original two-way travel time can be recovered from the data knowing the input sound speed.

Bottom tracking and range phasing: The K320R did its own bottom tracking. This was used in real time for adjusting the phasing of the logger (the 200 m window). The biggest concern was that the system did not phase up or down until ¾ of the available viewed range was water column. This was designed for simple echo sounding. As a result, when going downhill, there may be as little as 50 m of subbottom record preserved just before phasing. Manual override of the phasing was implemented whenever the operator noticed the issue.

Also, in post processing the bottom track was used for masking the water column in the creation of fence diagrams. In all but very soft sediments the tracking was at the sediment surface.

Positioning: Up to 18 September 1910 UTC, the antenna CNav solution fed into the Knudsen. After that point, at the request of Fugro, a Starfix solution was used, lever-armed from the antenna to the position to the transducer. This had occasional problems – (line 0184 - 16000 offshore) when the solution was disabled (?). This was solved in post-processing by remerging the C-Nav, once the clock offset had been estimated (see below). Also for an indeterminate period, the lever-armed solution was wrong.

<u>POS/MV</u>

Vessel orientation, heave and inertially-smoothed differential GPS was provided by the POS/MV system. It received its RTCM differential corrections from the C-Nav receiver. It was upgraded from a POS v.3 to a POS v.4 in May. This made the system noticeably more robust than in previous years. Throughout the whole cruise, only two POS glitches were noted:

- Lost DGPS on one line (CA solution still within 2m RMS anyway)
- On line MB 0375 the POS GPS receiver lost all satellites so that POS went onto DR mode – C-Nav antenna solutions were unaffected so used to replace the POS position for this period.

Delayed (“True”) Heave was logged for the entire operation. In this case it was not necessary to apply as all work was deep-water operations.

CTD-Rosette

As the MVP was not functional at the start of the expedition, the Rosette's CTD was used to make sound speed measurements. This cost 45-60 minutes per cast and to match deck crew scheduling, only two casts per night were usually taken (at the start of mapping at ~2000 and at termination around ~0700). While this was an advantage for the oceanographic community, about ~15% of mapping time was lost. The original aim was to use the ODIM MVP which can be deployed while underway. Hardware issues, outlined below, however, precluded this.

MVP

Despite requests to have the MVP operational (originally for Leg 1b), it had not been tested as of the start of Leg 3b (started mapping on JD257). Initial tests revealed a missing spring in the brake so one had to be jury-rigged. The first deployment (~JD260) went into the bottom (brake failed). Only on JD 272 (29 September) was the MVP usefully used and a successful profile was run along the shelf edge (in water depths less than 100 m) for a period of 4 hours. The following night, it became apparent that, if the full cable length were used (required for depths over ~200 m) the drag on the cable was too great for the brake at usual survey speed (13.5 knots). As a result, the choice was between surveying at slower speeds (10 knots) and losing ~25% of our coverage, or not using the MVP. As Error analysis of the CTD had revealed reasonably stable lower water masses and the system was normally only using the inner +/-55° sector of the swath, the decision was taken to stay with CTD casts.

On the last survey night, the decision was again taken to deploy the MVP over the field of active gas seeps in 70 to 80 m of water. A specific 2-hour long line was chosen and run at 9 knots to allow safe MVP operations. Unfortunately after 30 minutes of deployment, the brackish surface waters running through the outer sheave froze the block solid. Thus is became apparent that, even if the brake had been fully functional, the MVP could not have been used as it is not able to operate in air temperature less than -5°C.

34.2.2 Onboard logging and processing procedures

Leg 1b – 30 June to 16 July 2009 – Victoria to Sachs Harbour

Multibeam and sub-bottom profiler collection began shortly after leaving Victoria. Both the multibeam and sub-bottom systems were logged continuously throughout the entire transit. In addition the following data was logged during the transit:

- raw CNAV GPS data
- ASCII NMEA CNAV GPS data
- POS/MV heave data
- Barometric data

The EM302 data was logged in the Kongsberg raw format and converted to the OMG format after line completion (new survey lines were automatically generated every hour). The soundings were cleaned and inspected in near real-time with the 3 team members maintaining a 24-hour watch throughout most of the cruise.

The K320R data was logged in the Knudsen binary and SEGY formats. Data were converted to OMG format.

<u>Leg 2a – 16 July to 30 July 2009 – Beaufort Sea</u>

Multibeam and sub-bottom profiler acquisition began immediately after leaving Sachs Harbour, both systems were logged continuously throughout the entire leg except during stationary science sampling operations. In addition the following data was logged at all times:

- CNAV GPS
    - pseudo-ranges
    - NMEA
- POS/MV delayed heave
- Air pressure for correction of inverse barometer effect

The EM302 data was logged in the Kongsberg raw format and converted to the OMG format after line completion (new survey lines were automatically generated every hour). The soundings were visually inspected and filtered in near real-time with the 2 team members maintaining a 24-hour watch throughout most of the cruise.

CTD casts were available for the science stations, but were not available immediately for input into the MBES acquisition system (SIS) for refraction correction (see results section below). Multibeam soundings were corrected for refraction in real-time with sound speed profiles derived from average temperature and salinity profiles from the ¼° World Ocean Atlas (WOA 2001) until CTD casts were available for input to the acquisition system (described in Beaudoin 2008). An uncertainty analysis was performed in order to assess the impact of using the WOA01 casts in lieu of actual measurements. This procedure is fully described in Beaudoin (2006), however a brief description is warranted.

Observed casts from 24 CTD stations in Leg 2a and 161 casts in Leg 2b were used as a sample of actual conditions; these were compared to WOA01 profiles for the same date/location using a raytrace simulator which mimics the sounding geometry of the EM302 system onboard the CCGS *Amundsen*. The discrepancy between raytraced solutions was monitored over the entire water column and was reported as a series of bias profiles (see results section below).

In Leg 2a, the worst-case observed bias (for the outermost beam of the 120° sector) was observed to be 1.5 m in depth and 2.5 m in horizontal whereas worst-case bias for nadir was 0.75 m. In Leg 2b, the worst-case observed bias (for the outermost beam of the 120° sector) was observed to be 1.1 m in depth and 1.7 m in horizontal whereas worst-case bias for nadir was 0.5 m. In most cases, the biases were less than 0.5 m, 1.0 m and 2.0 m for nadir beam depth, outer beam depth and outer beam horizontal, respectively (see Figure 34.5).

A tidal correction was applied in real-time using the WebTide tidal model as described in Beaudoin (2008). Tidal signals are known to be significantly modified by the presence of sea ice. The tidal correction, though small, could be biased due to an unknown phase lag of the tidal signal due to the heavy ice cover in the area. Raw GPS pseudo-ranges and barometric pressure were logged for a continuing investigation into the use of GPS height for WebTide validation and/or tidal reduction as described by Church (2009).

The K320R data was logged in the Knudsen binary (.keb) and SEGY (.sgy) formats. Data were converted to OMG format. The Knudsen was set to run in "Auto-phase" mode; this mode of operation records a 200 m range of signal return (to maximize range resolution), loosely centered about the bottom detection. The range window (e.g. 0-200 m, 100-300 m, 200-400 m) was automatically changed to accommodate changes in topography. The SEGY format does not allow for this type of range change within a file (though the Knudsen binary format does), thus several .sgy files may exist for a single .keb file.

<u>Leg 3b – 12 September to 8 October 2009 – Beaufort Sea</u>

Sound speed reduction: The original plan of using the MVP-300 for all sound speed measurements was not possible due to hardware issues. As a result the Rosette's CTD was used. Normally two profiles were obtained each day, costing ~1.5-2 hours of mapping operations. The evening CTD solution was used for real time processing (results presented at end of cruise). Routine post-cruise reprocessing for ArcticNet may blend the evening and morning CTD's on a time basis if required. As most of the operations were conducted at swath sectors less than 55° this shouldn't be necessary. For all operations, the surface sound speed probe was functional and clearly indicated the rapidly changing near surface sound speeds. The inshore areas were generally faster (warmer) with a pronounced gradient in the vicinity of the shelf edge. Analysis of the deeper CTD profiles indicated that the majority of the variability was confined to the near surface ~ 50 m layer. Below that depth the sound speed structure was remarkably stable so that for the deeper depths surveyed, the impact was minimal.

Tidal reduction: The Arctic-8 WebTidal model was used for all tidal reductions. Tides in this part of the Beaufort Sea are generally less than +/-50 cm so had little impact on the accuracy. C-Nav RTG ellipsoid height solutions were collected at all times. When corrected to the geoid, they indicated a faint tidal signature but the noise was at the same level. Post-cruise reprocessing of the raw GPS observables (logged at all times) through PPP may be done if there is interest.

Bathymetric data processing: All EM302 data was processed immediately after acquisition using the OMG swathed toolkit. The raw .all data were converted to the OMG "merged" format and the POS RP navigation solution was merged for each shot. Bathymetric data cleaning in line mode was performed (pre-defluffed and median filtered before interactive editing) and a daily grid updated. Gridding of overlapping swaths was weighted based on beam # decaying to the outermost beams. For the purposes of grid interpolation, the beam footprint was calculated based on a nominal projected 1° beam at that depth and incidence angle. In the creation of the final shipboard grid, regional survey lines (057.4° and 237.4° azimuth) were separated from transits and priority corridors. The final grid reflects primarily regional survey lines with additions of opportunistic transits and priority line segments where their data quality exceeded the regional data (i.e. during storm windows). Regional 1000m spacing data from JD 261/262 (during the 35 knot gale) was almost entirely resurveyed (on JD276) and thus removed from the data. The resurvey on JD276 was partly affected by ice ribbons and thus a few small data gaps remain in the upper slope (200-400m) region. Data from the JD 277 gale (30 knots) remained in the data in the NE area as there was no other data in that region.

Outside the core area defined by IOL, the data quality was quite sea state dependent. The grid at 15 m resolution showed some of this sounding noise. It should be borne in mind however, that the typical ribbing seen in the data was at the +/-0.2% of depth range (well within the +/-0.75% for IHO Special Order surveys). The decision was taken to grid at this finer resolution (3% of Z at 500 m) as, in the lower sea state periods, there was clearly resolvable morphology.

34.2.3 Mapping procedures and system performance

Leg 1b – 30 June to 16 July 2009 – Victoria to Sachs Harbour

Data quality during the transit from Victoria to the Aleutian Islands was somewhat marginal due to the 16 knot vessel speeds, the depths encountered and prevailing weather conditions. In the shallower waters from the Aleutians to Sachs Harbour, the EM302 performed well when the ship was not breaking ice. The multibeam backscatter had some calibration issues that will be investigated further.

For the entire length of the transit, a strip chart summary was maintained in order to view coverage and data quality (see Figure 34.3).

A significant amount of sea ice was encountered in the Ajurak lease block in Leg 1b but nevertheless it was possible to collect useful sub bottom data. The multibeam data was marginal however.

Legs 2a and 2b – 16 July to 27 August 2009 – Beaufort Sea

Data quality of the EM302 and K320R were acceptable in ice free areas, however much of the Ajurak block was covered with sea ice. Data collected during icebreaking was, in general, quite poor. Bathymetric and backscatter artifacts were observed in the multibeam data and generally coincided with inter-sector boundaries (see Figure 34.6 and 33.7). The bathymetric artifacts can be manually removed, however, this is labour intensive.

Backscatter artifacts may be corrected with upgrades to existing OMG beam pattern normalization software (currently does not fully support EM302).

34.3 Preliminary results

34.3.1 Leg 1b – 30 June to 16 July 2009 – Victoria to Sachs Harbour

Figure 34.2. Map with cruise track and location of the short seabed mapping activities during Leg 1b.

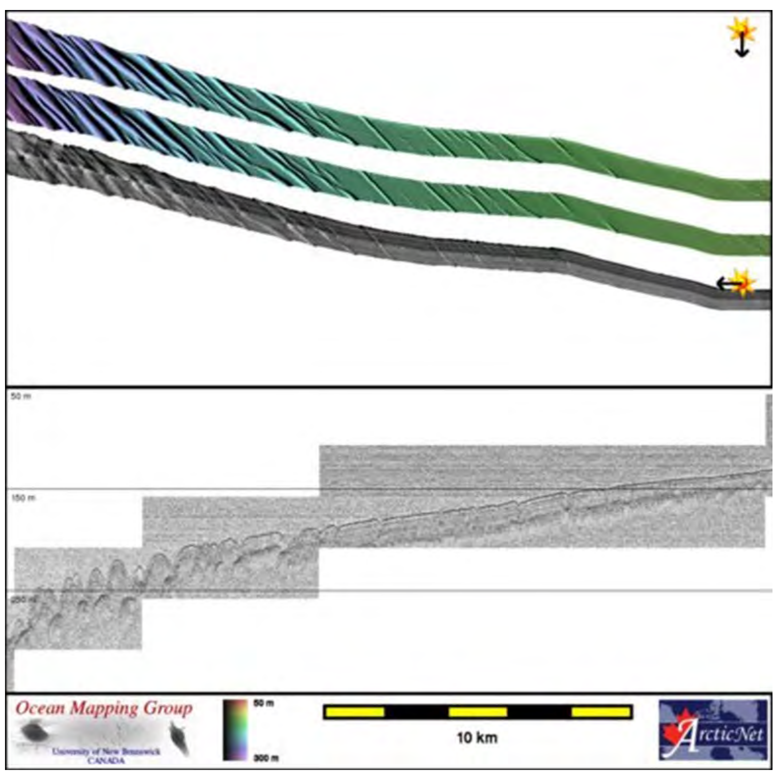

Figure 34.3. Example of strip chart data summary generated during transit seabed mapping in Leg 1b (area in the red box in the map above).

34.3.2 Leg 2a – 16 July to 30 July 2009 – Beaufort Sea

The last cast of the field program (plotted in blue in Figure 34.4) differed significantly from all other casts (though it was in close proximity to casts from previous days during the cruise). The discrepancy could be due to problems with the pressure sensor. It could also be explained as an upwelling event, however an upwelling event of this magnitude has not been observed in any prior field season at this time of year (upwelling is typically associated with high winds during October and November). Unfortunately, it was not possible to acquire a second cast to support either hypothesis.

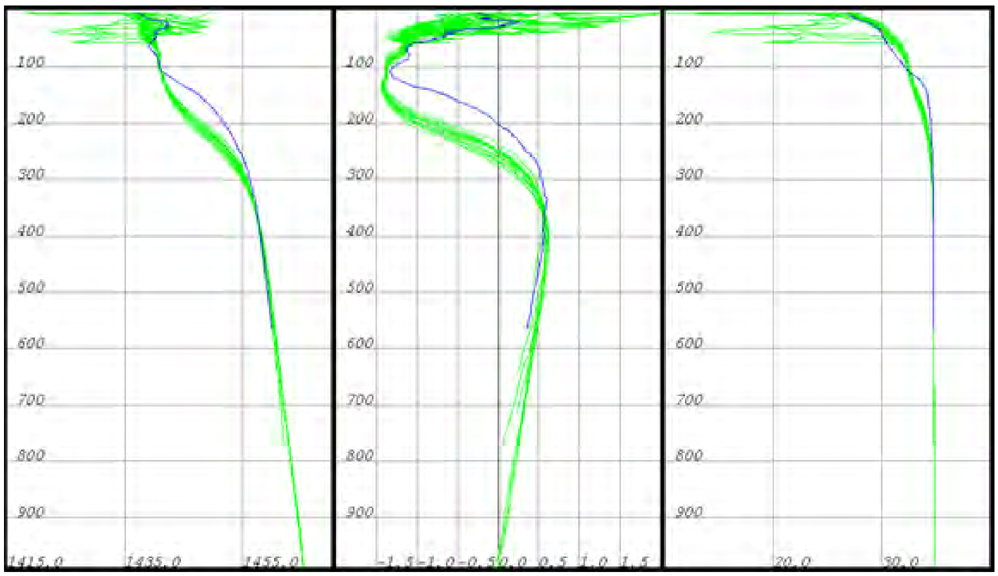

Figure 34.4. Leg 2a profiles of sound speed, temperature and salinity from 24 CTD stations throughout the Ajurak block. The last cast of the field program is plotted in blue and differs significantly from other casts.

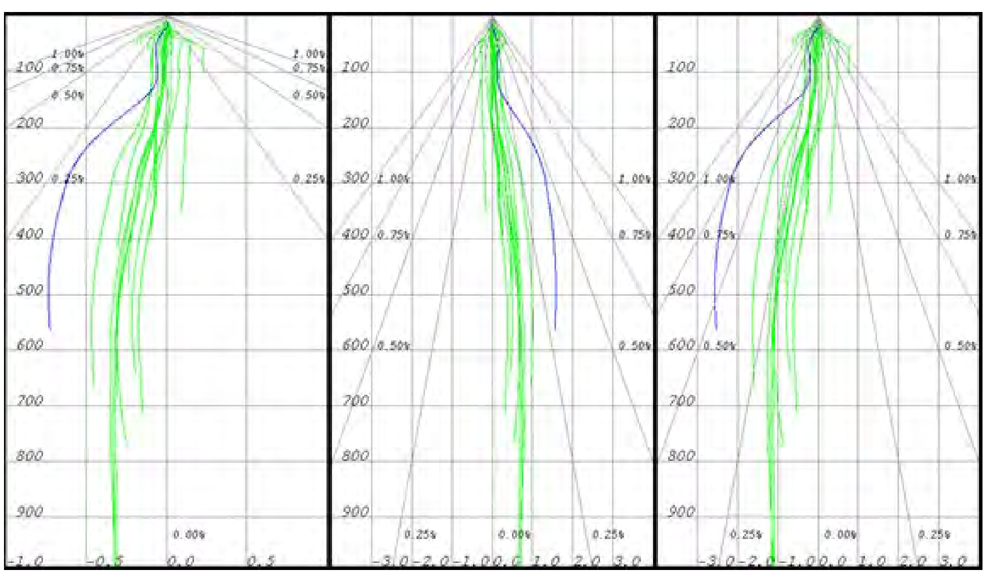

Figure 34.5. Leg 2a bias profiles for nadir depth, outerbeam depth and outerbeam horizontal solutions for 24 comparisons of CTD observations against WOA01 predictions. The worst-case bias (in blue) was observed with CTD cast 22, the so-called “upwelled” cast discussed below.

Due to the relatively shallow water and the low frequency of the multibeam sounder, penetration into seabed can occur, causing the sounder to mistrack sub-bottom layers in the nadir region for much of the survey block area. The nadir “bulge” in Figure 34.7 provides a good example; these overly deep soundings are automatically filtered in post-processing, however, the filter is overly aggressive in significant topography and necessitates interaction to reclaim valid soundings.

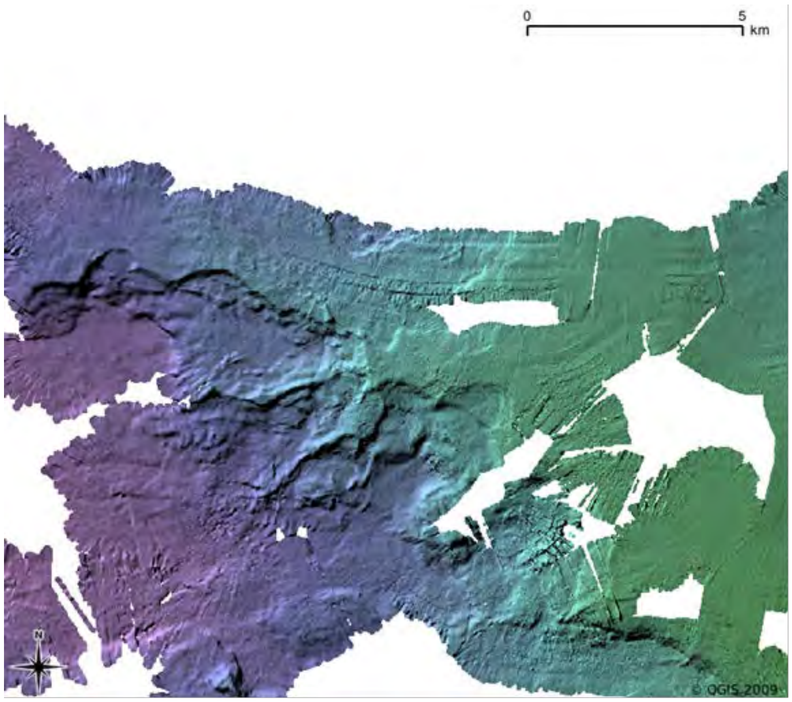

Figure 34.6. Sample mistracking artifacts along the northernmost line in the Ajurak block during Leg 2a, refer to upper central portion of image just north of the slump feature.

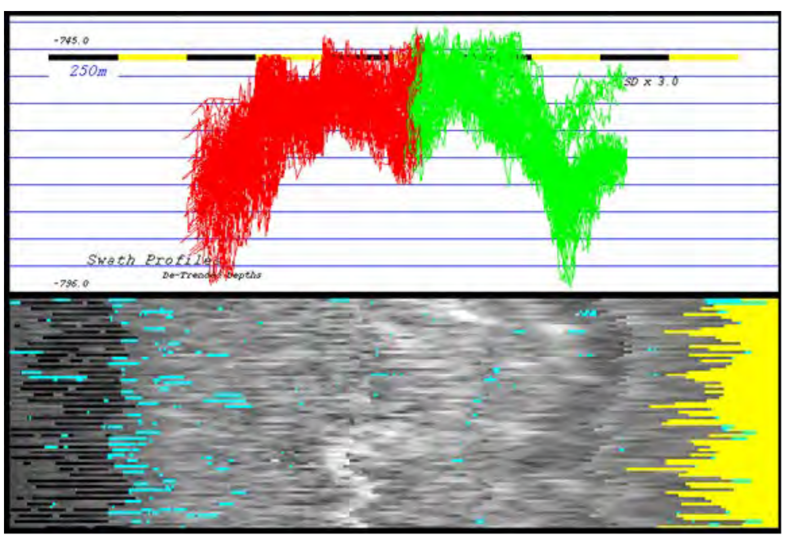

Figure 34.7. Sample from Leg 2a of inter-sector staircase type artifacts associated with artifacts shown in Figure 34.6. 80 swaths are plotted in the upper graph, with depth on the y-axis and across-track distance on the y-axis. The lower image represents a pseudo plan view of beam averaged backscatter (y-axis is ping number, x-axis is beam number). Low backscatter on the port side may be associated with the artifact.

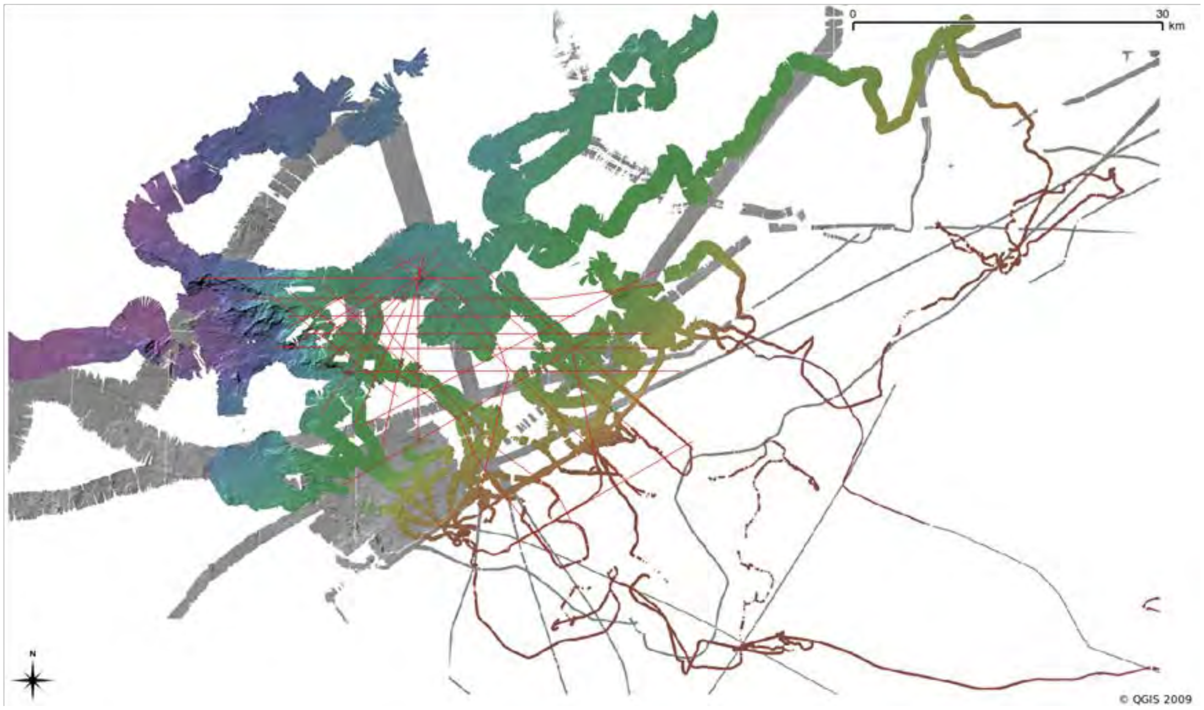

Figure 34.8. Mapping coverage achieved as of Tuesday 28 July, at the end of Leg 2a. Greyscale is coverage achieved prior to the 2009 field season, color coded bathymetry is coverage achieved during Legs 1b and 2a. Red lines represent priority survey lines provided by IOL.

34.3.3 Leg 2b – 30 July to 27 August 2009 – Beaufort Sea

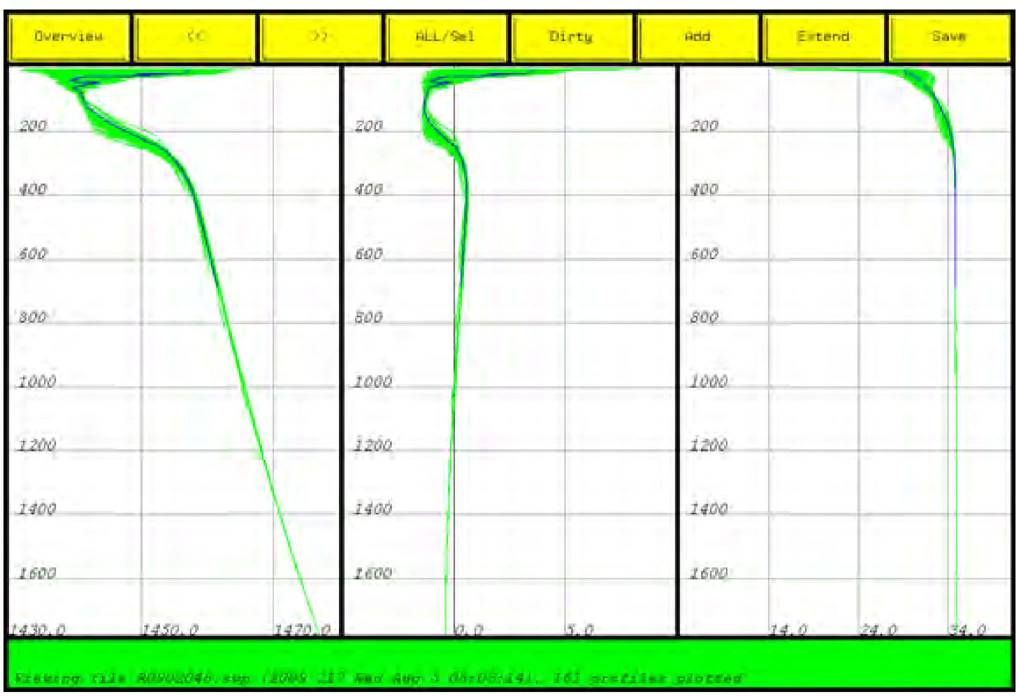

Figure 34.9. Leg 2b profiles of sound speed, temperature and salinity from 161 CTD casts throughout the survey area.

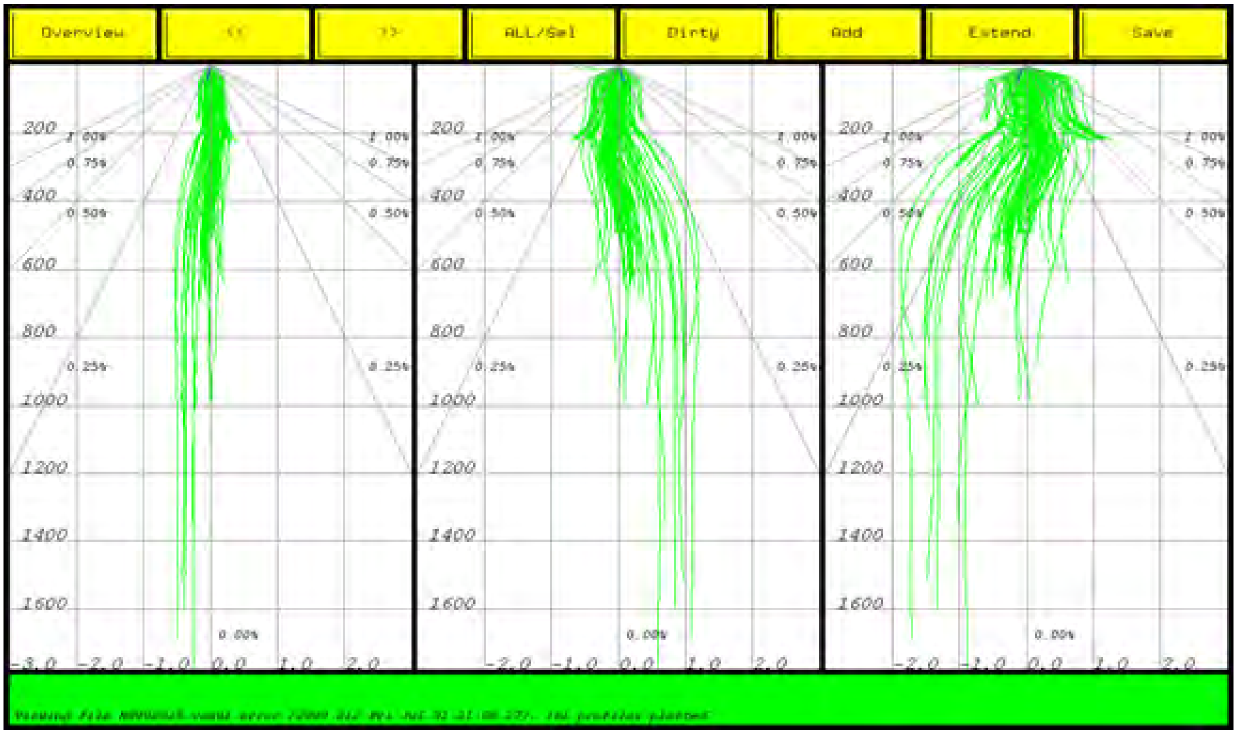

Figure 34.10. Leg 2b bias profiles for nadir depth, outerbeam depth and outerbeam horizontal solutions for 161 comparisons of CTD observations against WOA01 predictions.

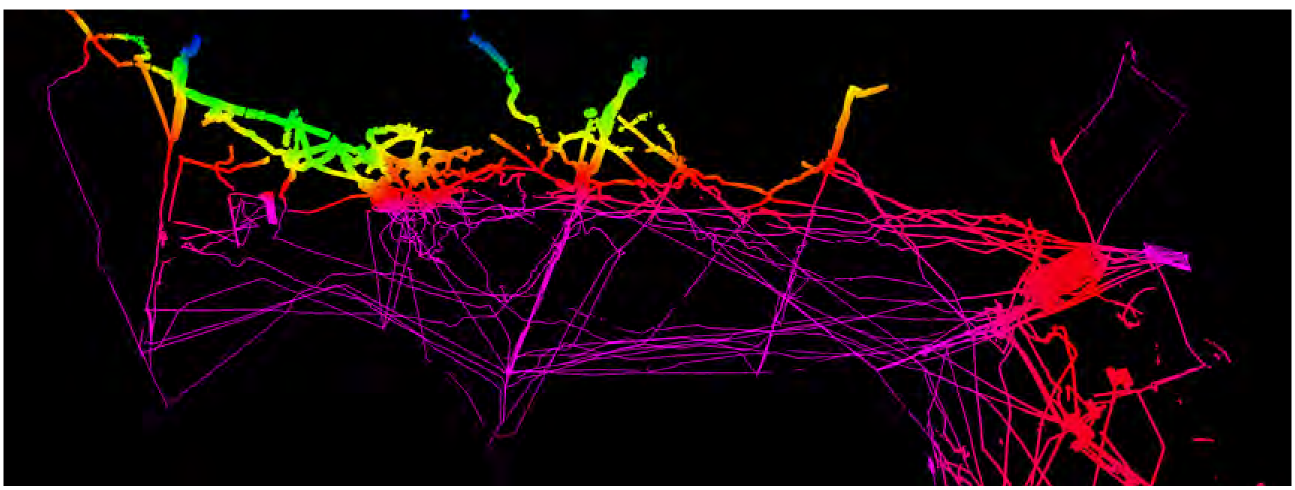

Figure 34.11. Mapping coverage achieved as of Tuesday 24 August 2009 (Leg 2b) along the McKenzie shelf. North is pointed to the top.

34.3.4 Leg 3b – 12 September to 8 October 2009 – Beaufort Sea

The main aim of the mapping program was to cover core regions with Imperial Oil's Ajurak lease block. The complementary regional mapping program of the Geological Survey of Canada (functionally ArcticNet geoscience interests) was the secondary objective (which benefitted strongly from the Ajurak Block coverage).

Time log of surveying

JD257 – Arrived in Block, started Priority Lines.
JD258 – Continued Priority Lines
JD259 – Continued Priority Lines – deteriorating conditions
JD260 – Continued Priority Lines – Did part of Offshore 8000, 10000 interleaved with coring - start of gale
JD261 – Finished Priority Lines – Started Inshore Grid - Full 40 knot gale.
JD262 – Did 1000m spacing of Inshore Grid – in gale (later rerun on JD276)
JD263 – Tried starting Offshore Grid – diverted to the NW by Viking Vision – first Drill Site Focus Grid
JD264 – Offshore Grid and Drill Site Focus Grid (interleaved with coring)
JD265 – Splitting Inshore Grid in better weather.
JD266 – Offshore Grid and a few Drill Site Focus Grid (interleaved with coring)
JD267 – Offshore Grid and a few Drill Site Focus Grid (interleaved with coring)
JD268 – Offshore Grid and a few Drill Site Focus Grid (interleaved with coring)
JD269 – Offshore Grid and Drill Site Focus
JD270 – Offshore Grid and fill shelf top gaps in Petrel/Nahidik coverage.
JD271 – Complete all Drill Site Focus and start Inshore NE Extension Grid
JD272 – NE Extension Grid and start GSC Slump Grid
JD273 – GSC Slump Grid and rerun some of gale-plagued Inshore Grid – Off to Tuk for parts.
JD274 – Back from Tuk – Finish GSC Slump, add more to Offshore Grid
JD275 – Extend Offshore grid to NE to cover remained of IOL Block – having to punch through an ice floe line resulting in a band of bad data trending ~ N-S in middle of survey area
JD276 – Reshoot of Inshore data collected in gale on JD262 – Flat calm but Ice-Plagued now. Ice ridge across western end requires punching through.
JD277 – Back into a 30 knot gale. Extending area to NE to cover outer limits of IOL block and get more GSC regional data. Steamed over ice ridge dropout corridor of JD275 for the purpose of filling it in. Extended one line further to the NE while waiting for seas to calm enough for coring.
JD278 – Building to NE and N to cover last remnants of IOL block and extending GSC regional coverage.
JD279 – Final night, filling in shelf lines at head of 2nd slump where extensive gap plumes had been found. Tried deploying MVP but outer sheave froze up.
JD280 – Steaming for Paulatuk

Priority lines

For the first few days a series of client-specific lines was run along tracks predefined by IOL. To maximize the along track density the swath was pulled in to +/- 500 m (~±45° or 90° less) to keep the ping rate as high as possible. A 7 knots speed was used except in slow zones where 5 knots was used. Line 27 had to be aborted due to the storm and was only reshot later.

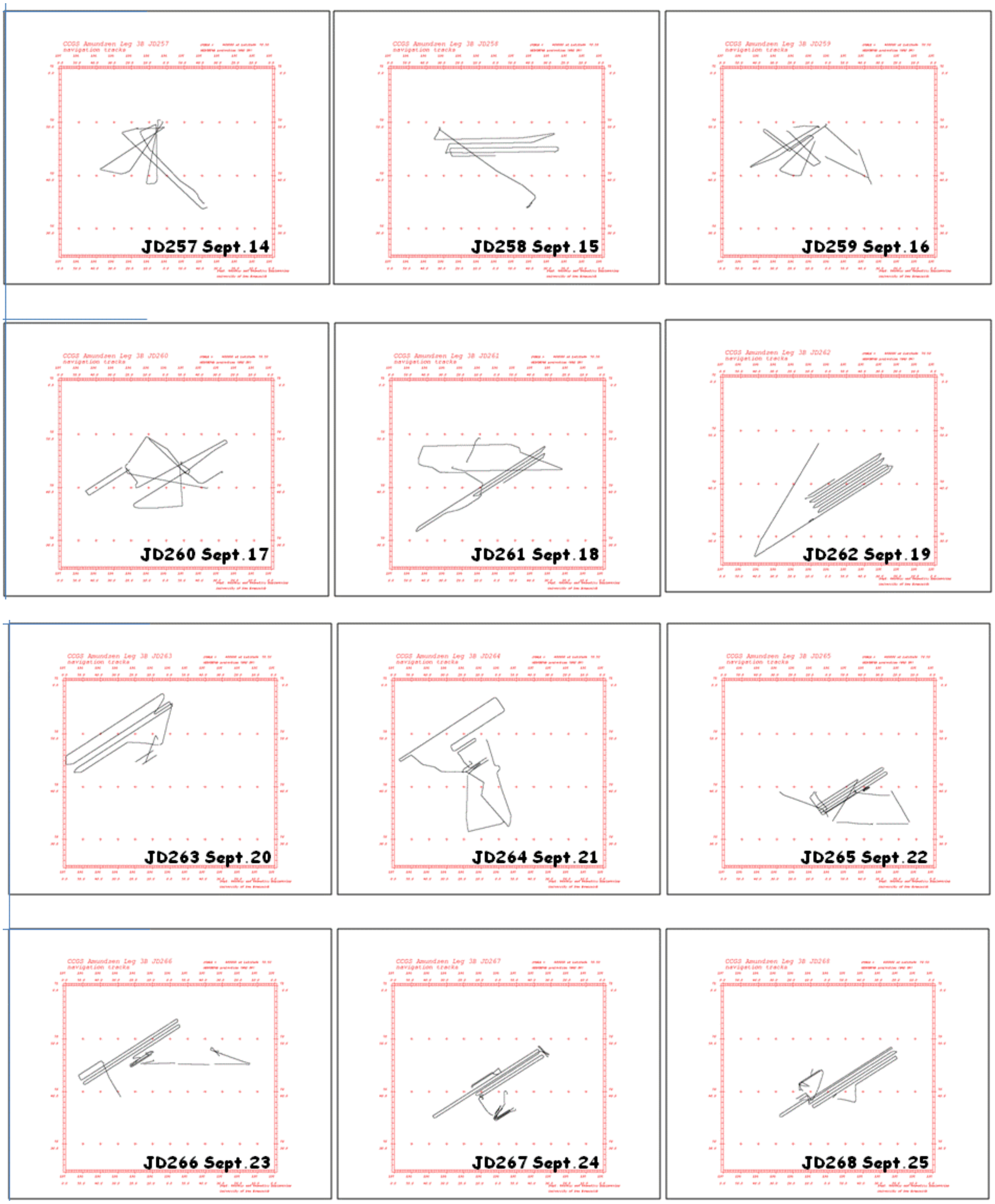

Figure 34.12. Seafloor mapping and subbottom profiling coverage for each day of Leg 3b from 14 September to 6 October.

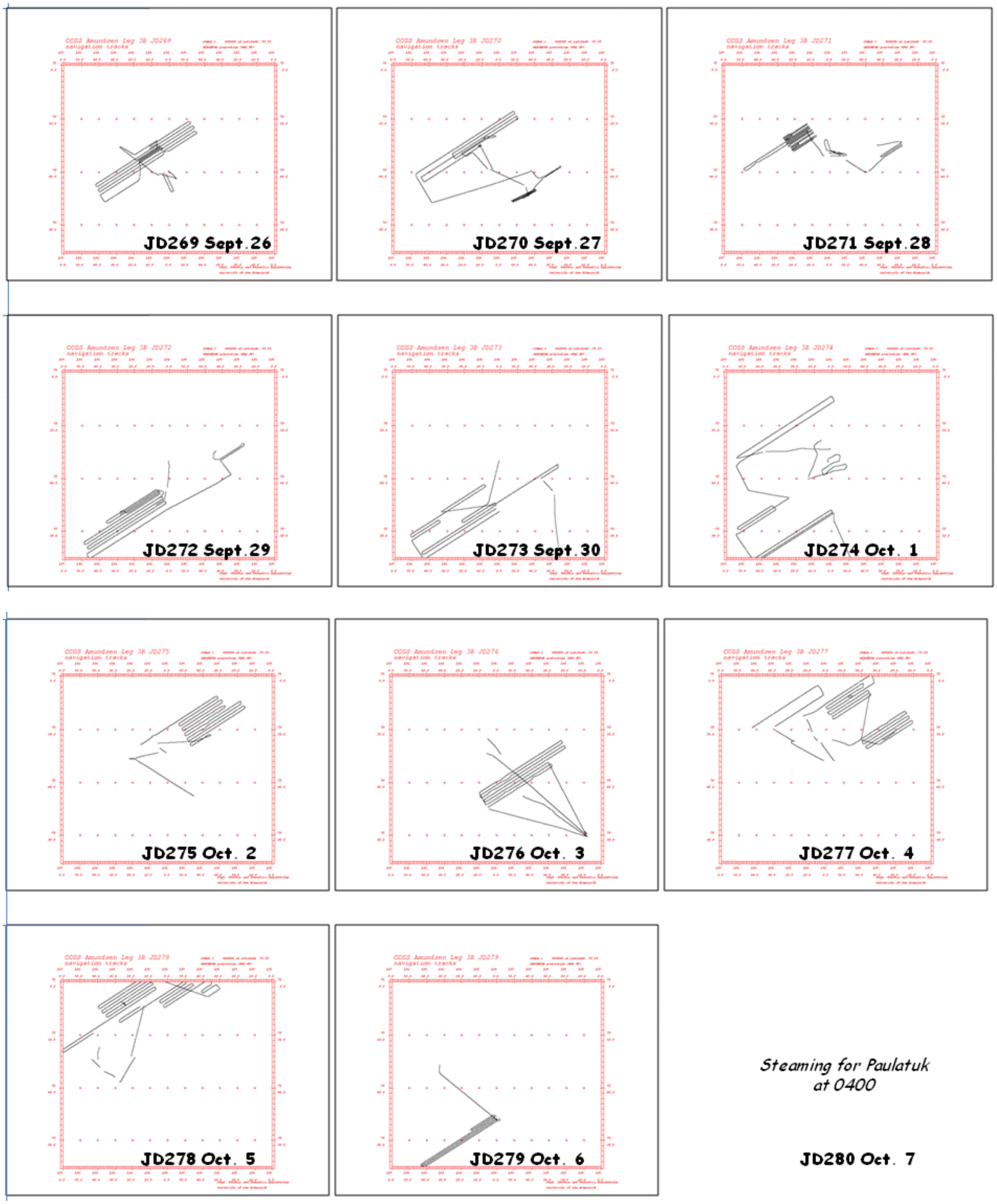

Figure 34.13 (continued from previous page). Seafloor mapping and subbottom profiling coverage for each day of Leg 3b from 14 September to 6 October.

Inshore block: 500 m line spacing – First coverage at 1000 m intervals (JD262) was run in the gale resulting in a lot of bottom tracking issues related to bubble wash down. At first 8-10 knots was used in the poorer sea states, but on improving weather, no degradation was seen at the full 13.5 knots so that was used.

Offshore block: Deeper than ~500 m, the decision was made to open to 1000 m line spacing. All line subsets that lay within specific "client-supplied" slow zones were initially run at 5 knots. However it soon became apparent that the subbottom suffered at speeds less than 7 knots so that was used for all slow zones.

Drill site (Ajurak Spur) block: For a specific subarea, the 1000 m offshore lines were split thrice (333 m resultant line spacing). All these lines were run at 7 knots. Some repeated due to early sea state issues.

GSC slump block: When the Inshore, Offshore and Drill site blocks were completed, regional surveying was started to expand the coverage based on GSC priorities. This was also assigned as a high priority by IOL (ahead of expanding coverage elsewhere in the IOL block).

IOL block coverage: Once all other mapping components had been achieved, the aim was to cover as much of the IOL block remaining in deeper water (>200 m). This included slight expansions to take into account GSC regional geological aims (and to make ship time usage during turns more efficient).

FEF investigations: For the 3 main Fluid–Escape Features (FEF), extra transits were run at various azimuths to better define the subsurface seismic character of these. As the sea state dropped, the quality of the water column imagery improved, and gas seeps plumes started to be seen.

Gas seep investigations: Once the Water Column gain shift had been applied (routinely applied to EM710 data, but not necessary for EM122 data), the visibility of both the regional deep-scattering layer and the gas plumes improved immensely. As well as confirming plumes from the 3 major FEFs, on the inshore region, above shelf break, much smaller seeps were picked up. The highest density of these seeps was noted on the shelf to the west of the 2nd Slump.

34.3.5 Leg 4a – 8 October to 6 November – Beaufort Sea, NW Passage, Baffin Bay

The multibeam system was severely hampered during this leg do to the presence of a large amount of sea ice. There was some good quality data acquired during the transit between stations on the Amundsen Gulf as well as a small amount of opportunity mapping around stations. The mapping planned for Viscount Melville Sound and Barrow Strait was not completed due to sea ice. The survey in the Scott Inlet area was attempted but the presence of even relatively thin ice severely affected the quality of the multibeam data, when it was able to acquire at all. However, the system was able to image seafloor seeps in the Smith Inlet area in order to locate a search area for the ROV investigation. The Water Column data was also affected by noise from breaking ice as well as interference from the other acoustic systems. There was also a significant software problem that necessitated the reinstalling of the Kongsberg database software. This issue was encountered on Leg 2 and will be resolved in cooperation with the multibeam manufacturer. There were also issues related to mistracking and backscatter calibration that have already been noted in previous cruise reports which will also be addressed.

The sub-bottom system was also affected by the presence of sea ice but to a much lesser degree, with relativity good data collected for the majority of the transit of Leg 4a. All data from Leg 4b will be available on the Ocean Mapping group website (www.omg.unb.ca) once it is fully processed.

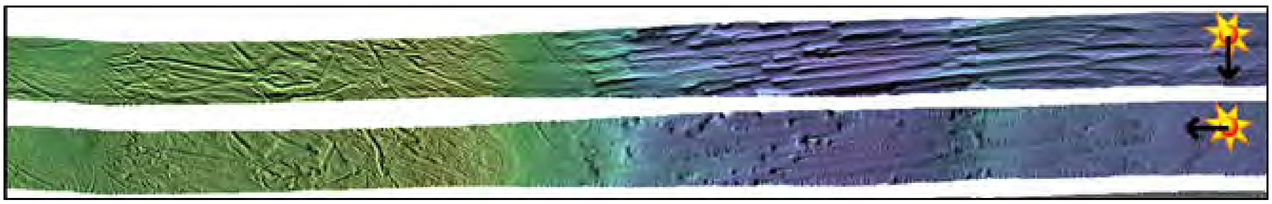

Figure 34.14. Example of multibeam bathymetry collected during transit between oceanographic stations in Leg 4a.

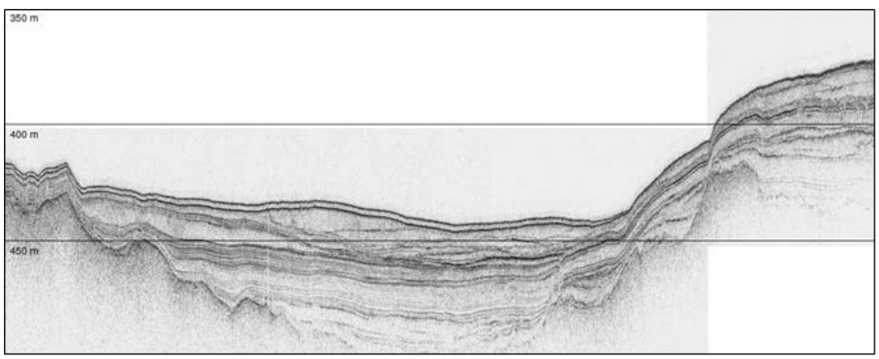

Figure 34.15. Example of sub bottom profile collected in Amundsen Gulf during Leg 4a.

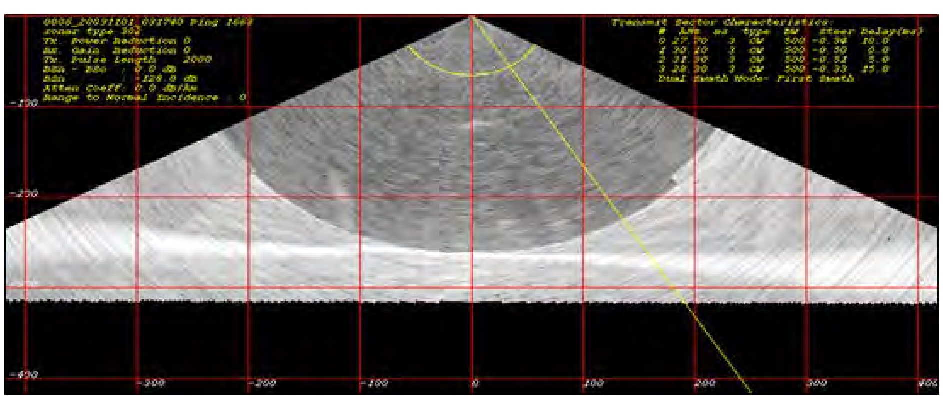

Figure 34.16. Example of water column imaging showing small seep features near Smith Inlet, visited during Leg 4a.

34.3.6 Leg 4b – 6 November to 18 November – Labrador fjords

There were no dedicated mapping projects during Leg 4b, however multibeam and subbottom data were collected along all ship tracks. The subbottom data was useful in aiding the selection of suitable areas for piston coring.

In addition, a large amount of multibeam data was provided by T. Bell of Memorial University. This data was collected in August 2009 in Okak Bay and was processed in time to provide a safe route for the *Amundsen* so that a complete set of sampling stations could be accessed in Okak Bay.

Figure 34.17. Example of bathymetry collected with the multibeam in Okak Bay during Leg 4b.

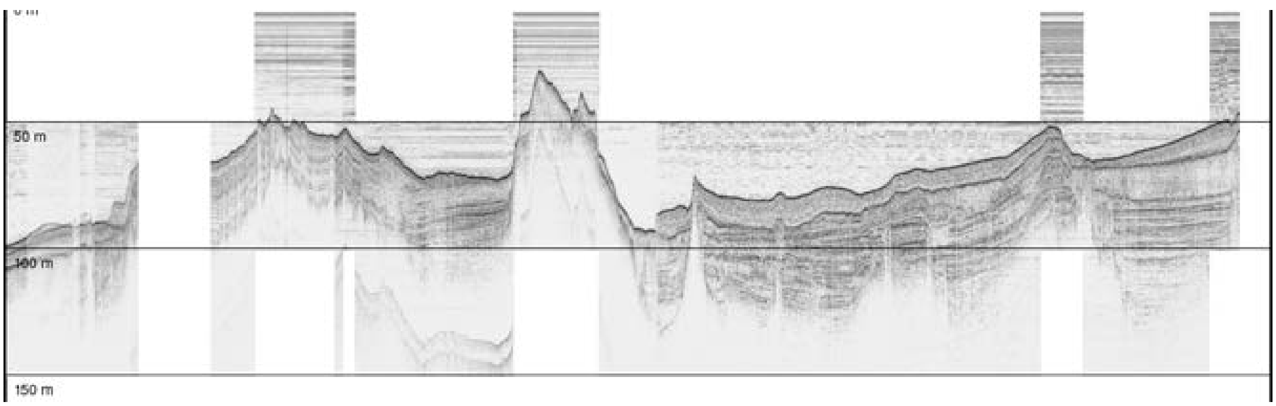

Figure 34.18. Example of sub bottom profile collected in Saglek Fiord during Leg 4b.

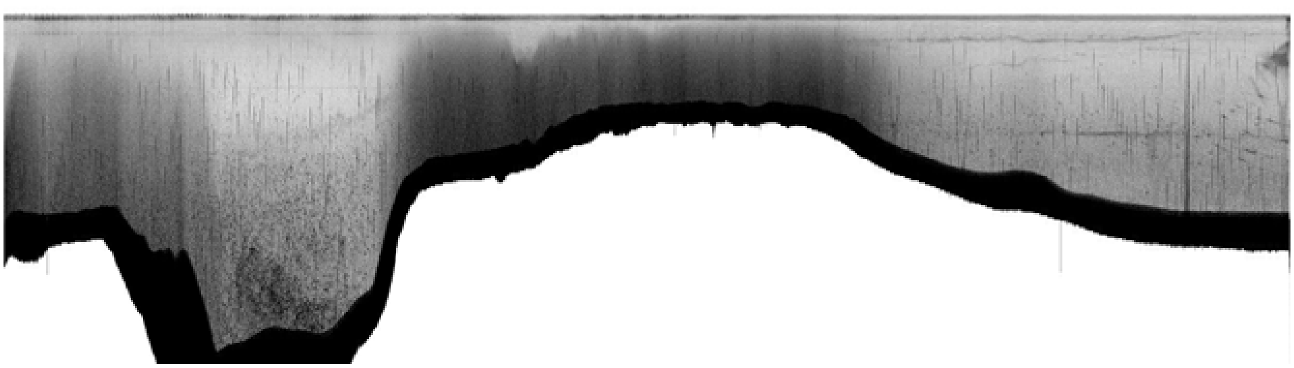

Figure 34.19. Example of water column imaging entering Okak Harbour during Leg 4b (note the acoustic interference).

34.4 Comments and recommendations

34.4.1 Leg 2a – 16 July to 30 July 2009 – Beaufort Sea

Due to limitations of a 2-man crew's ability to maintain a 24-hour watch, occasional instances of bottom mistracking would occur when the systems were left unattended for short periods of time, e.g during meals or breaks. It is recommended that the number of mapping technicians be increased to 4 persons during dedicated mapping operations to ensure round the clock data quality.

The multibeam does have some issues that were being investigated:

"Freeze up" of multibeam acquisition software (SIS) with inability to ping afterwards: a solution is being sought with Kongsberg; they've acknowledged a similar problem occurring with VERY DEEP and EXTRA DEEP modes, however, the problem occurred in MEDIUM mode. Kongsberg instructed to enable additional logging of system status via telnet to help isolate the problem if it occurs again.

Multibeam Built-In Self Test (BIST) #4 fails: the issue has been identified by Kongsberg, replacement part(s) are being sent with next crew change on 27 August.

34.4.2 Leg 2b – 30 July to 27 August 2009 – Beaufort Sea

Following the issues described in the Leg 2a above, SIS continued to freeze up, the most serious case occurred on 17 August and lasted for two days. The failure can be described by the following symptoms:

- The sounder stops transmitting and/or receiving, all ancillary sensors remain functional and their data stream is updated in SIS.
- No “signal” information is available in any of the signal related displays (e.g. stave display, beam intensity, water column display, etc.).
- The sounder continues to output a pulse sync signal to the Knudsen which continues to work correctly (i.e. disabling pinging will stop the Knudsen from pinging, and vice versa).

Kongsberg suggested trying the following troubleshooting measures:

- De-energize TRU, swap the BSP67 boards, wait 5-10 minutes, re-energize TRU and check for functionality.
- De-energize TRU, remove the 2nd BSP67 board and 2nd RX32 board, re-energize TRU. Then run : c:\program files\kongsbergmaritime\SIS\PU\EM302\PUCD\TRUSetup.jar and configure the system to be a 1°x 4°, run SIS and configure RX opening angle to 4° in the Installation Parameters. (these steps reduced it to a single ping system with a 4° receiver). Check for functionality.
- Try all possible swapping combinations of BSP67 and RX32 boards.

None of these had any effect. Kongsberg suggested to re-install the database by running C:\Program Files\Kongsberg Maritime\SIS\SQL\reinstall.bat, but making sure to save the

PU parameters in SIS first (File Export PU Parameters…). This last step got the system running after ~2 days of downtime and troubleshooting. The PU parameters were reloaded to see if it would reproduce the problem, it did not. Data were logged successfully while on station as a test (imaged the Rosette deployment cycle while logging water column).

After the Rosette deployment, the vessel reversed engines causing intense vibration in the lower deck which caused the TRU to become unresponsive. The telnet logging session was unresponsive and the transceiver was also not responsive to ping over Ethernet. The transceiver was de-energized for ~30 minutes, after which all cable connections were checked. It was found that the power input cables in the rear of the transceiver were NOT secured against vibration and were loose (though none were *completely* disconnected). These cables were put firmly back in place, most were loose to some degree. All other cable connections were checked with nothing of note found. The TRU was re-energized, and the system worked as it had prior to the jarring event. In hindsight, it has been noticed that the system usually freezes for several tens of seconds after especially jarring icebreaking events or aggressive reversing common while maneuvering on station or when aggressively coming to full stop by reversing propulsion. These system freeze up events have similar symptoms as described above, i.e. the sounder signal displays freeze up and it appears that the system is not even trying to ping, however, you can usually pick up noise from other sounders in the water column display. This is in contrast to the 2 day downtime symptoms where the system would not even register interference from other sounders, almost as if the receivers weren't actually functioning.

Since that time, the system has been functioning normally.

34.4.3 Leg 3b – 12 September to 8 October 2009 – Beaufort Sea

Hardware Issues: The EM302 froze occasionally (4 times in the 30-day survey) under the specific condition that it lost bottom tracking and the allowable depth gates were unrealistically wide. This caused it to search for false deep depths. The result was SIS continuing to see orientation and position, but not able to fire. Transceiver IP was pingable and the telnet session remained active. This condition required hard reboot of transceiver to come back.

Sea State Issues: As noted previously, the flush mounted arrays, unlike gondola mounted systems, are very prone to bubble wash down. Under conditions of less than 15 knots of wind, the system is unaffected and the full 13.5 knot (or 16 if you can afford fuel) mapping is viable. Above 20 knots one starts to note bubble wash down events that first corrupt the backscatter imagery, and then start to cause the system to intermittently lose track of the bottom. The exact onset of this is azimuth dependent. Above 25 knots, the bottom tracking becomes notably poorer. Above 30 knots, the EM302 data is unacceptable for survey even at slower speed. At this time, the K320R sub-bottom profiler is still functional however.

Icebreaking Issues: While the EM302 is fully protected during ice breaking, it cannot usefully operate during those periods due to high noise conditions and occasional masking by ice blocks. For most of the survey there was no ice, but from JD 275 onward, the ice pack started moving back south into the survey block. It was manifested as long ribbons of sea ice that required punching through. During breaking, the EM302 data was lost. In order to avoid this situation, some attempts were made to go around the worst blocks. The problem with this is it distorts the fence diagrams as they required close conformance to the intended survey lines.

Soft Sediment Issues: A notable bottom tracking bias was intermittently seen throughout the mission. This primarily involved tracking too deep close to nadir. This occurred throughout the mission, particularly in the low impedance (soft) sediment encountered on most of the slope. The magnitude of the artefact corresponds to a 0.1 to 0.25% of depth trough (well within IHO Special Order +/-0.75%).

Transceiver clock issues: The Knudsen K320R clock is fixed only to the PC time. This was occasionally (every few days) reset to UTC (to ~ 0.5 second res though). So merging other navigation solutions is slightly problematic.

34.4.4 Leg 4a – 8 October to 6 November – Beaufort Sea, NW Passage, Baffin Bay
Leg 4b – 6 November to 18 November – Labrador fjords

Overall, systems worked as well as can be expected considering the conditions encountered. The one exception was the amount of interference between the acoustical systems on board the *Amundsen*. It is recommended that a more cooperative approach be developed with respect to the management of these acoustic systems on board. There were issues with corrupted data that could be avoided if all the systems were synchronised in a manner to avoid interference. It is also possible that some of the data collected might have quality problems if there was not someone on board dedicated to monitoring the systems. This year it was particularly obvious as the water column imaging potential of the EM302 was explored and was particularly susceptible to interference from other systems.

There were still some outstanding issues with the upgraded EM302. These issues will be addressed by the Ocean Mapping Group in cooperation with Kongsberg in order to hopefully clear them up before next year's Expedition.

Finally, the potential of the water column imaging capabilities should be further explored for both oceanographic and search & recovery operations. This capability should be communicated to the ArcticNet community.

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35 Remotely Operated Vehicle (ROV) operations – Legs 2a, 3b and 4a

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Cruise participants Leg 3b: Imperial Oil, Sylvain Blondeau[3] and Vincent Auger[5]
Cruise participants Leg 4a: Luc Michaud[3], Pascal Massot[3] and Maéva Gauthier[6]
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35.1 Introduction

35.1.1 Leg 2a – 16 July to 30 July 2009 – Beaufort Sea
Leg 3b – 12 September to 8 October 2009 – Beaufort Sea

The objective of the Leg 2a ROV dive was to conduct a visual survey of the ocean bottom and associated epibenthic fauna across a specific expulsion feature (or mud volcano) at Station 10. A box core collected on this feature a few days before had released a fair amount of gas when reaching the water surface. The major goal of the dive was to compare the bottom topography, bottom morphology and associated fauna at the edge and into the circular feature.

The objectives of the ROV dives for Leg 3b were to perform video transects, inspect the ship's propeller, and support beacon and mooring deployments and recoveries.

35.1.2 Leg 4a – 8 October to 6 November – Beaufort Sea, NW Passage, Baffin Bay

The ROV work targets the visual analysis of the epibenthic macro- and megafauna with the association of geological features. The three areas of interests were Viscount-Melville Sound, Barrow Strait and Scott Inlet.

Marine mammal usage area, Viscount Melville Sound

The Melville Sound is associated with increased mammal activity, notably male beluga whales. This aggregation of belugas may be related to the structure of the sea bottom and overall productivity of the benthic environment. The objective of the dive was to carry out a video survey of the seabed in a delimited area within the centre of the beluga usage block (Figure 35.1).

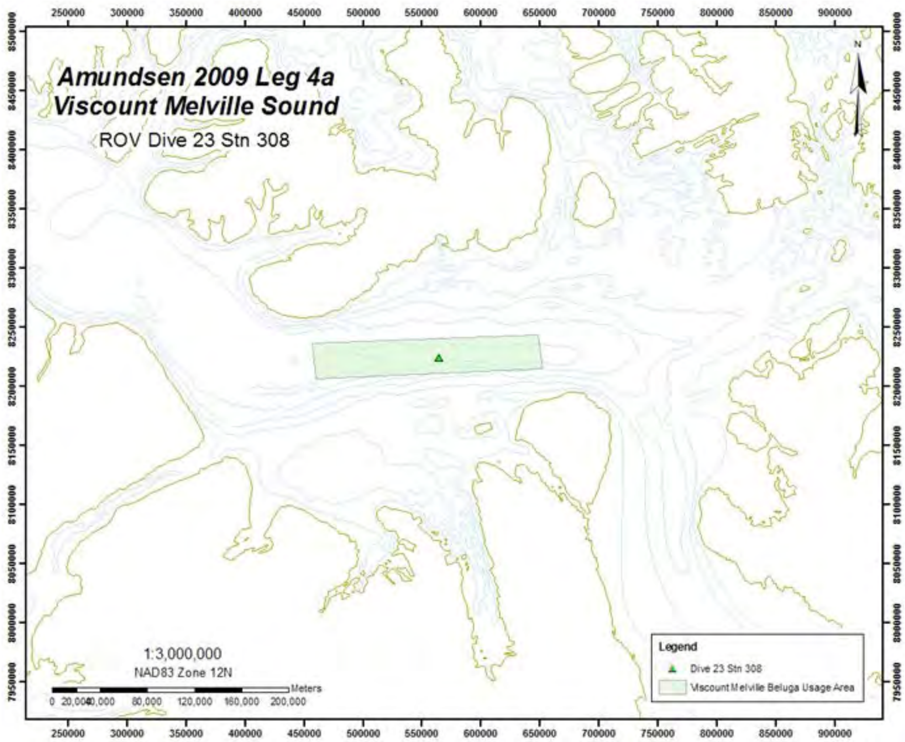

Figure 35.1. Beluga usage area in Viscount Mellville Sound where a ROV dive was conducted during Leg 4a.

<u>Scott Trough, Baffin Island</u>

During a seismic survey off the eastern coast of Baffin Island in 1976, an expansive oil slick was noted at the sea surface, appearing to be bubbling from depth (Loncarevic 1976, Loncarevic and Falconer 1977). Subsequent surveys to this site over the next ten years included the collection of gravity, magnetic and high-resolution seismic data; bedrock, sediment and water column sampling; geochemical and chemical analyses; and submersible investigation including photographic and video documentation of the sea bottom and water column in the area of the slick (MacLean et al. 1981, Levy and MacLean 1981). The presence of the slick was again noted on a 2005 satellite image, indicating the continuous seepage of hydrocarbons from the seabed.

Multibeam bathymetry and backscatter data in the area of purported seabed oil seepage at Scott Trough was collected by the *Amundsen* in 2008. Based on previous work, archive submersible and seismic data, and last year's multibeam data, the potential region of seepage appears to be along a fault zone on the southeastern edge of Scott Trough. It is believed that more than one point of seepage may be present. A ROV dive to this site was proposed to delineate the seepage area and to identify any unique seabed features and benthic environments associated with the seep locale.

35.2 Methodology

The CCGS *Amundsen* is equipped with a Sub-Atlantic Super Mohawk Remotely Operated Vehicle (ROV) that can be deployed through the moonpool of the vessel. The ROV is lodged in a cage (Tether Management System) that holds a 250 m long tether. The cage and ROV can be lowered to a maximal depth of 2000 m. The ROV is equipped with one black and white and one color video camera as well as two manipulator arms that can be used for sample collection or object manipulation.

Sub-Atlantic Super Mohawk ROV system specifications:

- Serial No. 005 TMS: 1273-MAS Serial No. 006
- Depth rating 2000 msw
- Propulsion 6 off CTE-02 440 VAC Thrusters
- Forward thrust 117 kgf
- Lateral thrust 88 kgf
- Vertical thrust 78 kgf
- Tritech Sonar
- Tritech Colour Zoom Camera
- Tritech Low light Mono Camera
- 2 x 5 Function Hydrolek Manipulators
- Lighting 3 x 250 Watt
- OceanTools MiniFOG Gyrocompass

Figure 35.2. The CCGS *Amundsen*'s Sub-Atlantic Super Mohawk Remotely Operated Vehicle (ROV).

The ROV is designed for a wide range of underwater tasks including but not limited to:

- Diver monitoring and support
- Inspection of structures
- Payload item deployment
- Maintenance and repair
- Surveys
- Oceanography & research
- Retrieval of ordnance

35.2.1 Leg 2a – 16 July to 30 July 2009 – Beaufort Sea

The circular shaped expulsion feature at Station 10 is approximately 1 km in diameter with its surface lying at approximately 420 m (Figure 35.3). The entire Station 10 area was covered with 9/10 of heavy pack-ice. After measuring the drift of the ship and ice pack, the vessel was positioned in a starting area that would allow the ROV to sample across the feature. Using mostly passive drifting with moderate thrusting operations to maintain the transect in the centre of the feature, the ship drifted across the feature at a speed ranging from 0.3 to 0.6 knots in a northeast to southwest direction.

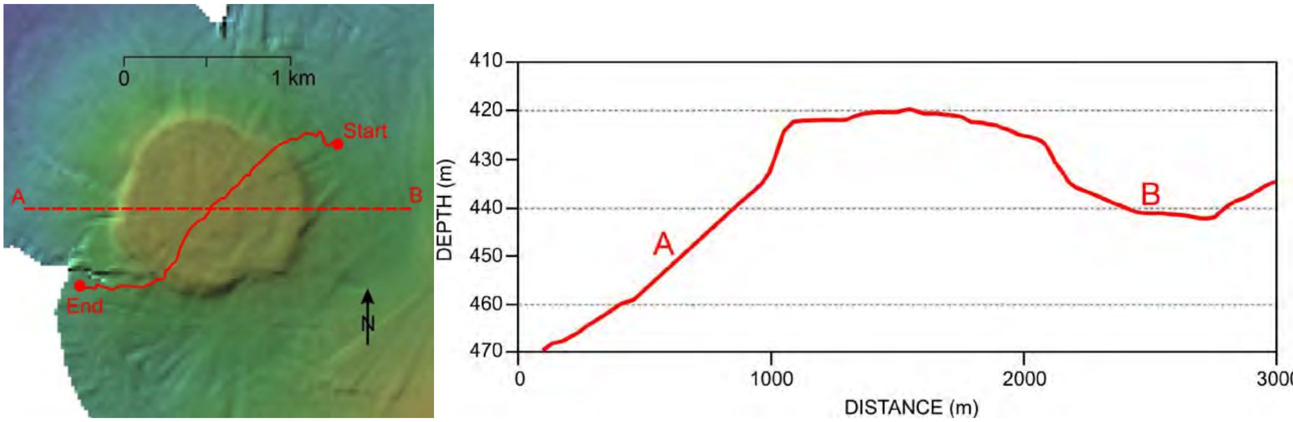

Figure 35.3. The Station 10 expulsion feature showing the position of the ROV transect. East-West cross section showing the depth of the feature and adjacent slopes. Image from *Amundsen*'s EM-302 multibeam courtesy of J. Beaudoin (OMG-UNB).

35.2.2 Leg 3b – 12 September to 8 October 2009 – Beaufort Sea

During the course of Leg 3b the ROV performed 4 dives totaling 12 hours and 32 minutes of diving time.

ROV Dive #18 Log
Date: 29 September 2009.
Duration: 4h42m @ 300 m depth
Tasks: 2 km transect and ship's propeller inspection

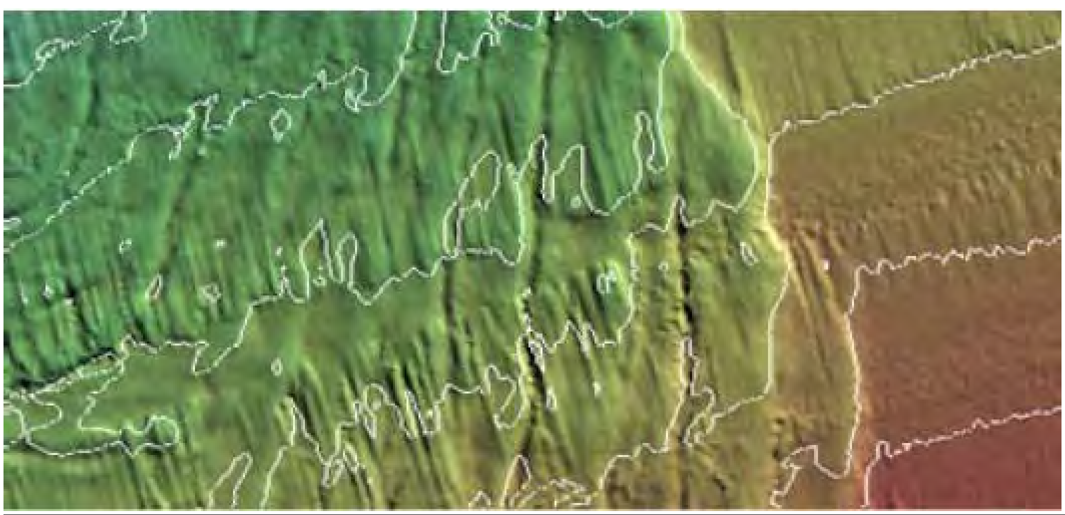
Figure 35.4. Bathymetry in the area of ROV Dive 18 during Leg 3b.

Event log:
7:30 Pre-dive complete.
8:30 Pre-dive meeting.
10:00 Going back to site after impromptu survey line started during meeting.
10:21 Start of deployment.
10:26 Cage in Water.

10:31 Lost communication with ROV while cage in moon pool.
10:38 Back on deck.
10:45 Problem with moon pool doors (cover hatch won't close)
10:55 Loose connections in the control panel – doors are operational again.
11:00 Start of ROV testing – problem seemed to have resolved itself.
12:00 End of testing, ROV is stable. Clear to dive.
12:18 Opening shell door
12:20 Installing cable guide
12:30 Cage at 60m
12:45 Going down to 250m. Sylvain piloting around cage.
13:07 On bottom
13:25 Starting transect bearing 81. Current depth 297m
15:50 Transect completed. Starting to come up.
16:15 waiting at 60m for propeller inspection.
16:21 going to 20m depth with cage
16:25 Going towards the propellers with ROV
17:00 On deck

<u>ROV Dive #19 Log</u>
Date: 2 October 2009.
Duration: 3h27m @ 786m depth
Tasks: 1 km transect along slope

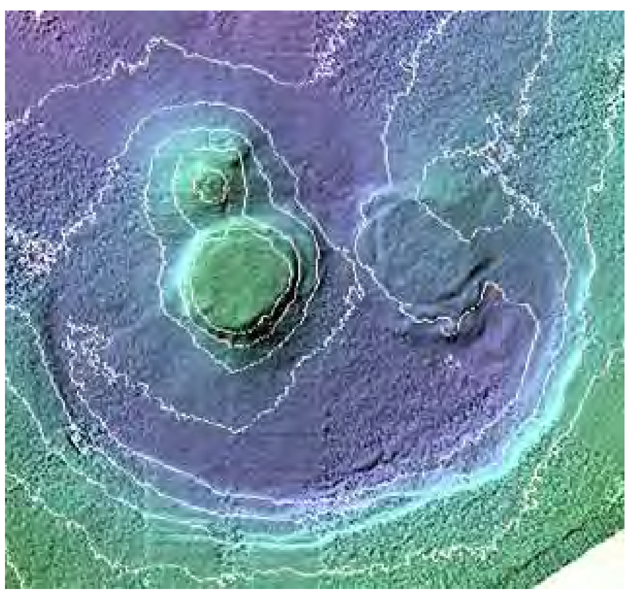

Figure 35.5. Bathymetry in the area of ROV Dive 19 during Leg 3b.

Event Log:
6:00 Looking at ice conditions, looks good no ice within 2 nm
6:15 Opening moon pool
6:18 Deployment
6:23 ROV in water
6:33 ROV out of moon pool
7:06 750 on winch – ROV says 690.
7:08 Going out of cage

7:14 Cage at 750m, going down to 786m w/ ROV
7:20 On the bottom
7:25 Ready to go, 0.5 knots w/ ship
7:40 Started transect
7:50 Going up 10m on cage, ROV now at 772, Cage ~740
8:05 Going up 10m on cage ROV at 760
8:45 In cage, arms stowed, coming back up
8:55 Cage at 178m
9:05 Going back down – problems with cable winding, need to unwind to correct.
9:45 On deck

<u>ROV Dive #20 Log</u>
Date: 2 October 2009
Duration: 1h57m @ 800 m depth
Tasks: Beacon Recovery

Figure 35.6. Photograph of the beacon recovered during ROV dive 20 in Leg 3b.

Event Log:
15:23 Moon pool doors opening
15:25 ROV off deck
15:27 ROV in water
15:29 Cable guide installed
15:56 Cage at 547m
16:04 Outside cage at 729m, going down w/ cage to 750m
16:13 On bottom – 799m
16:17 Found beacon – base at 797m
16:31 Beacon cut, in manipulators
16:34 At cage w/ beacon, going up
17:05 Beacon released in moon pool opening – recovered at the surface
17:20 On deck

ROV Dive #21 Log
Date: 3 October 2009
Duration: 2h26m @ 55 m depth
Tasks: Mooring rescue/recovery

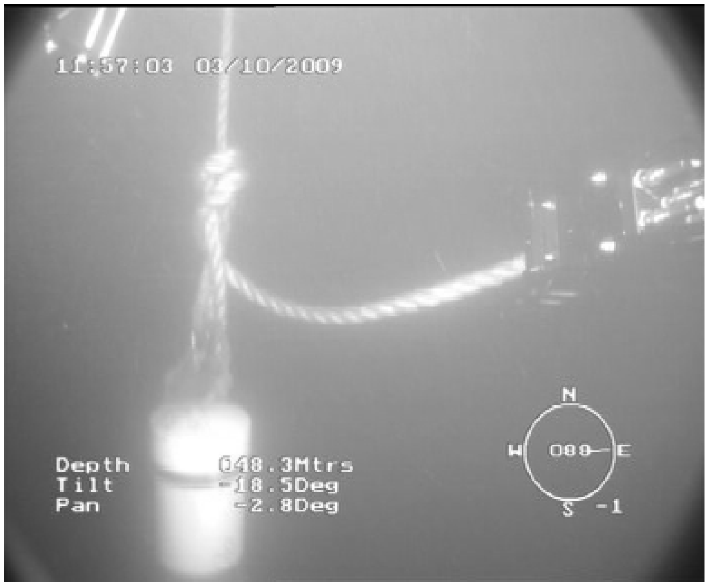

Figure 35.7. Photograph taken during ROV dive 21 (Leg 3b) of the knot keeping the mooring's float from surfacing.

Event Log:
10:09 Moon pool open
10:10 ROV off deck
10:12 ROV in water
10:15 Cable guide installed
10:17 ROV outside of moon pool
10:21 Going out of cage
10:37 Pilot change (Vincent in)
11:16 Moving ship at center of ground rope
11:20 Back to cage while ship is moving for tether management
11:25 Removed loop in cable
11:50 Found buoy side of mooring - 57 away of marked position.
11:50 Cleaning ROV of all mud to work around mooring
11:52 Moving ship away to try to untangle knot
12:00 Untangling float by pulling on ground rope
12:01 Float on surface
12:09 ROV in cage
12:35 ROV on deck

35.3 Preliminary results

35.3.1 Leg 2a – 16 July to 30 July 2009 – Beaufort Sea

Excluding the deployment and retrieval operations, the ROV bottom survey across the feature lasted approximately 115 minutes. The entire dive was recorded and video will be analysed for species diversity and abundance, bottom topography and morphology. A first analysis shows that the smooth and homogenous bottom morphology of the outer edges and slopes on both sides of the feature clearly differs from the rugged bottom speckled with black spots at the centre of the feature itself. At first glance, no major change in species composition or abundance was observed along the transect.

An in-depth analysis of the video survey will help determine the density and diversity of the epibenthic assemblages along the transect. Some of the black substance seen on the feature surface was also collected and will be analysed along with the push core samples obtained from the box core at the same station.

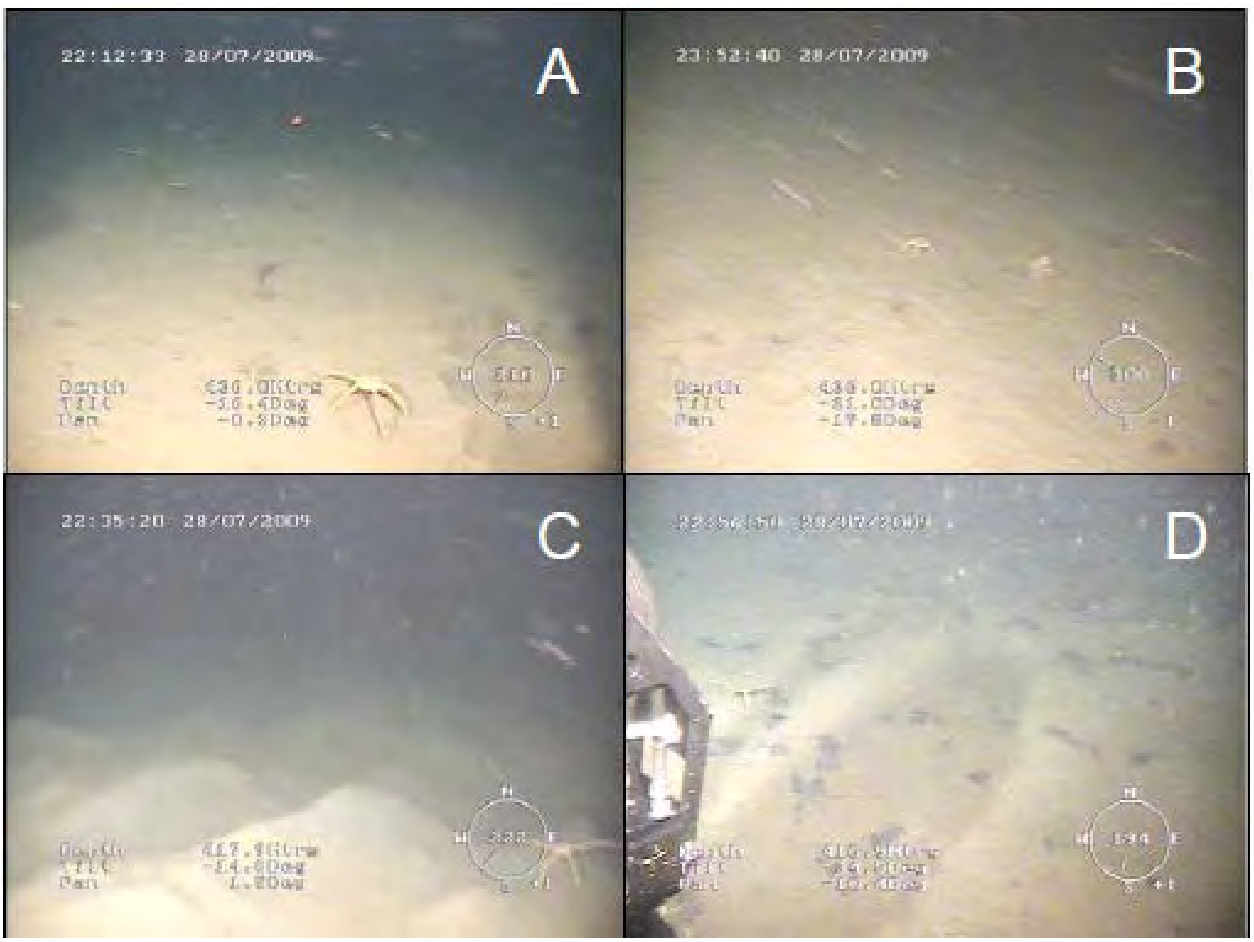

Figure 35.8. The smooth and homogenous bottom of the outer slopes on both sides of the feature (A: east slope: B: west slope; both at 430m) contrast with the rugged bottom (C) and black spots observed at the surface of the feature itself (D) (in 417 m).

Figure 35.9. Brittle stars, starfish, anemone, worms and small Eelpouts (*Lycodes*) dominated the epibenthic faunal assemblage both on and off the feature.

35.3.2 Leg 4a – 8 October to 6 November – Beaufort Sea, NW Passage, Baffin Bay

<u>ROV Dive #23 – Viscount Melville Sound</u>

Position: 74° 06.244'N, 108° 52.578'W
Start of dive: 20 October 2009 14:24 UTC
End of dive: 20 October 2009 17:58 UTC
Pilots: L. Michaud, P. Massot

Rationale: The Melville Sound is associated with increased marine mammal activity, notably male beluga whales. This aggregation of belugas may be related to the structure of the sea bottom and overall productivity of the benthic environment. The objective of the dive was to carry out a video survey of the seabed in a delimited area within the centre of the beluga usage block.

Pre-dive: A pre-dive meeting to discuss the dive plan was held at 13:30 UTC attended by the Chief Officer of the *Amundsen*, the Chief Scientist, the scientists and the pilots. The objectives of all concerned parties were discussed during this meeting to ensure that the dive plan would include everyone's need. The steps to be followed prior to the dive were reviewed and approved. A pre-dive check of the ROV was conducted at 05:00 UTC on 20 October. All systems were functional and the ROV was considered ready for deployment. An additional colour camera was installed on the ROV by the GSC scientists at 06:00 UTC on 20 October. The Sonardyne Ranger Pro positioning system transducer was deployed in the ship's acoustic well at 13:00 UTC on 20 October. The Ranger Pro beacons were pre-mounted on the ROV and the Tether Management System (TMS) prior to the dive.

Dive: The dive was scheduled to be carried out at 6:00 UTC on 20 October 2009. Because of the need to de-ice the moonpool, the dive started 8 hours late at 14:24 UTC (08:24am local time). The ROV was first deployed at a depth of 20 m to confirm that the USBL positioning system was functional. With the USBL system functioning, the ROV was sent down to 513 m at 20 m/minute. At 15:01, The TMS was positioned at 13 m above the bottom, i.e. 500 m below the surface. The ROV reached the bottom at 15:06. The transect directions were based on the ship's position and drift direction. A total of 6 transects, each of a length of 50 m were carried out at depths ranging between 504 and 513 m (Figure 35.10). For each transect, the ROV stopped at the beginning to zoom in on the seabed with the video camera.

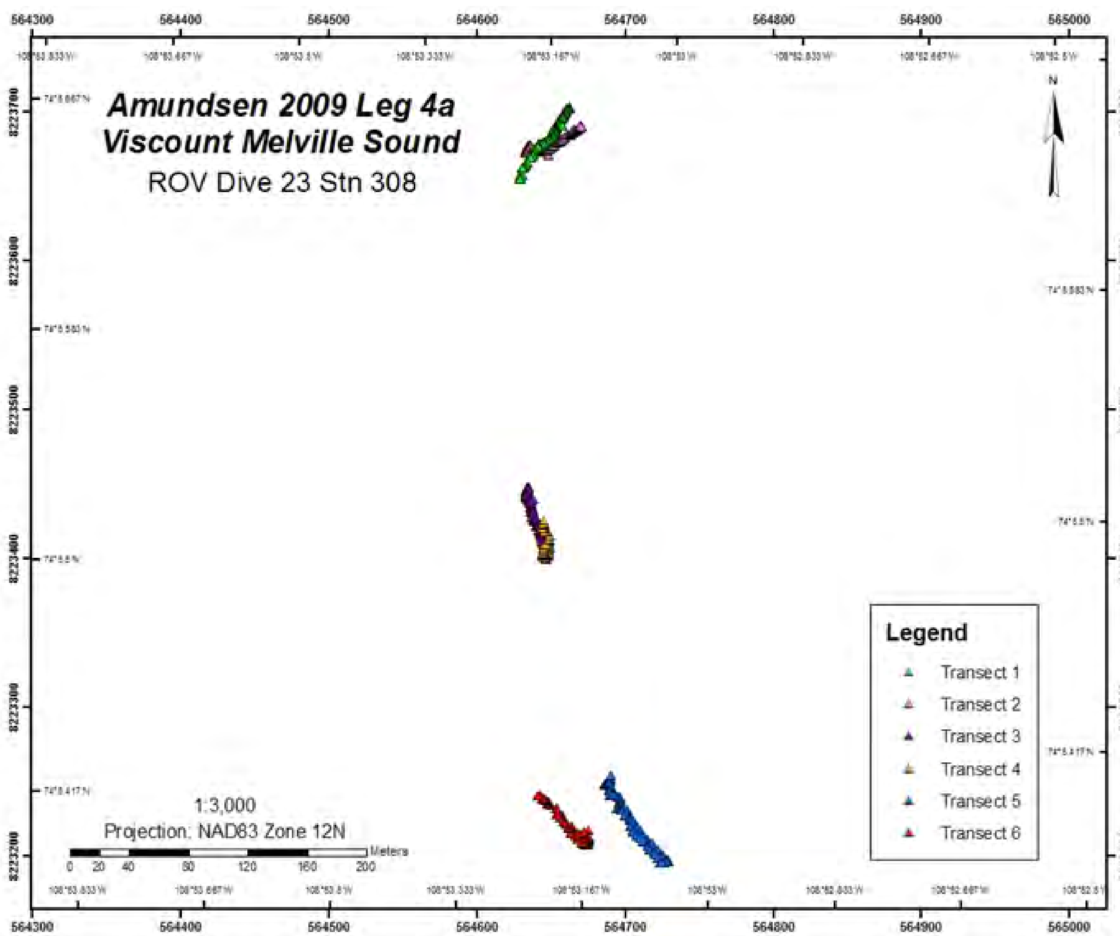

Figure 35.10. Location of transects carried out with the ROV in Viscount Melville Sound (Station 308) during Leg 4a (dive #23).

The first two transects were spaced 15 m apart (transects 1 and 2). At the end of the second transect, the ROV was being pulled by the drifting ship and therefore had to be repositioned directly under the ship (110 m south of the first two transects). Four other transects (transects 3, 4, 5 and 6) each separated by 20 m were carried out in an east-west direction (Figure 35.10). At 17:01 UTC, the ROV headed back to the TMS. The ROV entered the TMS at 17:30 UTC. At 17:58 UTC the ROV was brought back on board the ship and the dive was considered officially over.

For all transects, the visibility and video capture was of good quality. The black and white camera proved to be the best option for navigation; however, all transect surveys were recorded using the colour camera to ensure best video quality. Throughout the surveys, the ROV maintained its headings using the new gyrocompass.

The GSCA VladCam Bullet video pressure case was mounted low on the ROV and a new Sony HD video camcorder model HDR-CX520v was contained within and used for the first time. The camera was set to autofocus and a new Sony low lux feature was set. Unfortunately, due to the horizontal mounting of the camera the video footage was of limited value as the water column was the dominant view. Footage of the bottom could be seen when the ROV touched down on the seabed but within seconds the suspended sediment became the centre for focus due to strong backscatter from the Deep Sea Power & Light 250 watt halogen lamps. For subsequent dives the pressure case would be mounted at a downward facing angle if possible within the tight space constrained by the TMS. On a positive note, the camera recording was solid for the entire dive and ran for over 6 hours until switched off at the surface.

During the dive, one scientist took notes in a Access Database log. All scientists present during the dive contributed to describing the benthic environment for this log. The dive coordinator was responsible for identifying the beginning and end of each transect and for ensuring that the transects were run in accordance with the dive plan. Many characteristics of the geology and biology of the seabed were noted during the dive (Table 35.1).

Table 35.1. ROV dive log for Dive #23 carried out in Viscount Melville Sound during Leg 4a.

Reco rd seq.	Date	Time	Substrate	Comments	User	Biogenic rough ness	Physical rough ness
1	2009/10/20	15:01:00	mud/sand	500m ROV leaves cage	Katie		flat
2	2009/10/20	15:06:00	mud/sand	ROV on bottom 513m, bioturbated bottom, feather stars, Shrimp	Katie	Biotur bation	flat
3	2009/10/20	15:07:00		48° heading - 1st transect	Katie		
4	2009/10/20	15:08:00	mud/sand	strange object sticking out of bottom	Katie		
5	2009/10/20	15:11:00	mud/sand	Silty bottom, lots of plankton in water column. Change of heading 66°	Katie	Biotur bation	flat
6	2009/10/20	15:12:54	mud/sand	Ray on bottom!!!	Katie	Biotur bation	flat
7	2009/10/20	15:14:01	mud/sand	New heading 246°	Katie		flat
8	2009/10/20	15:15:00	mud/sand	Zoom in to bottom, bioturbated, shrimp, fine sediment, sediment mounds	Katie	bioturb ation	flat

Record seq.	Date	Time	Substrate	Comments	User	Biogenic roughness	Physical roughness
9	2009/10/20	15:18:00	mud/sand	Start of transect 1: 246° heading	Katie		flat
10	2009/10/20	15:20:05	mud/sand	jelly fish, Big red shrimp	Katie		flat
11	2009/10/20	15:21:00	mud/sand	a rock	Katie		flat
12	2009/10/20	15:23:00	mud/sand	Soft corals?, Rocks, lots of bioturbation, mounds	Katie	bioturbation	flat
13	2009/10/20	15:24:00	mud/sand	End of transect 1	Katie		flat
14	2009/10/20	15:29:00	mud/sand	Lots of rocks sitting atop muddy bottom	Katie		flat
15	2009/10/20	15:29:00	mud/sand	Beginning of Transect 2. Coral, Sea star with proboscis extended, Tube worms, Good visibility.66 degree heading start of transect	Katie		flat
16	2009/10/20	15:33:00	mud/sand	Hole in bottom	Katie		flat
17	2009/10/20	15:35:29	mud/sand	End of transect 2	Katie		flat
18	2009/10/20	15:37:00	mud/sand	Brittle star in vegetation at end of transect 2, Rough bottom - burrows, trails	Katie		flat
19	2009/10/20	15:41:00	mud/sand	Ship moving in icepack. Must move next ROV transect closer, Cage ascending 10m	Katie		flat
20	2009/10/20	15:42:00	mud/sand	Transect 2 - 110m from ship position	Katie		flat
21	2009/10/20	15:45:52	mud/sand	Too far too see the details on the fish	Katie		flat
22	2009/10/20	15:47:00	mud/sand	Moving to other side of ship, white sponge on bottom	Katie		flat
23	2009/10/20	15:48:00	mud/sand	New pilot – L. Michaud. P. Massot steps down	Katie		flat
24	2009/10/20	15:51:03	mud/sand	En route to next transect, We'll start under the ship now because we are drifting	Katie		flat
25	2009/10/20	15:56:09	mud/sand	ROV under the ship, ~110m from last transect. Start of transect 3, a rock, Anemones, Tube worms, Bottom still muddy with few rocks	Katie	bioturbation	flat
26	2009/10/20	16:00:00	mud/sand	Big anemone, Heading this transect 189°, 10 m to starboard side of ship. Start Transect 3	Katie		flat
27	2009/10/20	16:03:00	mud/sand	Large anemone	Katie	bioturbation	flat
28	2009/10/20	16:04:00	mud/sand	Big tube worm, End of Transect 3	Katie	bioturbation	flat
29	2009/10/20	16:11:00	mud/sand	Leaving end of transect 3. En route to transect 4 (Tentative of transect 4 from 16:13 to 16:18, low visibility due to mud clouds from transect 3)	Katie		flat
30	2009/10/20	16:12:00	mud/sand	Good visibility on this dive	Katie		
31	2009/10/20	16:20:00	mud/sand	Under the ship, Starting set of new transects	Katie		flat
32	2009/10/20	16:28:00	mud/sand	Start of transect 5. Heading 170°. ~140m from last transect	Katie		flat
33	2009/10/20	16:29:00	mud/sand	Transect 5 - at start to zoom in	Katie		flat
34	2009/10/20	16:30:50	mud/sand	Small sponge? Seastar	Katie		flat
35	2009/10/20	16:32:00	mud/sand	Start of transect 5	Katie		flat
36	2009/10/20	16:33:00	mud/sand	Seastar. Biorturbated. 504m water depth	Katie	bioturbation	flat
37	2009/10/20	16:33:55	mud/sand	Sponge	Katie		flat
38	2009/10/20	16:35:00	mud/sand	10m past end of transect 5 - end.	Katie		flat
39	2009/10/20	16:37:00	mud/sand	2 seastars with single arm/proboscus extended in water column. Feeding	Katie		flat

Record seq.	Date	Time	Substrate	Comments	User	Biogenic roughness	Physical roughness
				behaviour? Sponge			
40	2009/10/20	16:37:26	mud/sand	En route to next transect	Katie		flat
41	2009/10/20	16:44:00	mud/sand	zoom into bottom close to start of transect 6, anemones, bioturbated, rough bottom, tube worms	Katie	bioturbation	flat
42	2009/10/20	16:46:50	mud/sand	Starting transect 6, 20m from last transect, sponge. Heading 340°	Katie		flat
43	2009/10/20	16:49:00	mud/sand	Hole in bottom - burrow pit?	Katie		flat
44	2009/10/20	16:49:48	mud/sand	End of transect 6, tube worms?	Katie		flat
45	2009/10/20	16:51:55	mud/sand	Eel-like organism on bottom, Trail in sediment leading up to creature, bulbous, translucent head, with long, sinuous body, Moving a bit?? 503m water depth. Size - larger than ROV claw length	Katie		flat
46	2009/10/20	16:58:00	mud/sand	Heading towards next transect	Katie		flat
47	2009/10/20	17:01:00	mud/sand	Ending dive. Transect back to cage.	Katie		flat
48	2009/10/20	17:30:04	mud/sand	Entering cage	Katie		flat
49	2009/10/20	17:31:00	mud/sand	Start ascent with ROV in cage.	Katie		flat
50	2009/10/20	17:58:32	mud/sand	ROV back on the ship. End of dive.	Katie		flat

Post-dive: Once the dive ended, the ROV was secured in its hold. Thirty minutes after the end of the dive, the ship resumed its transit towards the next station in Viscount-Melville sound. Sea ice coverage in the area was extensive but the ship was making good progress with a speed of approximately 12 knots. Soon after the ship started its transit, one of the scientists realized that the USBL transceiver head was still deployed in the acoustic well. Once down in the acoustic well, the transceiver head extends 95 cm below the hull of the ship. Upon immediate investigation, it was discovered that unfortunately, the USBL transceiver head was lost during transit probably due to ice passing under the hull of the ship. As there was no replacement Ranger Pro transceiver on board the ship, all other dives had to be carried out using the Track Link positioning system.

A post-dive check of the ROV was conducted at 15:00 UTC on 21 October. The post-dive check revealed that the aft starboard thruster was non-functional, the TMS cable was badly coiled and the pay out sensor needed to be recalibrated. All other systems were functional. The pilots and scientists also verified that the video and navigation recordings were of good quality.

ROV Dive #24 – North Baffin Bay

Position: 76° 19.6682'N, 071° 13.5324'W
Start of dive: 30 October 2009 03:16 UTC
End of dive: 30 October 2009 04:20 UTC
Pilots: L. Michaud, P. Massot

Rationale: The post-dive check #23 revealed a few mechanical and electrical problems with the ROV system and with the positioning of the GSC colour camera (see Dive report #23 above). The rationale behind the proposed dive #24 was to test out the repairs made and the new position of the colour camera before the scheduled dive of Scott Inlet. Dive #24 was also an opportunity to calibrate the USBL Track Link system and to assess the ease of handling the SIP samplers newly fitted on the TMS.

Pre-dive: A pre-dive meeting to discuss the dive plan was held the day before. A pre-dive short meeting was also held 30 minutes prior to the dive. The USBL transceiver was deployed in the acoustic well shortly before the dive and after communication with the bridge.

Dive: The ROV went down to 35m depth and started testing the thrusters. The same thruster that broke on dive 23 stopped functioning shortly after the beginning of the test (03:49 UTC). The calibration of the navigation system was started and the best scenario was 50cm offset. Moving up at 30m depth did not improve the accuracy. Because of these reasons, combined with increasing wind and the presence of icebergs in the area, the dive was called over at 04:14 UTC.

Post-dive: The USBL transceiver was recovered in the acoustic well. The navigation system needed to be calibrated in better conditions (protected area, less current). There will be another opportunity for a test dive near Scott Inlet. The thruster needs to be replaced.

<u>ROV Dive #25 – Scott Inlet (test)</u>

Position: 71° 23.787'N, 070° 08.959'W
Depth of dive: 650 m
Start of dive: 01 November 2009 17:30 UTC
End of dive: 01 November 2009 20:40 UTC
Pilots: Luc Michaud, Pascal Massot

Rationale: The post-dive checks # 23 and # 24 revealed a few mechanical and electrical problems with the ROV system and with the positioning of the GSC colour camera. The rationale behind the proposed dive # 25 was to test out the repairs made and the new position of the colour camera before the scheduled dive of Scott Inlet. Dive # 25 was also an opportunity to calibrate the USBL Track Link system and to assess the ease of handling the SIP samplers newly fitted on the TMS.

Pre-dive: A meeting was held the day before the dive to review the objectives and roles. The USBL transceiver was deployed in the acoustic well shortly before the dive and after communication with the bridge.

Dive: The ROV went down to 20m depth to calibrate the navigation system. The accuracy appeared really good (3cm offset) and the changed thruster was functional. It was realized at 18:17 UTC that the ship and ROV were 1.7 km from the starting point. The drift was large and it was realized that the seabed slope was relatively pronounced (from 650m to 540m depth). The ROV control asked the bridge to slow down to stay in position instead of drifting. It was hard to control at first and so the cage had to be moved up a few times. The ship was stationary at 18:37 UTC and it allowed the ROV to get out of the TMS and go to the seabed to test the SIP sampler. At 18:42 UTC, the ROV touched the seabed (1h12 after the beginning of the dive). The ROV went under the cage to test the SIP sampler wrapped on its arm with tie wraps, but it was now missing. The ROV went back to the cage to get the second SIP sampler. After some manipulations, the SIP sampler was gripped and the ROV was back to the bottom at 19:35 UTC. The SIP test was completed at 19:45 UTC and a transect was then carried out. At 20:05 UTC, the ROV was back in the TMS and headed up. The dive ended at 20:40 UTC.

Post-dive: The USBL transceiver was recovered in the acoustic well. Footage from the GSC colour camera was really clear and the quality was good. The new angle appeared to be the best and the light was sufficient to see the seabed.

<u>ROV Dive #25 – Scott Trough, Baffin Island</u>

Position: 71° 22.788 N, 070° 04.273 W
Start of dive: 02 November 2009 15:15 UTC
End of dive: 02 November 2009 22:37 UTC
Pilots: L. Michaud, P. Massot

Rationale: Surveys to this site have noted the presence of oil slick at the surface, suggesting the continuous seepage of hydrocarbons from the seabed. Based on these previous studies and 2008's multibeam data, the potential region of seepage appeared to be along a fault zone on the southeastern edge of Scott Trough and that more than one point of seepage may be present. The ROV dive to this site was proposed to delineate the seepage area and to identify any unique seabed features and benthic environments associated with the seep locale.

Pre-dive: A pre-dive meeting to discuss the dive plan was held at 02:30 UTC attended by the Chief Scientist, the scientists and the pilots. The objectives of all concerned parties were discussed during this meeting to ensure that the dive plan would include everyone's need. The steps to be followed prior to the dive were reviewed and approved. A pre-dive check of the ROV was conducted at 16:30 UTC on 02 November. All systems were functional and the ROV was considered ready for deployment. The colour camera was installed on the ROV by the GSC scientists just before the dive. The USBL positioning system transducer was deployed in the ship's acoustic well just before the dive after communication with the bridge. The SIP sampler was sterilized and put on top of the Tether Management System (TMS) prior to the dive.

Dive: The dive was scheduled to be carried out at 15:15 UTC on 02 November 2009. Because of the need to de-ice the moonpool, the dive started about 1h30 later at 16:52 UTC. The ROV was first deployed at a depth of 30m to check that the USBL positioning system was functional. With the USBL system functioning, the ROV was sent down to 257 m at 20 m/minute. At 17:21, the TMS was positioned at 20 m above the bottom; i.e. 237 m below the surface. The ROV reached the bottom at 17:27. The transect directions were based on the current's direction. Because of the distance possible to cover with the ship keeping its position and the cable from the ROV to the TMS, 4 X 50 m-transects out of 8 transects could be carried out at the first site (Figure 35.11).

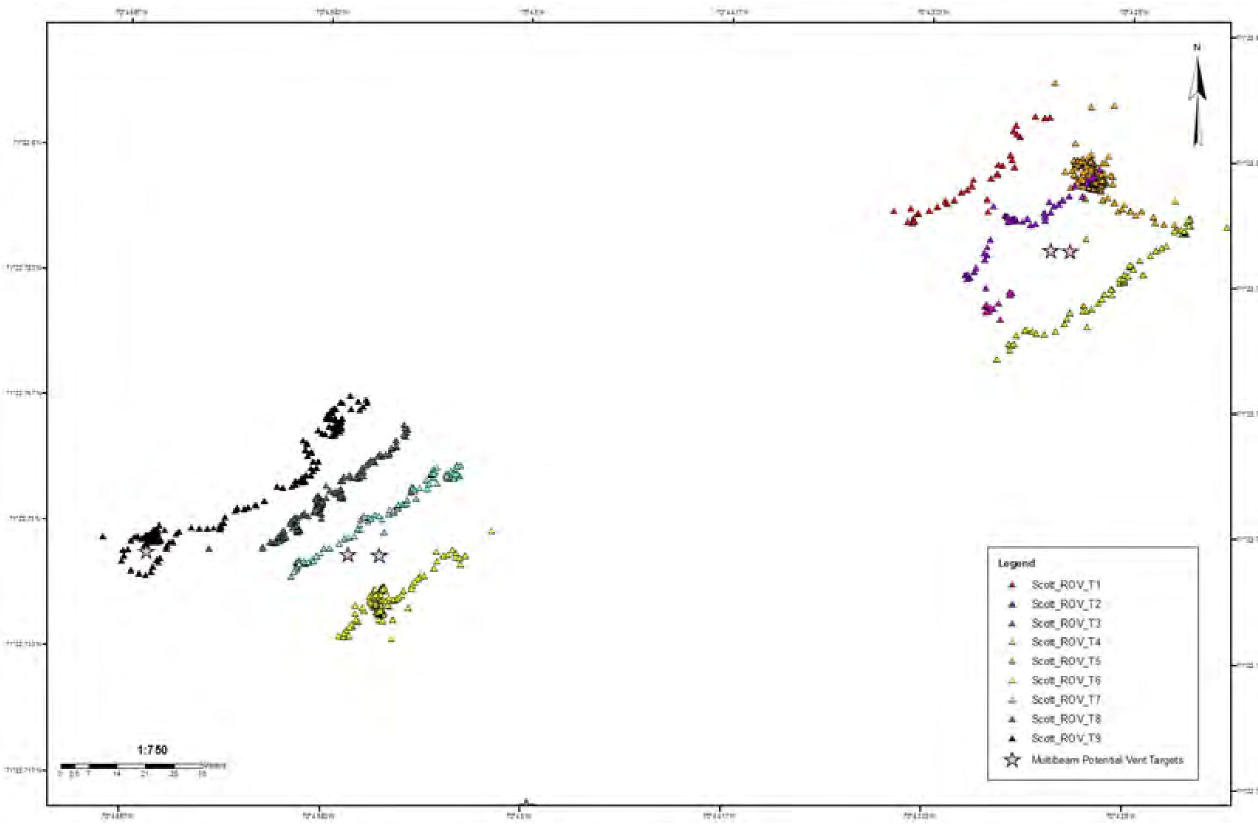

Figure 35.11. Transects performed with the ROV in Scott Trough, Baffin Island (dive #26), during Leg 4a.

At 17:29, a reconnaissance tour was completed over waypoint #1 and #4 before starting the transects. No evidence of seeps were found. The four transects were plotted to include seeps #1 and #4 approximately in the middle of the grid in order to take account for the offset of the USBL. Some bacterial mats were found in an area and it was decided to add a fifth transect running on top of the edge of the transects done (Figure 35.11) to increase chances to find important seeps around these bacterial mats. Large bacterial mats were spotted near seep target #1. Bubbles were coming out of the seafloor in that area.

After consultation, it was decided to move on to the other potential seep site instead of covering more ground around Site 1. Four transects were carried out to explore the area of waypoint and a reconnaissance was made around seep target #2.

For each transect spaced 15m apart, the ROV stopped at the beginning to zoom in on the seabed with the video camera to have a closer look at the bottom type/texture and fauna present that were not easily recognizable when flying over at a height of 1m. Each time, stops were a few minutes in length and were sometimes skipped due to suspended sediments. Problems were encountered with the positioning system, the ROV was jumping quite a lot on the Track Link system. The substrate was composed of boulders, which caused the cable to get stuck around some during the dives, stopping transect before finishing it. Propulsion problems occurred as well, but it was not clear if it was the cable that pulled the ROV or a thruster that did not work properly.

At 22:01 UTC, the ROV headed back to the TMS. It was found that there were two loops on the tether. The ROV entered the TMS at 22:07 UTC and it was found that a thruster was not functioning. At 22:37 UTC the ROV was brought back on board the ship and the dive was considered officially over.

During the dive, one scientist took notes in a Access Database log. All scientists present during the dive contributed to describing the benthic environment for this log. The dive coordinator was responsible for identifying the beginning and end of each transect and for ensuring that the transects were run in accordance with the dive plan. Many characteristics of the geology and biology of the seabed were noted during the dive (Table 35.2).

Table 35.2. ROV dive log for dive #26 in Scott Trough, Baffin Island, carried out during Leg 4a.

Date	Time	Comment	Substrate	User
02-Nov-09	15:54:00	Dive #26 in Scott Inlet. Depth is 250m. Duration 6hours. Some areas where there might be seeps will be surveyed. Opening the moon pool.		Maeva
02-Nov-09	16:52:00	Problems maintaining ship's position due to current and ice. Finally back on station. Had to pull up USBL to transit. Redeploy USBL. Deploying the ROV (~1.5 hours delay)		Katie
02-Nov-09	16:55:00	ROV in moon pool		Katie
02-Nov-09	17:00:00	Testing thrusters in moon pool		Katie
02-Nov-09	17:06:00	Stopping at 30m. Nav check		Katie
02-Nov-09	17:09:00	Descending. Some current		Katie
02-Nov-09	17:21:00	Stopping cage. Deploying ROV. Water depth 257m. Cage at 237m		Katie
02-Nov-09	17:26:00	At bottom		Katie
02-Nov-09	17:27:00	Lots of boulders and cobbles. Lots of brittle stars. Pebbles and sand. Sponge on rock	mixed	Katie
02-Nov-09	17:29:00	Start recon over seep sites 1 and 4 before start of transects		Katie
02-Nov-09	17:31:00	At start point seep site 1. Basket star. Lots of brittle stars. Worms. Fish. Lots of life. Heading to seep 4 along recon line	pebbles/cobbles	Katie
02-Nov-09	17:36:00	Crinoid on large rock. At second seep target (#4). Lots of bottom life, water column. No signs of seepage		Katie
02-Nov-09	17:46:00	At seep target #4. Heading towards start of first 50m transect		Katie
02-Nov-09	17:51:00	At start of first transect - waypoint 9. Moving cage 10m upwards (tether dragging on bottom - lots of rocks). Lots of rocks, cobbles. Soft coral	mixed	Katie
02-Nov-09	17:58:00	Repositioning on waypoint 9. Ship drifting, pulling cage		Katie
02-Nov-09	17:58:00	Start of transect 1, zooming in cobbles, boulders, gravel on sandy/mud. Stars, snails	pebbles/cobbles	Katie
02-Nov-09	18:01:00	Starting transect 1. alcyonacea - pink soft corals		Katie
02-Nov-09	18:02:00	Boulders. large sea stars. getting pulled by cable on bottom	mixed	Katie

Date	Time	Comment	Substrate	User
		rocks		
02-Nov-09	18:05:00	End of transect 1, waypoint 10		Katie
02-Nov-09	18:08:00	En route to transect 2		Katie
02-Nov-09	18:12:00	Start of transect 2 - waypoint 11, zoom in		Katie
02-Nov-09	18:14:00	Lots of cobble and gravel. Snails, sea pens, brittle stars, sea spider on rock - rock has white residue on it		Katie
02-Nov-09	18:15:00	Small white patches on gravel on bottom - bacterial mat? Rusty coloured rock		Katie
02-Nov-09	18:16:00	Starting transect 2		Katie
02-Nov-09	18:18:00	Problem moving forward - propulsion? Cable wrapped up?		Katie
02-Nov-09	18:20:00	End of transect 2 - waypoint 12	mixed	Katie
02-Nov-09	18:23:00	Following same transect back - cable probably wrapped around boulder		Katie
02-Nov-09	18:26:00	Very cobbly, pebbly bottom, Large boulder. Start of transect 3. White patches on bottom and black residue	pebbles/co bbles	Katie
02-Nov-09	18:31:00	Black bottomed rock, Bacterial mats, Still lots of other benthic life		Katie
02-Nov-09	18:35:00	Trying to pick up white/ black covered rock, Sediment black under surface		Katie
02-Nov-09	18:41:00	Start of transect 3 - waypoint 13		Katie
02-Nov-09	18:42:00	Going downslope		Katie
02-Nov-09	18:46:00	Going back along same transect to waypoint 13 - original was offset		Katie
02-Nov-09	18:47:00	Larger bacterial mat, 25m from seep coordinate 1. At beginning of transect 3 again - mark with waypoint 14		Katie
02-Nov-09	18:57:00	Redoing transect 3 - third attempt. First two were offset		Katie
02-Nov-09	18:58:00	End of transect 3 - waypoint 15. Gravel, sand, mud mix. Lots of brittle stars. Heading to transect 4		Katie
02-Nov-09	19:00:00	At start of transect 4. Zoomin in : sponge, cobble, gravel.		Katie
02-Nov-09	19:06:00	Starting transect 4		Maeva
02-Nov-09	19:08:00	Mix of cobble sizes		Katie
02-Nov-09	19:09:00	Basket star		Katie
02-Nov-09	19:11:00	End of transect 4. Positioning system jumping around up to 15m, Zoom in		Katie
02-Nov-09	19:12:00	Small sculpin, Coral		Katie
02-Nov-09	19:19:00	Running a transect across the NE ends of the transect lines		Katie
02-Nov-09	19:23:00	Start of transect 5 along top of previous 4. Tall soft coral		Katie
02-Nov-09	19:26:00	Near waypoint 1 - large bacterial mats		Katie
02-Nov-09	19:28:00	Bubbling coming out of seafloor, Starfish sitting right on top of hole with bubbles coming out		Katie
02-Nov-09	19:37:00	Lots of bacterial matting, Black and white covering rocks and sand		Katie
02-Nov-09	19:40:00	Picking up bacterial coated rock		Katie
02-Nov-09	19:44:00	Heading towards cage		Katie
02-Nov-09	19:58:00	At cage, ready to move to next potential seep area		Katie
02-Nov-09	20:00:00	Moving to seep target #3. Ship moving in tandem with ROV, cage USBL head lifted due to ice		Katie
02-Nov-09	20:19:00	Ship is in position over next site. Re-lowering USBL head		Katie
02-Nov-09	20:29:00	ROV heading to bottom to start of transect 6 at new site. 257m water depth		Katie
02-Nov-09	20:33:00	ROV on bottom. Water depth 259m		Katie
02-Nov-09	20:35:00	Ship drifting. ROV being pulled. Ship trying to reposition in circle		Katie
02-Nov-09	20:36:00	Mud with cobbles, pebbles, gravel. Start of transect 6, zooming in. Lots of stars, White sponge	mixed	Katie
02-Nov-09	20:41:00	Start of transect 6 - waypoint 19		Katie

Date	Time	Comment	Substrate	User
02-Nov-09	20:41:00	Lots of gravel		Katie
02-Nov-09	20:43:00	Too far off transect, returning to beginning to restart		Katie
02-Nov-09	20:46:00	Nav jumping around significantly		Katie
02-Nov-09	20:47:00	Restarting transect 6		Katie
02-Nov-09	20:49:00	Fine gravel. Lots of stars		Katie
02-Nov-09	20:50:00	Tether appears to be stuck on bottom, ROV being pulled		Katie
02-Nov-09	20:56:00	End of transect 6. 10 minutes to complete transect. Waypoint 20. Urchin. Small mud mounds, Gravel, cobbles on top of mud. Orange sea star coated in mud	mixed	Katie
02-Nov-09	21:00:00	En route to next transect		Katie
02-Nov-09	21:01:00	Big boulders. Moving down slope		Katie
02-Nov-09	21:02:00	At start of Transect 7, zoom in. Boulder, Gravel covered mud. Sponge		Katie
02-Nov-09	21:05:00	Start of transect 7 - waypoint 21		Katie
02-Nov-09	21:10:00	End of transect 7. Waypoint 22, zooming in. Lots of gravel, cobbles covering muddy bottom		Katie
02-Nov-09	21:12:00	Moving to next transect		Katie
02-Nov-09	21:14:00	At beginning of transect 8. 45 minutes bottom time left		Katie
02-Nov-09	21:18:00	Zooming in, lots of suspended sediment in water column		Katie
02-Nov-09	21:19:00	Pile of cobbles covered in growth, Piled up by ROV?		Katie
02-Nov-09	21:21:00	Start of transect 8. Waypoint 23		Katie
02-Nov-09	21:24:00	Cable pulling ROV		Katie
02-Nov-09	21:25:00	Pulling some cable into cage, getting tangled up on bottom and pulling ROV		Katie
02-Nov-09	21:26:00	Boulders, Pile of mud in midst of gravel-strewn seabed	mixed	Katie
02-Nov-09	21:29:00	End of transect 8 - waypoint 24		Katie
02-Nov-09	21:32:00	Moving towards next transect		Katie
02-Nov-09	21:32:00	Slope. Lots of crinoids		Katie
02-Nov-09	21:36:00	Beginning of transect 9. Sponge, stars. Lots of cobbles, gravel on bottom	mixed	Katie
02-Nov-09	21:37:00	Starting transect 9. Waypoint 25		Katie
02-Nov-09	21:38:00	Big cobbles, rocks, boulders. Crinoids		Katie
02-Nov-09	21:39:00	Pulling cable into cage		Katie
02-Nov-09	21:44:00	In vicinity of seep target #2. No signs of seepage, bacterial mats		Katie
02-Nov-09	21:47:00	On seep target #2 according to nav		Katie
02-Nov-09	21:50:00	Exploring area around seep targe #2		Katie
02-Nov-09	21:52:00	Heading back towards cage across bottom via central seep targets		Katie
02-Nov-09	21:54:00	Pulling cable in		Katie
02-Nov-09	21:57:00	On bottom under the cage		Katie
02-Nov-09	21:58:00	Zooming in on bottom. Gravel and cobbles on mud	mixed	Katie
02-Nov-09	22:01:00	Loops in cable on bottom. Bringing into cage and detangling		Katie
02-Nov-09	22:02:00	Returning to cage		Katie
02-Nov-09	22:07:00	ROV in cage. Thruster not working again - probably caused navigation issues		Katie
02-Nov-09	22:24:00	ROV in moon pool		Katie
02-Nov-09	22:37:00	End of dive. ROV back.		Katie

Post-dive: Once the dive ended, the ROV was secured in its hold. A post-dive check of the ROV was conducted at 17:00 UTC on 03 November. The post-dive check revealed that the aft starboard thruster was non-functional. All other systems were functional. The pilots and scientists also verified that the video and navigation recordings were of good quality.

35.4 Comments and recommendations

35.4.1 Leg 4a – 8 October to 6 November – Beaufort Sea, NW Passage, Baffin Bay

ROV Dive #23 – Viscount Melville Sound

Pre-dive meetings to discuss the dive plan should be held at least 12 hours before the actual deployment of the ROV. During these meetings, all personnel involved in the dive should be assigned specific responsibilities to ensure that all tasks related to the dive are covered. A short Toolbox Meeting to recap responsibilities should be held 30 minutes before the dive. An indicator light should be installed on the bridge to warn the navigation officers when there is an instrument deployed in the acoustic well and direct confirmation between the bridge and USBL monitor should be made prior to ship's movement. Personnel involved in the ROV dives should be well rested before any dive is carried out. The ROV transects should be carried out moving into the direction of the current to avoid re-suspended sediments stirred up by the ROV.

For future ROV dives without a positioning system, it would be possible to make approximately 50 metre transects by calculating the time it took to do so during Dive #23. Another method would be to run the vehicle out on a fixed heading from the ship, pull the tether tight and take the ROV out of auto heading. The reciprocal heading would give a transect direction back to the ship. Also, it is possible to get a sonar measurement for positioning the TMS. This method would provide range and bearing from the vehicle's current position, relative to the cage. The cage should be positioned under the moonpool and adjusted for ship speed and water current while a dive is underway. It would then be possible to plot the complete transect and move to a new position and repeat the method. Using WorkBoat it would be possible to easily plot data and end up with reasonable positioning for the completed the tracks.

36 Geotechnical mapping and sampling – Legs 3b and 4a

ArcticNet Phase 2 – Project titled *The Canadian Arctic Seabed: Navigation and Resource Mapping*. ArcticNet/Phase2/Hugues Clarke_Seabed_mapping.

Project leaders: Steve Blasco[1] (Steve.Blasco@NRCan-RNCan.gc.ca), John Hughes Clarke[2] (jhc@omg.unb.ca), and Imperial Oil (Legs 2a and 3b)
Cruise participants Leg 3b: Imperial Oil, Steve Blasco[1], John Hughes Clarke[2], Katie Blasco[1], Ian Church[2], Reenu Toodesh[2], Kate Jarrett[1], Kevin MacKillop[1], James Muggah[2], Bob Murphy[1] and Anna Pienkowski[3]
Cruise participants Leg 4a: Angus Robertson[1], Katie Blasco[1], Doug Cartwright[2] and Christine Legere[2]

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[2] *University of New Brunswick, Ocean Mapping Group, Department of Geodesy and Geomatics Engineering, P.O. Box 4400, Fredericton, NB, E3B 5A3, Canada.*
[3] *University of Alberta, Earth and Atmospheric Sciences, 1-26 Earth Sciences Building, Edmonton, AB, T6G 2R3, Canada.*

36.1 Introduction

36.1.1 Leg 3b – 12 September to 8 October 2009 – Beaufort Sea

Hydrocarbon exploration activity has shifted from the inner shelf to outer shelf/upper slope region of the Beaufort Sea. Few data exist to map the types and distribution of seabed geohazards which will affect exploration drilling operations. In collaboration with Imperial Oil Limited, British Petroleum, the University of New Brunswick and University of Alberta, the *Amundsen* conducted a data acquisition program in Leg 3b to investigate the extent and severity of seabed geohazards. The knowledge gained will feed National Energy Board regulatory processes, industry engineering design scenarios and environmental impact assessment processes.

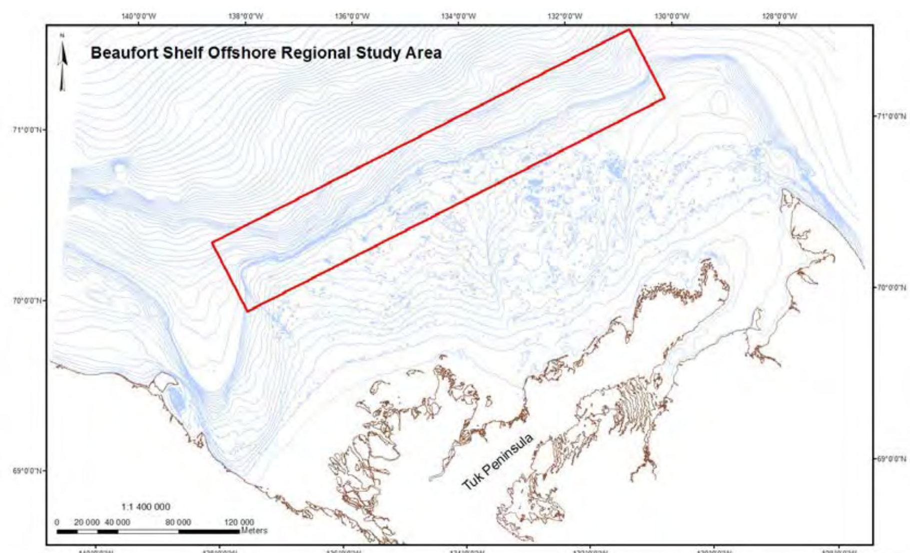

Figure 36.1. Beaufort Shelf study area of interest which was the focus of activities during Leg 3b.

36.1.2 Leg 4a – 8 October to 6 November – Beaufort Sea, NW Passage, Baffin Bay

During Leg 4a, the *Amundsen* transited the Northwest Passage, beginning in the Beaufort Sea, Northwest Territories and traveling through to Iqaluit, Baffin Island, Nunavut. The objectives of the GSC-UNB team included: multibeam, sub-bottom and water column mapping; box-core sub-sampling by push core for geotechnical sediment characteristics; box-core surface sediment sampling for microfossil analysis and age dating (U of A); ROV/video acquisition for benthic habitat characterization and multibeam calibration (NRCan partners, Museum of Nature); evaluation of current ROV technology onboard; and Gore sampling for sea surface and sediment hydrocarbon residues. The sites of proposed targeted geological and benthic study (Figure 36.2) along the transit were as follows (in order of priority):

1. Viscount Melville Bathymetric Depression
   a. Multibeam and sub-bottom of east-west rectangular block, or at minimum, a single east-west and three north-south transects of the block given by Pierre Richard, Department of Fisheries and Oceans (DFO)
   b. ROV footage along one transect within the block
   c. One boxcore in the deepest area surveyed plus push core for geotechnical properties and surface sediment sample
2. Barrow Strait
   a. Collection of water column data (and multibeam and sub-bottom) over pockmarks survey in 2005/2008 to look for evidence of gas seepage
   b. Continue mapping around pockmark region starting to the west and encompassing the bottom fault/ridge feature mapped in 2008
   c. ROV transect over the pockmarks and one boxcore with push core and surface sample
3. Scott Inlet
   a. Multibeam mapping of the 2008 block to obtain water column data for seepage analysis
   b. Northward continuation of survey towards Buchan Trough
   c. ROV of southeast trough wall in area of suspected seep
   d. One boxcore along slope/ROV transect plus push core and surface sample
   e. Gore sampling of oil slick at water surface
4. M'Clure Strait
   a. Multibeam and sub-bottom data collection (none to date in this region)
5. Lancaster Sound
   a. Multibeam and sub-bottom transect that passes through potential oil slick sites (T. Brent, GSC Calgary)
6. Peel Sound
   a. Continuation of mapping in area of glacial sole marks
7. South Baffin PLFs
   a. Multibeam and sub-bottom in area of possible mud volcanoes and/or bioherms
8. Amundsen Gulf sole marks, deep water scours and Sachs Harbour additional mapping (from Leg 3b plan).

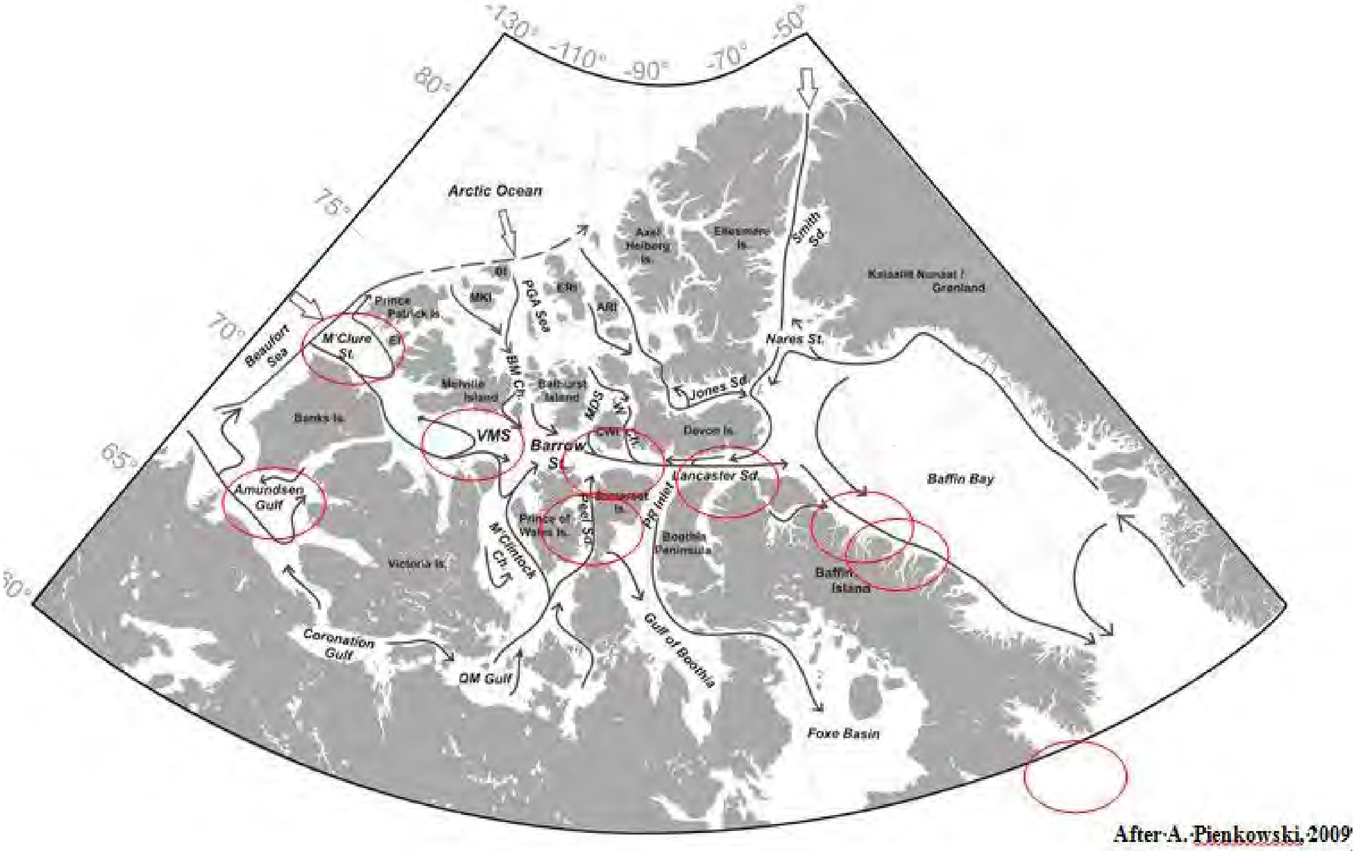

Figure 36.2. Multibeam/Sub-bottom mapping and benthic habitat characterization location targeted along the ship's track through the NW Passage in Leg 4a.

36.2 Methodology

The following navigation parameters were used for the collection of ROV and core data by Imperial Oil contractors during Leg 3b:

Geodetic Parameters:

Spheroid Parameters	Projection Parameters
Spheroid: GRS80	Projection: UTM
Semi-Major Axis: 6378137.0m	Zone: 8N
Inverse flattening: 1/298.257222101	Central Meridian: 135°
Work Datum: NAD83 (Canadian Spatial Reference System)	Scale Factor at Central Meridian: 0.9996
	False Eastin: 500,000m
	False Northing: 0m
	Latitude of Origin; 0°00'00.00"

Datum Transformation ITRF05 to NAD83 CSRS:

DGPS co-ordinates are referenced to the ITRF05 datum; the working datum is NAD83 (CSRS), therefore transformation of the co-ordinates, using the following transformation parameters was required:

DMA Convention (Epoch 2009-09-15)
ΔX: 1.0026 m
ΔY: -1.9100 m
ΔZ: -0.5389 m
RX: 0.026762 arc seconds
RY: -0.000196 arc seconds
RZ: 0.010947 arc seconds
Scale: -0.000521 ppm

36.2.1 Equipment and facilities

Mapping (see Section 33 for details)

- Kongsberg EM302 1° x 2° 30 kHz multibeam echosounder flush-mounted behind ice windows
- Knudsen K320R sub-bottom profiler, 16 element hull-mounted 3.5 kHz (12 ms chirp, 2-7 kHz)
- Applanix POS/MV 320 motion and orientation sensor
- Navigation system
- Moving Vessel Profiler (MVP, see Section 8)
- CTD-Rosette (See Section 8) – salinity and temperature measurements were used by the mapping team to calculate water velocities

Piston coring (Leg 3b only)

The piston corer used onboard the *Amundsen* was constructed based on blueprints of the Atlantic Geoscience Centre (AGC) Long Coring Facility (LCF) supplied by the Geologic Survey of Canada Atlantic (GSCA). The LCF system used by GSCA on the CCGS *Hudson* obtains a core sample with an ID of 99.23 mm. The 10 ft (305 cm) long barrels have an OD of 12.71 cm, wall thickness of 0.95325 cm and ID of 10.8035 cm. The core head is 3 m long, 0.6 m in diameter and weighs 3000 lbs (1365 kg). The core head is connected to the barrel string using a "half" coupling. A maximum of 10 barrels can comprise the barrel string and are attached to each other with external couplings. Each coupling has 16 holes drilled and tapped for ¾" set screws which mate to the grooves on the core barrels.

Core liner, manufactured to meet GSCA specifications, is made of cellulose acetate butyrate (CAB) plastic and contains the recovered sediment. The liner has an I.D. of 9.923 cm and an O.D. of 10.523 cm. The liner is inserted inside the core barrels and each length is held together with clear tape.

A split piston with two O-rings and a variable orifice size is used to prevent the corer from plugging and results in greater sediment penetration and reduced sample distortion. The split piston is pinned to an Electroline eye socket termination assembly fitting on the end of the 3/4" cable that is inserted through the core head. A core cutter (I.D. 10.008cm) houses the core catcher and serves as a replaceable nose cone for the corer. The 10 degree taper on the outside guides the cutter into the sediment. The inside bore channels the recovered sediment into the liner where it is retained during recovery. The cutter is fit over the end of the last core barrel and secured with 8 set screws.

The Trigger Weight Core (TWC) has a dual function. It acts as a trip weight and is used in conjunction with the trip arm to set the piston corer up for a predetermined free fall before sediment penetration. The corer and cable is shackled to the end of the trip arm. In addition the TWC acts as a gravity core which supplements the data obtained from the piston corer by collecting an undisturbed surface sample. The TWC consists of one barrel, coupling, nose cone, catcher, liner, one way valve and weight stand. Additional lead weights (donut shaped) may be added around the weight stand. The overall weight of the pilot corer can vary but it is approximately 300 to 400 lbs (140 to 180 kg).

The specifications of the coring system used on the CCGS *Amundsen* are identical to the GSCA system with the following exceptions:

- A core head of 1800 lbs was used during Leg 3b. A backup core head of 2200 lbs was available but not used.
- The length of the first barrel was 304 cm long, and the second and third barrels were 302 cm long.
- The TWC barrel was 126 cm long and the TWC weighed 250 lbs.

<u>Box coring</u>

The box core used is a GSCA system based on a Benthos Box corer design. The total weight of the system is 1500lbs.The box corer consists of a 50cm x 50cm x 60cm box and provides an undisturbed sample of the seafloor. The box corer was deployed and retrieved using the 500 horsepower Hawboldt winch and the large block on the A-frame.

<u>Sub-Atlantic Super Mohawk ROV</u> (see Section 34)

- docking cage with camera and spooling tether
- two cameras: black/white and colour
- forward-facing sonar
- manipulating arms
- sips gas sampler (Leg 4a)

<u>GSCA Vladcam Bullet (Leg 4a only)</u>

The Vladcam Bullet camera housing developed during July of 2009 was used on the ROV dives during this leg. This case was originally designed to fit a high definition Sony camcorder model HDR SR12. Due to recording duration limitations with this model (approximately 2 hrs in super high definition HD-FH) it was decided to try the newest model released in early October days before the trip. While onboard the underwater housing was easily modified to accommodate the new smaller Sony HDR-CX520V which was thought to be able to record well over 4 hrs of HD-FH to a large solid state internal hard drive.

Gore Sampling (Leg 4a only)

In conjunction with W.L. Gore Maryland, several Gore sampler modules were used on this mission to perform sediment sampling and water surface oil slick sampling. See below methodology for details of procedures and equipment used.

Facilities

- Foredeck coring container – used for coring equipment and tool storage, core preparation
- Foredeck A-frame and crane for piston and box core deployment
- Geotechnical: Chemistry/Geopaleo aft laboratory (Level 500) – 2 rooms
  - o Sealing station – cutting down cores and waxing
  - o Torvane measurements and constant volume sampling
- Aft refrigerated core storage container near helideck
- ½ of acquisition room (202) for UNB/GSC use
  - o UNB: several laptop and desktop computers plus acquisition hardware
  - o GSC: one laptop computer
- HP Designjet T1100 Plotter located in server room
- Storage space for empty core liners – various locations externally on vessel

36.2.2 Positioning

Multibeam and sub-bottom positioning was done by UNB (see Section 33 for details).

Positioning for piston core, trigger core, boxcore, and ROV was achieved using a RangerPro USBL system correlated with Fugro's Starfix GPS navigation package. A USBL calibration beacon was deployed through the ship's acoustic well (Figure 36.3) before the start of the coring and ROV work to calibrate the position of the on-ship USBL transducer. The transducer was lowered to a fixed position prior to each core and ROV dive from the acoustic well on the 600 level. The calibration beacon deployment location was at: 70°44.5255' N, 136°22.544' W, at a water depth of 795 m on the slope of a deep valley feature. IOL contractors operated the USBL beacon during Leg 3b.

Figure 36.3. USBL calibration beacon deployed through the ship's acoustic well before the start of coring and ROV operations.

In Leg 4a, the first ROV dive was positioned as described above using the RangerPro USBL system, but the next three using the back-up Track Link 1500 system made by Link Quest. The Track Link 1500 system was calibrated during a test dive in Scott Inlet during Leg 4a. The transducer (for both the RangerPro and Track Link systems) was lowered to a fixed position prior to the ROV dive from the acoustic well on the 600 level.

36.2.3 Seabed mapping procedures

Details on seabed mapping appear in Section 33 and are only briefly described here. Collection and processing of the multibeam and sub-bottom data was carried out by the UNB teams working shifts in the acquisition room. UNB made available to the GSC daily geotifs of the multibeam mapping to date, asrun line navigation files, raw sub-bottom seg-y files, and pdf images of both multibeam and sub-bottom lines along requested regional areas of interest. Final multibeam images and sub-bottom data will be available after further processing is completed by UNB after the cruise. Onboard preliminary regional analysis of geohazards and bottom features using ArcMap and GSCA Segy-Jp2 (B. Courtney) in-house seismic viewing software was carried out by S. Blasco and K. Blasco.

36.2.4 Piston and TWC coring procedure (Leg 3b only)

The GSC/UofA team of K. MacKillop, K. Jarrett, B. Murphy and A. Pienkowski were responsible for the set-up, deployment (with aid from the deck crew), collection and processing of the piston, trigger, box and push cores. K. Blasco was trained in nuances of piston, box, and push coring and surface sediment sampling for responsibilities on Leg 4a.

Deployments and recoveries

The configuration of the *Amundsen*'s foredeck only allowed for the deployment of the piston corer with three barrels. The core barrels were supported by blocks as the coring system was rigged between the A-frame and the port side crane (Figure 36.4). Once rigged, the corer was raised and rotated, using the port side crane, and lain across the vessel with the base of the corer hanging over the side under the A-frame (Figure 36.4). A 5/8" cable was attached to the piston core wire and the TWC trip arm was attached to the core head. The USBL beacon was attached to the 5/8" winch cable above the core head (Figure 36.5).

The crane was used to lift the core to hang vertically below the A-frame. The crane cable was then detached from the core head. The TWC was raised using the capstan on the 500 horsepower Hawboldt winch and the small block on the A-frame. It was then lowered over the side and attached to the trip arm (Figure 36.6). The coring system was then lowered using the Hawboldt winch and the large block on the A-frame (Figure 36.6). The reverse procedure was used for retrieval of the TWC and piston core.

Figure 36.4. Preparation and deployment of the piston core used for geotechnical sampling during Leg 3b.

Figure 36.5. USBL beacon attached above the piston core head prior to deployment.

Figure 36.6. Deployment of the piston core or Trigger Weight Core (TWC) from the foredeck during Leg 3b.

Core processing and subsampling

All GSCA piston and TWC cores were processed according to standard GSC Atlantic core procedures (refer to GSC Open File #1044). All cores were identified alphabetically by section at the time of dismantling individual core barrels from the bottom to the top, commencing with the bottom-most core barrel and proceeding to the uppermost barrel containing sediment. Each 302 cm length of liner was extruded from the barrel and cut in half on the foredeck, using a GSCA pipe cutter. The sediment in the liner was cut using a wire saw and the section ends were carefully capped to minimise disturbance to the sediment surface. The top end cap was labelled with the cruise number, station number, section label and top. The base of the core is designated with the letter A and the top of the base section is designated as B. The base section is AB. Each section was brought into the aft Chemistry Lab and stored horizontally on the bench. Each core, starting with the base section AB, was processed using the following procedure. The core liner was labelled with an up arrow, cruise number, station number, section label and the top and base of the section were labelled with the appropriate letter. End caps were removed if the sediment was not too fluid, and the section length was recorded.

Undrained shear strength measurements and constant volume samples were taken at the top and base of each section where possible. Inert packing was placed in the voids created by the constant volume sampling, and the ends of each core section were recapped, taped and waxed. The sealed core sections were stored upright in the refrigerated reefer container and maintained at 4°C. All core cutters and catchers were measured, labelled, placed in split liners, waxed and stored upright in buckets in the refrigerated container. All extruded core sections due to sediment expansion or core processing methods were likewise labeled and stored. All samples and subsamples were catalogued and their location information within the container was recorded in an excel spreadsheet.

Station location information, core section lengths, extruded pieces and cutter/catcher lengths, sediment description and core performance information have been documented on deck sheets, and input into the ED (Expedition) database. The ED database was backed up and will be verified before downloading into the main ORACLE sample database.

Physical properties measurements

Undrained torvane shear strength measurements and constant volume samples were taken at the ends of each section if the condition of the sediment allowed. The constant volume sampler was inserted into the end of the section, the undrained shear strength measurement was taken and then the constant volume sampler was removed.

The undrained shear strength was measured using a hand-held Hoskin Scientific Torvane. The dial on the Torvane was zeroed, the fins on the vane were completely inserted into the sediment. The dial was rotated at a constant rate until the sediment failed (Figure 36.7 left).

Figure 36.7. Left: Shear strength measurements performed on the sediment cores collected during Leg 3b. Right: Bulk density and water content determinations conducted on cores collected during Leg 3b.

The Torvane dial reading ranges from 0 to 1 and reports values in kg-force/cm^2 units (1 kg/cm^2 = 98.07 kPa). The Torvane has three adapter vanes as described below:

L - Sensitive vane has a range of 0 to 0.2 kg-force/cm^2
Su = dial reading * 0.2 kg-force/cm^2
M - Regular vane has a range of 0 to 1.0 kg-force/cm^2
Su = dial reading * 1 kg-force/cm^2
S - High capacity vane has a range of 0 to 2.5 kg-force/cm^2
Su = dial reading * 2.5 kg-force/cm^2

Constant volume samples for bulk density and water content determinations were taken by inserting stainless steel samplers of a known volume (Figure 36.7 right). Prior to insertion, the sampler was lightly sprayed with Pam cooking oil and gently wiped with a small Kimwipe tissue. The bevelled edge of the sampler was placed on the flat sediment surface and carefully inserted into the sediment at a constant rate using two flat headed spatulas. The sampler is inserted at a constant rate to minimize compression of the sediment within the sampler. The sampler was then carefully removed and the sediment was trimmed using a wire saw and extruded into a pre-weighed 1 oz screw-top glass bottle. The bottle cap was then labelled and sealed using electrical tape to prevent the lid from loosening. The samples will be weighed, dried at 105°C for 24 hours and re-weighed to determine bulk density, dry density and water content according to ASTM Test Method D 2216-90 (revision of 2216- 63, 2216-80) Standard method for laboratory determination of water (moisture) content of soil and rock. All relevant information for the Torvane measurements and constant volume samples was recorded on data sheets and input into excel spreadsheets and will be incorporated into the GSCA physical property database.

36.2.5 Box coring procedure

The box corer was deployed and retrieved using 500 horsepower Hawboldt winch through the A-frame (Figure 36.8 left). Upon retrieval, the box core frame was removed and water was drained from the top of the box. Photographs were taken of the sediment surface. A 50 cm length of CAB plastic core liner (push core) was slowly inserted using a vacuum backpressure technique to prevent sample compression (Figure 36.8 right). On average, one push core was taken from each box core and one surface samples were taken for micropaleontology. For this procedure, ~100 cc of surface sediment was skimmed off the top of the box core with a clean metal spatula.

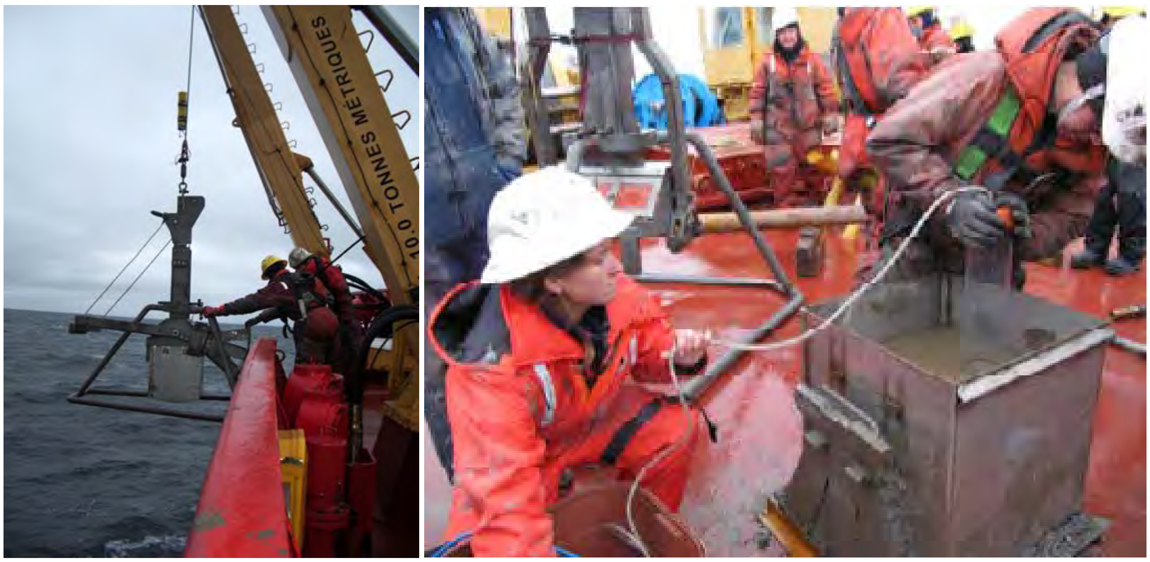

Figure 36.8. Box core deployment (left photo) and core processing and subsampling after retrieval (right).

In Leg 4a, a second push core was taken at several of the sites in order to perform a Gore sediment hydrocarbon analysis (see below). These cores were not kept intact because of the nature of the sampling procedure and were therefore not stored.

The push cores were taken back to the aft Geopaleo Lab for processing and then stored vertically in the refrigerated container on the helideck. All GSCA push cores were processed according to standard GSC Atlantic core procedures (refer to GSC Open File #1044). All cores were identified by cruise number, GSCA station number and alphabetical section, AB. The base of the core is designated with the letter A and the top of the base section is designated as B. Each section was brought into the Geopaleo Lab and stored vertically in core holders attached to the fixed work benches using bungees. Each push core was processed using the following procedure. The core liner was labelled with an up arrow, cruise number, station number, and section label. End caps were removed if the sediment was not too fluid, and the section length was recorded.

Undrained shear strength measurements were taken at the base of each section where possible. Constant volume samples were not undertaken due to a lack of sampling materials. The ends of each core section were then re-capped, taped and waxed. The sealed core sections were stored upright in the refrigerated reefer container and maintained at 7°C. Surface samples and rock samples were catalogued and placed in a bag in the refrigerated reefer container. The temperature of the container was regulated by a digital, alarmed temperature gauge monitored by the ship's electrician and checked twice daily by K. Blasco.

Station location information, core section lengths, sediment description and core performance information have been documented on deck sheets. This information will be input into the ED (Expedition) database upon return to Bedford Institute.

Torvane shear strength measurements were taken at the base of the push cores if the condition of the sediment allowed following the procedure described above in the piston core section (35.2.4).

36.2.6 Gore hydrocarbon sediment sub-sampling

Seven push core sub-samples were taken throughout the survey for testing with W.L. GORE membrane. Sub-samples of sediment were removed from the push cores and contained in special laboratory jars, thus exposing the sediment to the GORE-SORBER material which will pick up hydrocarbon traces. A spatula was used to dig down into the push core so that a representative sample could be taken approximately 10-15 cm from the surface. This sediment was then scooped into the jars. These were capped tightly and then stored at room temperature. They will be couriered back to the GORE labs on arrival in Iqaluit for analysis. There were no obvious signs of hydrocarbons evident in the sediment or at the surface such as slicks during the operations.

36.2.7 Sediment sampling

Leg 3b – 12 September to 8 October 2009 – Beaufort Sea

A total of 50 piston cores were collected by GSC in conjunction with Fugro for Imperial Oil, out of an attempted 51, as well as 8 box cores and 1 push core. A total of 6 piston cores, 8 push cores (from the aforementioned box cores) and 47 trigger weight cores were collected by the GSC during Leg 3b (Table 36.1 and 35.2). All of the GSC cores were split, processed (following standard procedures) and curated at the GSCA core repository located at the Bedford Institute of Oceanography, Dartmouth, Nova Scotia.

Cores 200098040040, 20098040011, and 20098040013 contained fine grained sand. The latter two also contained shells or shell fragments. The core taken at site 2009804003 within the PLF sediments showed evidence of gas expansion.

Table 36.1. GSC piston and box core locations during Leg 3b.

Core ID	GSC ID	Type	Latitude N	Longitude W	Location
CL35_G	20098040003	Piston	70°48.077	136°05.917	Large PLF
CL35_B	20098040002	Box	70°48.076	136°05.936	Large PLF
CL3_G	20098040026	Piston	70°38.205	136°09.572	Base of slump
CL7_G	20098040013	Piston	70°33.487	135°57.173	Shelf edge south of slump
CL7_B	20098040011	Box	70°33.483	135°57.189	Shelf edge south of slump
CL4_G	20098040019	Piston	70°35.528	136°02.552	Upper slump
CL4_B	20098040014	Box	70°35.530	136°02.560	Upper slump
CL5_B	20098040020	Box	70°37.315	135°58.607	East of slump
CL6_B	20098040023	Box	70°37.268	135°50.915	Shelf edge
CL13_G	20098040036	Piston	70°40.497	136°01.180	East of slump
CL13_B	20098040034	Box	70°40.496	136°01.180	East of slump
CL10_G	20098040040	Piston	70°35.437	135°45.116	Atop Shelf – erosion
CL10_B	20098040038	Box	70°35.426	135°45.128	Atop Shelf – erosion
CL11_B	20098040041	Box	70°37.374	135°45.152	Atop Shelf – erosion

Table 36.2. Location of IOL/GSC piston cores obtained curing Leg 3b.

CL	Latitude N	Longitude W	USBL Depth
35	70°48.078	135°05.933	729
35	70°48.079	135°05.939	726
30	70°45.848	136°10.816	655
27	70°44.709	136°13.181	615
23	70°43.795	136°15.081	581
22	70°43.504	136°15.447	569
21	70°42.686	136°17.327	726
7	70°33.484	135°57.193	76
4	70°35.526	136°02.551	202
5	70°37.315	135°58.599	218
5A	70°37.314	135°58.603	215
6	70°37.264	135°50.917	165
33	70°38.998	135°56.807	278
3	70°38.207	136°09.565	469
14	70°40.398	136°14.141	545
15	70°41.144	136°10.044	526
26	70°44.355	136°08.671	616
25	70°44.369	136°06.900	640
31	70°46.930	136°12.226	675
29	70°46.033	136°18.939	651
28	70°44.944	136°28.328	998
1	70°52.323	136°12.165	890
2	70°44.041	136°01.369	577
12	70°39.569	136°05.689	442
13	70°40.498	136°01.172	439
16	70°43.220	136°02.914	552
19	70°43.265	135°53.514	498
18	70°43.271	135°51.840	517
9	70°40.210	135°42.235	647
8	70°40.161	135°37.779	204

CL	Latitude N	Longitude W	USBL Depth
10	70°35.426	135°45.125	74
11	70°37.376	135°45.150	109
17	70°45.170	135°33.199	370
20	70°47.585	135°33.751	425
20	70°47.583	135°33.761	417
37	70°55.680	136°13.485	952
36	70°48.060	136°03.948	773
34	70°48.730	136°05.991	789
32	70°45.926	136°04.116	696
24	70°47.965	136°18.600	690
38	70°47.809	136°38.963	1068
39	70°41.432	136°27.100	793
40	70°42.884	136°32.622	1111
41	70°43.971	136°39.724	1253
37	70°55.680	136°13.485	952
44	70°44.834	136°16.252	568

Leg 4a – 8 October to 6 November – Beaufort Sea, NW Passage, Baffin Bay

The GSC had originally requested push core samples at the three main sites of interest: Viscount Melville Sound, Barrow Strait and Scott Inlet. At the commencement of Leg 4a, K. Blasco requested additional cores at other box core sites if time permitted in the schedule. As a result, a total of 12 geotechnical push cores, 7 Gore sediment samples, and 13 surface samples were taken by the GSC from the Beaufort Shelf through the Passage to Scott Inlet. Push cores and surface samples were obtained in all three main sites of interest. All of the GSC cores will be split, processed (following standard procedures) and curated at the GSCA core repository located at the Bedford Institute of Oceanography, Dartmouth, Nova Scotia. A total of 13 Gore casts for sea surface oil analysis were also completed throughout the Passage, although no surface oil slicks were noted, even at Scott Inlet (possibly due to ice conditions).

Box core results are summarized in Table 36.3. Positions indicated are ship's position at the approximate time of bottom touch-down as measured by the UNB team observing the operations and are derived from the UNB navigation system. No layback corrections have been applied for offset between the ship's GPS and the box core location at the A-frame. Depth estimates are taken from the 3.5kHz Knudsen sub-bottom profiler and therefore may have an error bar of several metres.

Table 36.3. Summary of box coring operations conducted during Leg 4a.

GSC ID	UTC date	UTC time	Station	Latitude N	Longitude W	Sub type1	Sub type2	Sub type3	Depth (m)	Comment
0060	NA	NA	437	NA	NA	NA	NA	NA	NA	Misfire - cable tangled, bad sea state
0060	13-Oct	1:36	437	71 47.138	126 30.533	NA	NA	NA	325.41	Poor recovery, slumped, gravelly, no one sampled
0060	13-Oct	2:04	437	71 47.095	126 30.224	NA	NA	NA	326.01	Poor recovery, slumped,

GSC ID	UTC date	UTC time	Sta tion	Latitude N	Longitude W	Sub type1	Sub type2	Sub type3	Depth (m)	Comment
										gravelly
0061	14-Oct	2:47	408	71 17.164	127 46.985	Push	Surface	NA	153.59	GSC
0062	14-Oct	3:12	408	71 17.193	127 47.439	NA	NA	NA	152.48	No GSC sample
0063	14-Oct	3:41	408	71 17.212	127 47.892	Push	Surface	NA	150.93	GSC
0064	14-Oct	14:44	437	71 46.731	126 28.509	Push	Surface	NA	321.26	GSC
0065	14-Oct	15:10	437	71 45.899	126 28.313	NA	NA	NA	320.38	No GSC sample
0066	16-Oct	18:53	405	70 39.853	122 59.773	Push	Surface	Push - Gore	~560	GSC
0067	16-Oct	19:34	405	70 39.853	122 59.773	NA	NA	NA	~560	No GSC sample
0068	20-Oct	5:36	308	74 06.087	108 50.058	Push	Surface	Push - Gore	546.17	GSC
0069	20-Oct	6:13	308	74 06.074	108 50.192	NA	NA	NA	547.13	No GSC sample
0070	24-Oct	3:38	304	74 19.022	091 24.151	Push	Surface	Push - Gore	333.02	GSC
0071	24-Oct	4:10	304	74 19.063	091 24.366	NA	NA	NA	333.12	No GSC sample
0072	25-Oct	17:07	323	74 11.010	080 37.951	Push	Surface	Push - Gore	780.85	GSC
0073	25-Oct	18:30	323	74 10.345	080 43.511	NA	NA	NA	793.20	No GSC sample
0074	27-Oct	7:48	103	76 18.733	076 38.496	NA	NA	NA	194.19	Attempt - core triggered - no sample
0075	28-Oct	1:25	105	76 17.609	075 45.780	NA	NA	NA	314.01	Partial recovery; no GSC sample
0076	28-Oct	16:03	109	76 17.510	074 07.342	Push	Surface	Push - Gore	454.51	GSC
0077	28-Oct	16:35	109	76 17.337	074 08.365	NA	NA	NA	449.61	No GSC sample
0078	29-Oct	1:28	111	76 17.076	073 13.017	Push	Surface	NA	566.92	GSC
0079	30-Oct	0:08	115	76 20.028	071 14.343	Push	Surface A	Surface B	674.32	GSC
0080	30-Oct	0:44	115	76 20.046	071 14.317	NA	NA	NA	674.49	No GSC
0081	31-Oct	0:52	136	74 41.108	073 20.318	Push	Surface	Push - Gore	784.26	GSC
0082	02-Nov	0:19	141	71 22.970	070 09.273	Push	Surface	Push - Gore	412.99	GSC
0083	02-Nov	0:47	141	71 22.696	070 09.303	NA	NA	NA	396.10	2 Attempts to core this site - no recovery, sloped, rocks

36.2.8 Gore cast procedure

W.L. GORE also provided surface water slick samplers to be used during the survey. These experiments were done throughout the survey transect from the western Arctic through to southern Baffin Island for a total of 13 stations. Gloves were donned and the small samplers were removed from the containment jars and tied to the fishing line of a small rod and reel. The sample was then cast onto the water usually from the port rail and left trailing in the water for approximately 2 to 3 minutes. The water surface was usually always scanned but no slicks were ever seen. The exposed samplers were then placed back into the glass jars and sealed tightly prior to storage.

The deployment and recovery times were carefully recorded for navigation positions and environmental data was recorded from the bridge such as air temperature, sea surface temperature, corrected barometric pressure and wind. For both the sediment and slick samplers the Ocean Mapping Group from New Brunswick kindly provided the navigation information.

Figure 36.9. Deployment and processing of the GORE surface oil slick samplers used during Leg 4a.

36.2.9 ROV operations

ROV deployment, navigation, and piloting were conducted by V. Auger (ROPOS technician) and S. Blondeau (ArcticNet technician) during Leg 3b, and by L. Michaud and P. Massot during Leg 4a, with help from the ship's crew (refer to Section 34 for more details). The ROV was deployed from the moonpool and operations and navigation was done in the adjacent ROV control room (678) with communication to the bridge and top level acquisition and mapping teams as needed.

The ROV was equipped with a forward-facing sonar, two manipulator arms and two cameras front-mounted (one black and white, and one colour). In Leg 4a, a new GSCA VladCam colour high definition camera was equipped on the ROV. It was only possible to record one of these feeds at any one time. The black and white image was usually preferable because of the better resolution and colour contrast in low visibility settings. Video files were saved to hard drive every 15-20 minutes. A viewing region of approximately 1 m^2 was possible with the ArcticNet black and white camera and lighting configuration. All ROV dives were viewed real-time and documented by the GSC for use as multibeam calibration on seabed features, sediment identification, and future benthic habitat analysis by partners at NRCan, UQAR, UVic and the Museum of Nature. Copies of the dives were stored on external hard drive and/or DVD.

36.3 Preliminary results

Leg 3b saw the acquisition of seabed multibeam, sub-bottom, sediment cores data and ROV imagery of geohazard features in water depths ranging from 60 to 1200 m. A variety of instability features were observed in the data including deformed strata, submarine slumps, shallow faults, diapirs, mud volcanoes and low strength sediments.

36.3.1 Multibeam and subbottom surveys

<u>**Leg 3b – 12 September to 8 October 2009 – Beaufort Sea**</u>

Most of the mapping surveys were conducted at the Beaufort Shelf – downslope transition region between 70°25’ N and 70°58’ N and 135°15’ W and 137°0’ W, with total approximate line kilometers of seabed multibeam and sub-bottom data collected (up to 5 October at 12:00pm):

- Multibeam: 6630 km
- Sub-bottom: 6533 km

Regional lines were also run while in transit to and from Paulatuk to the shelf-slope area, over Kopanoar mud volcano and in a regional grid within the Ikit Trough (Figure 36.10).

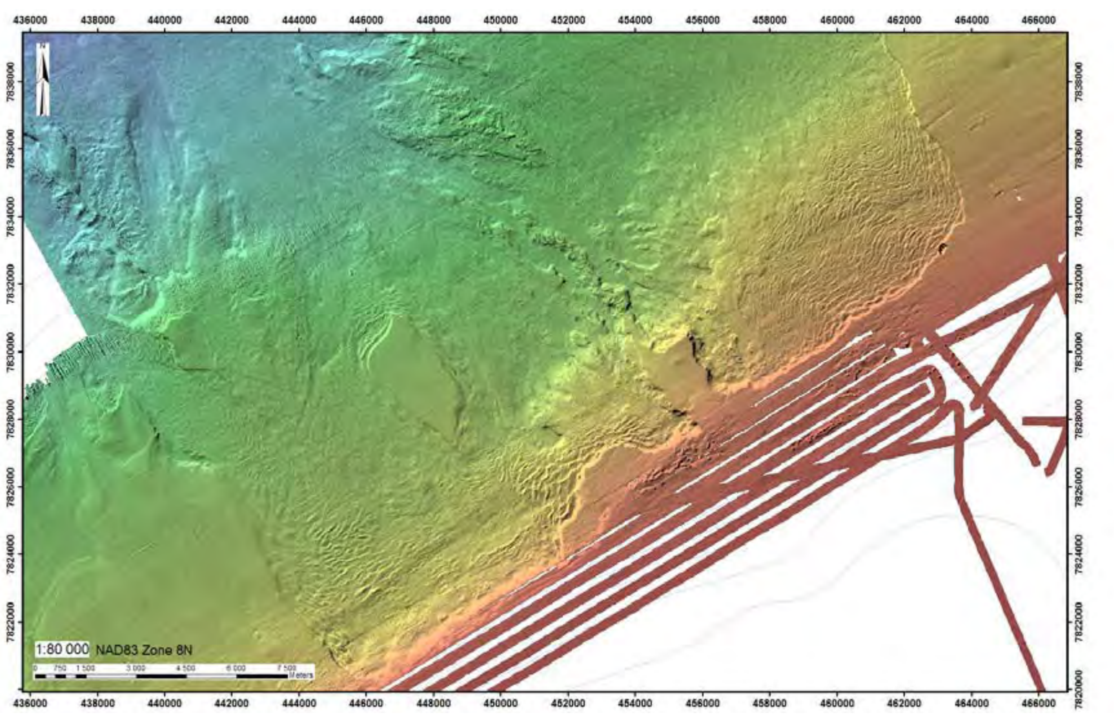

Figure 36.10. Raw 2009 multibeam bathymetry data collected during Leg 3b showing submarine sediment slumping along Beaufort shelf break (image courtesy of OMG, UNB, 2009).

Maximum penetration for the sub-bottom profiler was up to 100 m in soft sediments. Data collection speed varied between 5 knots and 14 knots, depending on the mapping region and survey resolution requirements (see Section 33 for details of mapping specifications and equipment settings). Regional seabed geohazards mapped during this study included: the seabed slump discovered in 1977 and mapped on two previous *Amundsen* cruises; a newly discovered shelf edge slump west of the aforementioned slump (Figure 36.11 top panel); a deep valley structure possibly related to relict topography at a previous sea-level lowstand; several large (500m+) PLFs, possibly mud volcanoes; a field of several hundred PLFs ~100m diameter along the shelf-slope transition; and evidence of prolific gas in the water column along the shelf-slope transition.

The sub-bottom data revealed eroded stratigraphy along the shelf edge break as was predicted from the known geological history of the sub-aerially exposed Beaufort Shelf. Outcropping sediment beds were evident on the sub-bottom records and a core at this location revealed a thin veneer of Holocene marine deposition as well as the presence of organics, possibly terrestrially related.

Within the two slumps along the shelf-slope transition, evidence of faulting and disturbed subsurface sediment deformation was apparent on sub-bottom lines (Figure 36.11 bottom panel).

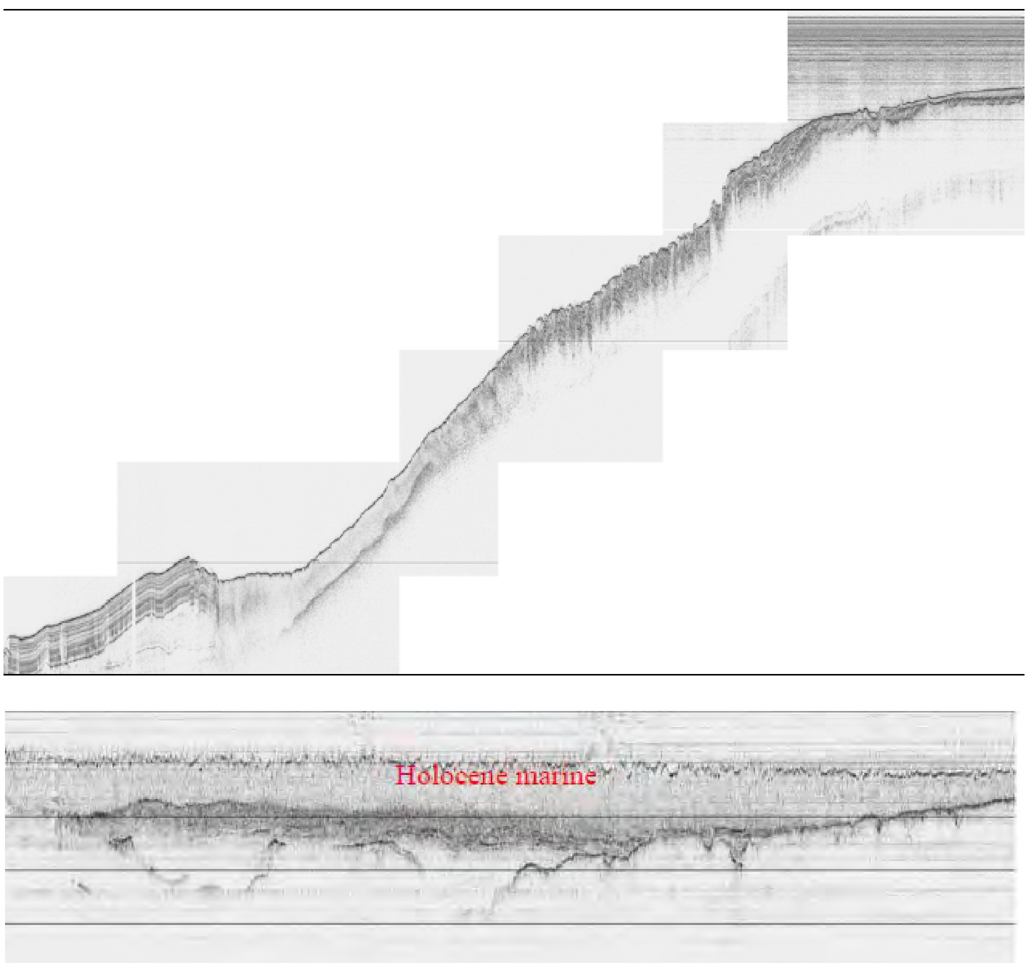

Figure 36.11. Raw 3.5 kHz sub-bottom transect across sediment failure at Beaufort shelf break (upper panel) and sub-bottom data collected in Ikit Trough during Leg 3b (image courtesy of OMG, UNB, 2009).

Leg 4a – 8 October to 6 November – Beaufort Sea, NW Passage, Baffin Bay

Total approximate line kilometers of seabed multibeam and sub-bottom data collected during Leg 4a were 7359 km for each system.

Mapping data was collected throughout the Northwest Passage, both along transect and over designated grids of interest. The high amount of ice throughout the Passage at this time of year prevented the collection of high quality multibeam data in both Viscount Melville Sound and Barrow Strait. A west to east transect through the middle of the beluga usage rectangle in Viscount was collected, providing mediocre quality sub-bottom data (Figure 36.12). It was decided that additional mapping in this region would not be productive due to the poor quality of the multibeam data and the mediocre quality of the sub-bottom data. There was no chance to run any dedicated mapping in Barrow Strait as the *Amundsen* was being escorted by the *Louis Saint-Laurent* due to ice conditions; therefore no mapping data over the pockmarks or other bottom features (faults, ridges) of interest was obtained in this region.

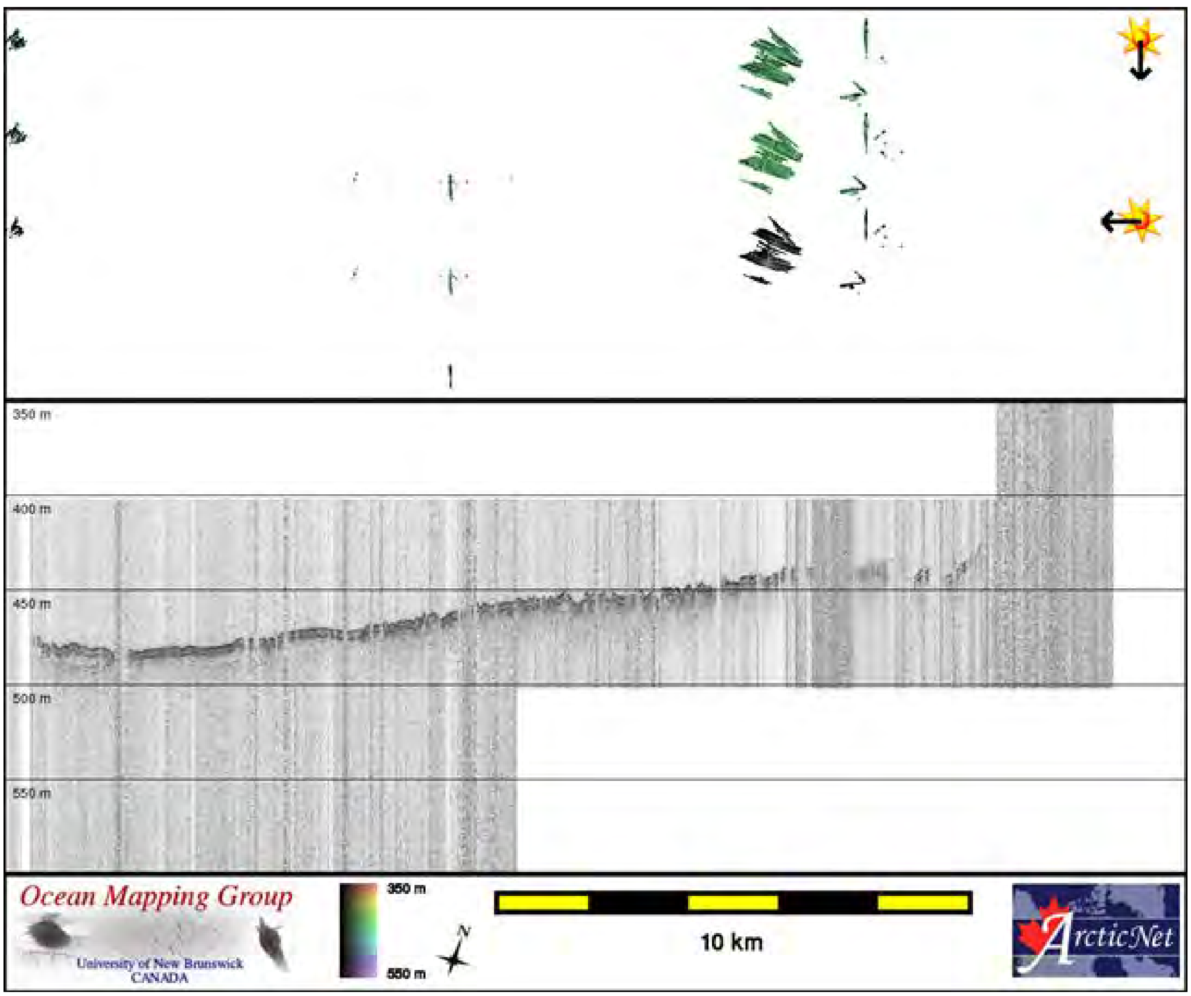

Figure 36.12. Multibeam and sub-bottom data collected in poor ice conditions in Viscount Melville Sound during Leg 4a.

Although ice also interfered with mapping at Scott Inlet, some good quality infill lines were collected over previously mapped regions to obtain water column data in advance of the ROV dive at the site. Several potential areas of fluid seepage from the sea floor were identified from the data in the southern Scott Trough grid. Additional data was collected to the southeast and southwest of the previously mapped block. This data will be primarily used for sub-bottom analysis as the multibeam quality was extremely poor due to ice conditions.

Although mapping plans in the three main areas of geologic and benthic interest this year were not completely fulfilled, opportunistic mapping of several sites of interest was undertaken. While on transect westward to Station 435, a corridor of data was collected along the Beaufort Shelf break. This area was of interest due to its association with potential faulting structures in the eastern Beaufort and its association with gas venting and mud volcanism. Preliminary analysis indicates that Pingo-like Features (PLFs), most likely mud volcanoes, exist along this region as well as unique bottom morphology along the N-S shelf portions of the transect. An earlier attempt to map this corridor during Leg 3b was thwarted due to ice conditions (Figure 36.13).

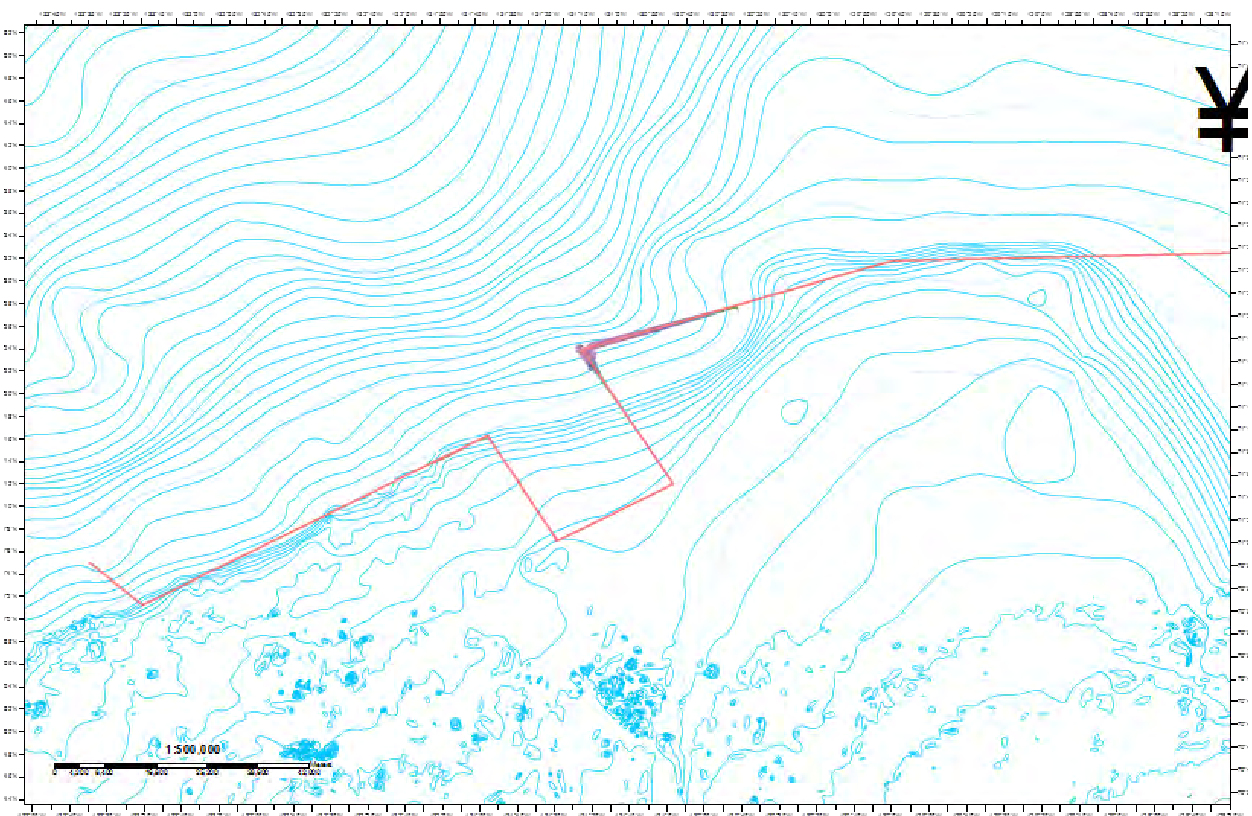

Figure 36.13. Multibeam transect across the eastern Beaufort Shelf break conducted during Leg 4a.

Opportunistic mapping in Amundsen Gulf and near Sachs Harbour allowed for the collection of multibeam and sub-bottom data in an area adjacent to previously collected data showing indications of glacial fluting and deep water scouring. Multibeam and sub-bottom data throughout the southern portion of Amundsen Gulf showed large bedrock valley and plateau structures (Figure 36.14).

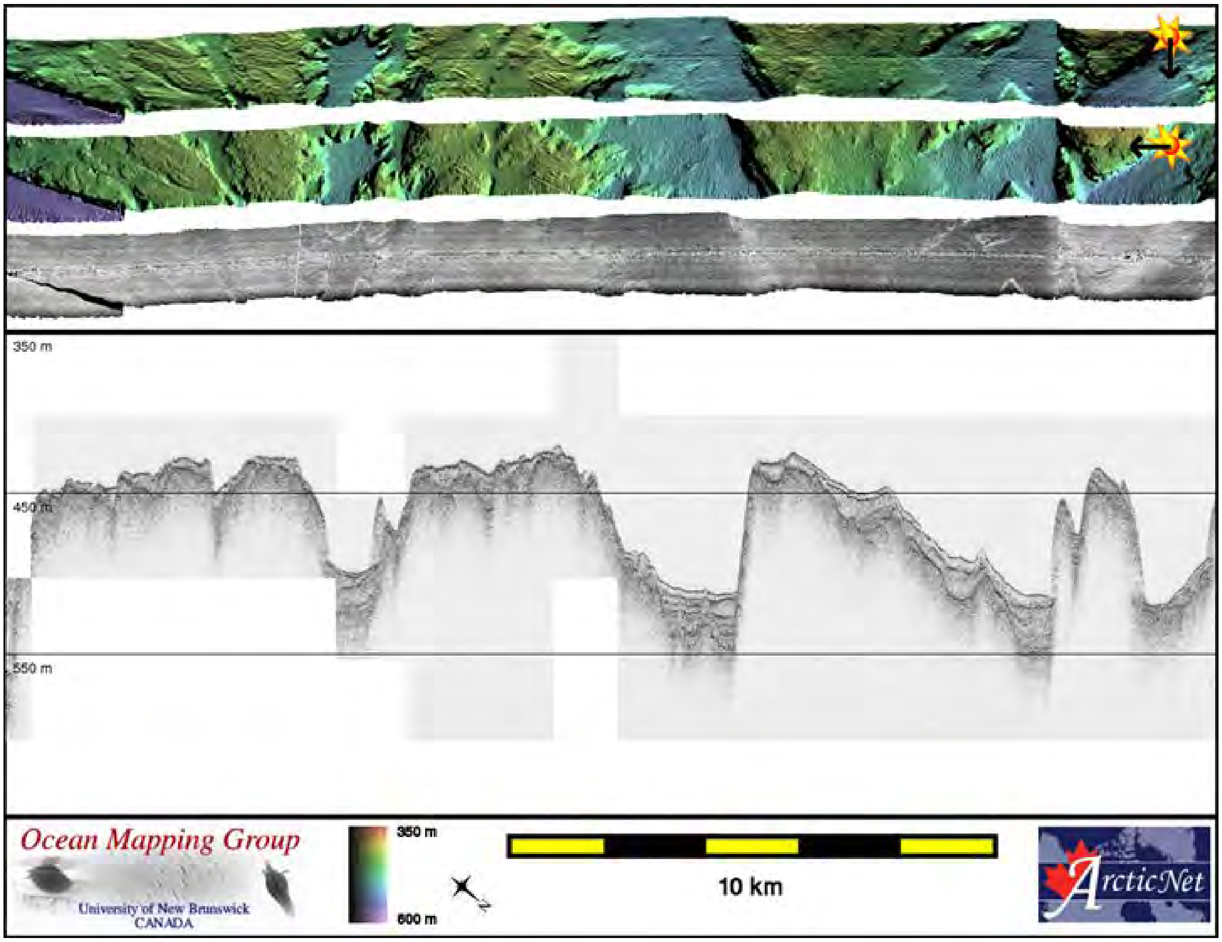

Figure 36.14. Multibeam and sub-bottom transects collected in Amundsen Gulf during Leg 4a.

Maximum penetration for the sub-bottom profiler was up to 100 m in softer sediments, although many of the areas throughout the Passage showed little penetration due to the presence of coarser bottom sediments and/or bedrock. Data collection speed varied between 5 knots and 13 knots, depending on the mapping region and survey resolution requirements. See Section 33 for details of mapping specifications and equipment settings.

36.3.2 Sediment sampling

Gore sediment and surface samples are summarized in Table 36.4 and 35.5. Gore positioning is based on UTC time correlated with ship's position as measured by UNB. Again, no layback correction for location of the cast relative to the ship position has been applied.

Table 36.4 (part 1 of 2). Details of locations and environmental conditions where the GORE-SORBER oil slick samplers was used during Leg 4a.

#	Sample ID	Geographic location	Station ID	Slick observed	Date in 2009	Time UTC	Datum	Deployment (Latitude N Longitude W)	Recovery (Latitude N Longitude W)	Air temp (°C)	Sea temp (°C)
1st Module Box											
1	688995	Beaufort Sea	437	No	Oct 12	174000-174500	WGS84	71° 47.215 126° 28.477	71° 46.937 126° 28.114	-1.2	0.63
2	688996	Beaufort Sea	408	No	Oct 14	011500-012100	WGS84	71° 47.128 126° 30.399	71° 47.167 126° 30.494	-2.2	1.02
3	688997	Amundsen Gulf	405	No	Oct 16	201000-202000	WGS84	70° 39.287 123° 00.683	70° 38.939 123° 00.491	No Ref	No Ref
4	688998	Barrow Strait	304	No	Oct 24	044500-045000	WGS84	74° 19.107 091° 24.545	74° 19.114 091° 24.562	-7.5	-0.4
5	688999	Lancaster Sound	323	No	Oct 25	182000-182400	WGS84	73° 55.779 085° 18.564	73° 56.018 085° 15.884	-8.2	- 0.81
6	689000	Baffin Bay	109	No	Oct 28	174900-175200	WGS84	76° 17.356 074° 05.731	76° 17.366 074° 05.915	-8	- 0.77
7	689001	Scott Inlet	146	No	Nov 1	161730-161900	WGS84	71° 24.144 070° 13.312	71° 24.224 070° 12.899	-12.1	- 0.66
10	689002	Scott Inlet	146	No	Nov 1	181700-182000	WGS84	71° 21.717 070° 15.713	71° 21.648 070° 15.727	-12.1	- 0.64
2nd Module Box											
1	689003	Blank									
2	689004	Blank									
3	689005	Blank									
4	689006	Blank									
5	689007	Blank									
6	689008	Blank									
7	689009	Blank									
8	689010	Blank									
9	689011	Blank									
10	689012	Blank									
3rd Module Box											
1	689017	Scott Inlet	146	No	Nov 1	203030-203230	WGS84	71° 21.369 070° 15.699	71° 21.384 070° 15.718	-12.5	- 0.49
2	689018	Davis Strait	No Station	No	Nov 3	192130-193430	WGS84	68° 20.443 063° 11.548	68° 18.674 063° 08.185	-7.2	- 0.43
3	689019	Davis Strait	No Station	No	Nov 4	155830-160130	WGS84	64° 36.067 063° 05.678	64° 35.933 063° 05.666	-4.3	0.07
4	689020	Blank									
5	689021	Blank									
6	689022	Blank									
7	689023	Blank									
8	689024	Blank									
9	689025	Blank									
10	689026	Blank									

Table 36.4 (part 2 of 2). Details of locations and environmental conditions where the GORE-SORBER oil slick samplers was used during Leg 4a.

#	Sample ID	Geographic location	Station ID	Pressure (mb)	Relative humidity (%)	Wind speed (knots)	Wind dir. (°)	Swell (m)	Ship move-ment	Comments
1st Module Box										
1	688995	Beaufort Sea	437	1023.9	84	25	155	2-3	Motion	Good deployment
2	688996	Beaufort Sea	408	1012.9	97	8	024	flat	Static	Ship came astern & lure experienced some prop wash
3	688997	Amundsen Gulf	405	No Ref	No Ref	No Ref	No Ref	No Ref	Static	High winds caused a disastrous deployment with the lure flying up on deck
4	688998	Barrow Strait	304	1021.2	86	9	013	No Ref	No Ref	No Ref
5	688999	Lancaster Sound	323	1015.4	78	22	012	No Ref	No Ref	No Ref
6	689000	Baffin Bay	109	1017.3	85	25	315	2	Static	Winds getting high so sampler skipped above the water and was suspended in air for 5-10s
7	689001	Scott Inlet	146	993.1	73	17	350	flat	Moving @ 6 kts	Scott Inlet area with patchy thin ice and flat water
10	689002	Scott Inlet	146	993.0	81	18	330	flat	Drift @ 1.1 kts	Scott Inlet area with patchy thin ice and flat water
2nd Module Box										
1	689003	Blank								
2	689004	Blank								
3	689005	Blank								
4	689006	Blank								
5	689007	Blank								
6	689008	Blank								
7	689009	Blank								
8	689010	Blank								
9	689011	Blank								
10	689012	Blank								
3rd Module Box										
1	689017	Scott Inlet	146	993	73	11	004	flat	Drift @ 0.6 kts	Scott Inlet area with patchy thin ice and flat water where open (probably about 75% ice cover)
2	689018	Davis Strait	No Station	1007.9	66	9	258	flat	Moving @ 2.5 kts	Sea surface almost flat with all open water and rare iceberg
3	689019	Davis Strait	No Station	1005.9	79	19	019	0.5	Moving @ 2.5 kts	Sea surface very small swell with all open water sun and large snowflakes falling
4	689020	Blank								
5	689021	Blank								
6	689022	Blank								
7	689023	Blank								
8	689024	Blank								
9	689025	Blank								
10	689026	Blank								

Table 36.5. Summary of samples taken with the GORE-SORBER sediment samplers during Leg 4a.

#	Sample ID	Geographic location	Station ID	GSCA Station	Depth (m)	Sample depth (cm)	Slick obs	Date in 2009	Time UTC	Datum	Position (Latitude N Longitude W)	Comments
1	186463	Amundsen Gulf	405	0066	560	10 - 15	No	Oct 16	1853	WGS 84	70° 39.853 122° 59.773	Sample OK
2	186464	Viscount Melville	308	0068	546	10 - 15	No	Oct 20	0536	WGS 84	74° 06.087 108° 50.058	Sample OK
3	186465	Barrow Strait	304	0070	333	10 - 15	No	Oct 24	0338	WGS 84	74° 19.022 091° 24.151	Sample OK
4	186466	Lancaster Sound	323	0072	781	10 - 15	No	Oct 25	1707	WGS 84	74° 11.010 080° 37.951	Sample OK
5	186467	Baffin Bay	109	0076	455	10 - 15	No	Oct 28	1603	WGS 84	76° 17.510 074° 07.342	Sample OK
6	186468	Baffin Bay	136	0081	784	10 - 15	No	Oct 31	0052	WGS 84	74° 41.108 073° 20.318	Sample OK
7	186469	Scott Inlet	146	0082	413	10 - 15	No	Nov 2	0019	WGS 84	71° 22.970 070° 09.273	Sample OK
8	186470	Blank										
9	186471	Blank										
10	186472	Blank										

36.3.3 ROV operations

<u>Leg 3b – 12 September to 8 October 2009 – Beaufort Sea</u>

A total of four dives were conducted in the shelf-slope region during Leg 3b (Table 36.6). The dives were conducted in conjunction with Imperial Oil, and will be used by the GSC to evaluate sea-bottom geology, calibrate multibeam backscatter data, and evaluate benthic communities. All dive sites showed a high level of organic particulate matter in the water column, making visibility difficult. Bottom sediments at all four sites were very fine muds, easily disturbed.

Table 36.6. ROV dives conducted during Leg 3b.

Dive	Site	Date	Latitude N (start)	Longitude W (start)	Comment
ROV1	Slump	29/09/09	70°37.638	136°03.137	
ROV5.1	PLF (mud volcano)	02/10/09	70°47.475	136°05.505	
ROV2	Northeast lobe of deepwater submarine valley	02/10/09	70°44.526	136°22.544	Retrieval of USBL calibration beacon
ASL Mooring	50m water depth	03/10/09	70°29.774	135°07.925	Retrieval of ASL mooring

Several types of starfish were observed, soft corals, fish and octopus. Shallower regions tended to be more prolific with animals, especially the upslope area east of the slump. Geologically, the footage was fairly unremarkable. Within the slump, several elevated north-south trending crests were traversed passing from west to east. The edge of slump exhibited only a gradual decrease in bathymetry. No sharp slopes or scarps were noted.

A traverse was run within the circular moat-like depression surrounding a 600 m+ diameter PLF believed to be a mud volcano. The transect began in the southern moat and transited south, upslope to level seabed. Again, no sharp slopes, scarps or bedding were noted, however a sinuous ridge-like east-west trending line was apparent, possibly related to sediment collapse, faulting and fluid migration. No active fluid seepage was noted.

Leg 4a – 8 October to 6 November – Beaufort Sea, NW Passage, Baffin Bay

A total of four dives were conducted during Leg 4a in Viscount Melville Sound, Baffin Bay, and Scott Inlet during Leg 4a. The dives were conducted in conjunction with UQAR and UVic, and will be used by the GSC to evaluate sea-bottom geology, calibrate multibeam backscatter data, and evaluate benthic communities. No dive was conducted in Barrow Strait due to the poor ice conditions.

Table 36.7. Locations of ROV dives performed during Leg 4a.

Dive #	Site	Latitude N	Longitude W	Comment
0023	Viscount Melville	74° 06.244	108° 52.578	Beluga Usage Area
0024	Baffin Bay	76° 19.668	071° 13.532	Test Dive
0025	Scott Inlet	71° 23.787	070° 08.959	Test Dive
0026	Scott Inlet	71° 22.788	070° 04.273	Seep Dive

During the first dive (0023) undertaken on 20 October, the new Vladcam Bullet HD camera was mounted very low on the ROV frame and positioned horizontally. This was due to very limited attachment space on the frame constrained by the tight TMS and moon pool tolerance. Unfortunately, when recovered, the imagery was poor due to the horizontal mounting location. Most of the video was of the water column with the occasional flash of the bottom before the thrusters and wake of the ROV suspended the bottom sediments.

Prior to the second dive, a much better mounting position was secured with careful consideration and engineering by the ROV team. The new position had the camera mounted on the upper syntactic foam of the submersible looking down from approximately 75 cm at a 45° angle. A test dive (0024) was undertaken on 30 October in Baffin Bay but due to poor positioning and increasing wind pushing ice the dive was scrubbed at the USBL calibration depth of 25 m.

The third dive (0025) was another test dive and undertaken on 1 November outside Scott Inlet and finally several hours of stunning HD video were produced. The camera was stopped at the surface by the operator seven hours after starting with free memory and lithium battery power left. The bottom varied with mud areas, gravel and cobbles. Some boulders were seen and a rich benthic fauna flourished in the cobble areas.

The fourth and last dive (0026) was undertaken on 2 November using the same mounting position for the HD camera as the previous dive. A very similar bottom to that described for 0025 was recorded with some white algal mats seen possibly growing near hydrocarbon escape areas. Beautiful HD video was recovered and the camera stopped about an hour after recovery on deck running for just over 8 hrs until the memory filled.

36.4 Comments and recommendations

36.4.1 Leg 3b – 12 September to 8 October 2009 – Beaufort Sea

<u>Equipment</u>

The set-up and maneuvering required for the piston coring operations was quite complex due to the limited foredeck space. A monorail system, along the port side of the vessel, would allow for the rigging of a longer barrel string and facilitate less complex handling procedures. Other suggested modifications to the coring system include:

- Design of a block system to better accommodate the present rigging and dismantling of the corer. One suggestion would be to build a frame for the core use head and hydraulic jacks with open cups to support the barrels.
- During the cruise the attachment of the trip arm to the 5/8” cable was modified and the wire clamp was removed. The current configuration is the trip arm attached to core head and then shackled to a larger shackle attached to the end of the 5/8” winch cable. The piston cable is also shackled to the larger shackle allowing the removal of the trip arm and its shackle upon recovery. This configuration removes the requirement of a kick off wire. It is recommended that this configuration be used in the future.
- The two piston core wires were damaged during coring and it is recommended that spare piston wires be on board. A 51’ wire is required for a 30’ core and a 41’ wire is required for a 20’ core.
- Manufacture molded rubber piston gaskets rather than punched out gaskets, which can damage the gaskets.
- Core barrels should be greased or rust checked and stored in another location to prevent the rusting of the barrel ends. If rusting occurs the barrels have to be sand blasted thus reducing the outer diameter of the barrel ends.
- Modify all barrels with 9 inches of sliding space on one end to a minimum of 18 inches. This allows the barrels to be joined together at either end.
- Currently there are two different size barrels on board. The original 10-foot (305 cm) long barrels and the slightly shorter 302 cm long barrels. Using the 302 cm long barrels requires cutting the CAB liner so that the liner breaks match up with the barrel lengths. It is recommended that only the 10 foot (305 cm) be used as the CAB liner is manufactured in approximately 10 foot lengths.
- Provide dedicated container space for all coring supplies.

The newly purchased (2009) Aquavision camera had not been installed on the ROV due to a missing cable. Discussions with V. Auger (ROPOS) indicated that even with this new camera, the image quality and viewing extent would not improve unless a better lighting system was also installed. For next year’s program, it is recommended to get the necessary pieces and install the Aquavision camera on the ROV, along with an updated lighting system, and to test the system in the water prior to the beginning of the 2010 cruise.

<u>Facilities</u>

Space usage in room 202, the acquisition room, was a particular issue as there were 12 or more computers operating at any given time and many people sharing the same desk space. If a similar data acquisition plan is proposed for future legs in future years, additional processing and data collection space should be provided to accommodate all scientific personnel.

The geotechnical team operated out of the aft geochemical laboratory as the geotechnical laboratory was allotted to Imperial Oil representatives. This space was adequate for processing and sealing the cores, however the geotechnical lab would be preferred in the future (provided it is not needed by a partner) because of its more convenient location in relation to the foredeck coring operations.

The installation of a man-door in the aft refrigerated core storage container would facilitate and provide safer access to the structure. Currently, the only access is through the two large container doors at front. Additionally, the installation of permanent core storage racks and shelves in the container would provide for economization of container space and improved storage capabilities, as well as eliminate the repeated need for onboard construction of storage racks each year. The 24-hour monitoring of the temperature alarm on this container is recommended.

36.4.2 Leg 4a – 8 October to 6 November – Beaufort Sea, NW Passage, Baffin Bay

<u>Mapping</u>

Due to the ice conditions, mapping objectives in Viscount Melville Sound, Barrow Strait, and partially in Scott Inlet, were not completed. Additional multibeam and sub-bottom mapping at these sites of benthic and geological interest is recommended for next year, preferably earlier in the season when ice conditions are more appropriate for multibeam data collection. Further research into interpretation and analysis of the water column data for indications of seafloor seepage is necessary. In the future, it would be useful to have available the raw multibeam and sub-bottom data collected by *Amundsen* in previous years. In most cases, the 10 m resolution multibeam grids were useful, but for ROV dives and selecting core locations, higher resolution is necessary. Access to previous years' sub-bottom data would also have been extremely useful for planning and interpretation.

Box coring

The box core unit worked very well. Some of the tolerances on the unit, such as the spade lift arm width could be adjusted slightly to speed up the alignment step when installing it. A couple of lifting rods could be easily built as well to allow the spade to be lifted into place in unison rather than using leverage on a slippery deck and brute strength. The main box core frame often had to be lifted prior to spade insertion using the winch as the height restricted the final positioning so an adjustment upward by 2 or 3 cm would alleviate this.

The foredeck dollies that were used to carry the boxes could be widened by a few centimeters to allow for easier alignment when the full box is lowered to the deck. A welded deck latching point often impeded the rolling of the dolly. The latching point could be easily moved approximately 50 cm outboard to eliminate this problem.

The placement of a few sipping holes around the perimeter of the stainless boxes, 3 to 5 cm below the top edge, would help initiate the removal of supernatant water once the box core is clear of the sea on recovery. This could help to preserve some of the delicate surface sediments and biota which are susceptible to damage when this water sloshes heavily on deck. None of the recovered cores had sediment reaching the top of the box so a series of small holes would not overly negatively influence the surface preservation.

For the first half of the survey, removal of the stainless boxes was completed using hands and fingers, which was rather difficult especially in sub-zero temperatures. In order to perform this step the sediment had to be excavated away from the exterior of the box where it made contact with the spade arms. This was often an aggravating and somewhat time consuming step. The removal handles fabricated on Leg 3b could not be located, so midway through the trip the marine engineering team came to the rescue and built two lifting tools from a simple sketch that could be hooked into the lifting lugs on the side of the box and lifted by two to four people. Handles should always be available to reduce the effort of box extraction.

In the core lab a simple liner grip was fabricated early in the leg out of plywood and gear clamp to hold the liner in a vertical position while cutting to length. This downsized the cutting operation from a two person job to a one person job. Further improvements to this system could be easily built from aluminum and rubber with a pivot point to allow vertical or horizontal positioning of the core. A simple collar could also be included to align at the sediment interface providing a base for the stainless cutter to initiate faster cutting and prevent any spiral cuts.

Positioning accuracy of the box core on the seafloor could be improved further with a USBL beacon and more powerful transducer operated by a dedicated navigation crew.

GORE-SORBER slick sampler

As the GORE sampling was added to the project after the initial planning stage it had little dedicated time allotted to it on Leg 4a. It was felt that several steps could be taken to improve the actual introduction and sustained exposure of the sampler to the sea surface.

Rather than the small pocket fishing rod used with the kit, a telescopic rod would allow the sampler to be dangled further away from the ship hull. The line and the bobbers could be heavier as well as they were often affected by the wind. It would be useful for the ship to slow and perform a slow turn of a few degrees over the 2 minute exposure time in the direction of the GORE sampler to give some lee in order to carry the sampler away from the hull. This survey was hampered often by short daylight and then heavy ice which pushed some of the sample stations into the evening. Unfortunately, no slicks were seen during the entire survey.

ROV camera systems

For the future the GSCA HD pressure housing could be smaller and lighter (a smaller system is in the design stage) allowing it to be mounted on the pan and tilt base of the Super Mohawk. This would allow the footage to be shot at the areas of most interest as controlled by the ROV pilots and science team. Another further enhancement to this would be to install an underwater connector on the pressure case to be wired in directly to the surface allowing live SD video feed in order to properly orientate the HD view.

The ROV was equipped with three 250 watt halogen lights that gave mediocre light. The ROV pilots had ordered LEDS for the trip but the supplier had problems delivering them on time. It was felt that the much hotter LED light temperature would allow truer colour of the seafloor and be more compatible with the Sony HD CCD.

The newly purchased (2009) Aquavision camera had not been installed on the ROV due to a missing cable. Discussions with V. Auger (ROPOS) on Leg 3b indicated that even with this new camera, the image quality and viewing extent would not improve unless a better lighting system was also installed. For next year's program, it is recommended to get the necessary pieces and install the Aquavision camera on the ROV, along with the updated LED lighting system, and to test the system in the water prior to the beginning of the 2010 cruise. The addition of lasers as a means of measuring features on-screen would facilitate analysis of the video footage for both geologic and benthic purposes.

Subsea positioning

Two crucial elements missing from the subsea positioning spread were a high power transducer head and a dedicated navigation team. The high power head was lost subsequent to the first dive, partially due to not having dedicated personnel assigned to this task. Private industry positioning is taken very seriously whether it be the petroleum industry, submarine telecom, archaeology, etc. This is not to be a multitasking position because it will eventually lead to problems in the positioning and lack of concentration on the other tasks the person is assigned to. The standby navigation system was a Track Link 1500 made by Link Quest but it was very unstable with numerous spurious readings possibly due to the low power, acoustic angle and ship noise. The ROV bottom transects, even in relatively shallow water of 250 m, were very noisy. A more accurate navigation system is needed for carrying out ROV operations and positioning cores.

Ship positioning

A working dynamic positioning system (DP) would assist with box coring and ROV transect operations. The DP would allow for automatic positioning of the ship according to the submersible position, allowing for longer and more accurate bottom transects to be run.

Safety and facilities

Before any helicopter transport, at the beginning of the mission, a short briefing on general safety around these aircraft should be conducted. There were likely several people with no experience in or around these machines who were transported from Paulatuk to the vessel. Cargo was being transported as well and daylight was limited, so rotor safety as a minimum should have been discussed as well as any potential ditching scenarios and proper PDF inflation timing.

During foredeck lifting operations, the absence of seizing wire on heavy lift shackles, swivels and blocks was noticed. It is recommended that this equipment be seized prior to use especially as some of the key blocks were well overhead and could prove lethal if dropped.

A working 110 volt plug available near the “A” frame or on the forward superstructure such as a weatherproof Kondo would be useful for vacuum pump operations rather than climbing in and out of the foredeck crane to connect to power.

The installation of a man-door in the aft refrigerated core storage container would facilitate and provide safer access to the structure. Currently, the only access is through the two large container doors at front. Additionally, the installation of permanent core storage racks and shelves in the container would provide for economization of container space and improved storage capabilities, as well as eliminate the repeated need for onboard construction of storage racks each year. The 24-hour digital monitoring of the temperature alarm on this container is recommended.

37 Sediments and benthos (CHONe) – Legs 2a, 4a, 4b and BaySys

ArcticNet Phase 2 – Project titled *Impact of Climate Change on Arctic Benthos*. ArcticNet/Phase2/Archambault_Arctic_benthos

ArcticNet Phase 2 – Project titled *The Canadian Arctic Seabed: Navigation and Resource Mapping*. ArcticNet/Phase2/Hugues Clarke_Seabed_mapping.

ArcticNet Phase 2 – Project titled *Understanding and Responding to the Effects of Climate Change and Modernization in Nunatsiavut.* ArcticNet/Phase2/Reimer_Nunatsiavut_nuluak

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37.1 Introduction

37.1.1 Leg 2a – 16 July to 30 July 2009 – Beaufort Sea

The collaboration between ArcticNet and Imperial Oil has extended the scientific program of ArcticNet on board the *Amundsen* to the Ajurak area in the Beaufort Sea. This team was responsible for the benthic sampling of the study area during Leg 2a.

37.1.2 Leg 4a – 8 October to 6 November – Beaufort Sea, NW Passage, Baffin Bay
Leg 4b – 6 November to 18 November – Labrador fjords

<u>ArcticNet projects</u>

It is now recognized that wide areas of the Arctic are changing from arctic to subarctic conditions. Rapid warming is causing higher water temperatures and reduced ice cover, two factors that will certainly provoke severe ecosystem changes propagating through all trophic levels. Over the past decade, a geographical displacement of marine mammal population distribution has been observed, that coincides with a reduction of benthic prey populations. According to a widely accepted conceptual model, the relative importance of sea-ice, pelagic and benthic biota in the overall carbon and energy flux will shift from a sea-ice algae-benthos to phytoplankton-zooplankton dominance. In the context of the potential benthic community changes, it is essential to establish benchmarks in biodiversity at key locations in the Canadian Arctic prior to (a) the expected changes in ice cover, ocean chemistry and climate and (b) the future human activities (transport, trawling or dredging, drilling, etc.) that are likely to happen in response to the predicted environmental changes. Unlike Canada's two other oceans, there is an opportunity to document pristine conditions before ocean change and exploitation occur.

These projects are also part of the studies titled *The Canadian Arctic Seabed: Navigation and Resource Mapping* and *Understanding and Responding to the Effects of Climate Change and Modernization in Nunatsiavut*, within the ArcticNet marine research program.

The objectives of this project were to:

- Describe communities in areas of enhanced and reduced productivity and diversity ("hotspots" and "coldspots") in the Canadian Arctic by comparing biodiversity, using a variety of indices (Price 2002) and secondary productivity of macrobenthic and meiobenthic communities.
- Quantify major fluxes and pathways of carbon and nutrients to gain an additional measure of productivity for benthic communities. These measurements provide a bulk parameter, commonly termed the 'sediment oxygen demand' (SOD), integrating total aerobic respiration of the community of benthic organisms contained in the core.

At the same time, changes in nutrient concentration for ammonia, nitrate, nitrite, silicate and phosphate in the ambient water are measured, to gain first knowledge on the role of benthic activity in nutrient cycling in Arctic waters.

<u>CHONe projects</u>

Legs 4a and 4b also involved a collaboration with the NSERC-funded Canadian Healthy Oceans Network (CHONe), which is a 5-year strategic partnership between Canadian university researchers, government agencies and ArcticNet. This network is about aligning Canadian marine science capacities to respond to research challenges and knowledge gaps on biodiversity in frontier oceanic environments, such the Canadian Arctic. CHONe is a national marine science initiative that is uniting researchers to provide scientific guidelines for policy in conservation and sustainable use of marine biodiversity resources in Canada's three oceans.

Within CHONe, the theme *Marine Biodiversity* is addressing how patterns of biological biodiversity are related to habitat diversity, specifically testing hypotheses that link functional (ecological roles of different species) and species biodiversity to habitat complexity. The theme *Ecosystem Function* aims at determining how ecosystem function (processes such as nutrient cycling) and health (whether ecosystems are able to maintain these processes) are linked to biodiversity and natural and anthropogenic disturbances. Specifically, the aim is to understand the role of biodiversity in marine ecosystem services (the "goods" provided to humans by living organisms) by linking biodiversity and ecosystem function measures, and to provide predictive models and tools to minimize anthropogenic impacts. The outcomes of each of these themes will be synthesized to identify approaches to bridge science and policy. This collaborative cruise allowed obtaining samples for 8 different projects inside CHONe, in addition to the ArticNet project outlined above.

Theme Marine Biodiversity / Diversity in Space: The objective was to estimate the strength and form of the relation of biodiversity to habitat diversity at multiple scales, to evaluate leading explanations for the relation and to generate ecosystem scale estimates of biodiversity and function using recent advances in ecological scaling.

Biodiversity in Arctic corridor (P. Archambault and K. Conlan): Evaluate the natural benthic diversity along the Arctic Corridor to search for new species for curation and to establish benchmarks in specific areas of the Arctic. This project is closely related to the Hebert and Dufresne project.

Geological controls on marine benthic habitat (S. Bentley): Elucidate and determine the relation of seabed geology and structural complexity to modern arctic and subarctic benthic habitat quality and faunal diversity. The specific research objectives were to:

- Relate the present benthic macrofaunal community to associated seabed structures (vertical and lateral), and bioturbation depths and rates
- Estimate lateral and vertical gradients, such as changes in intensity and frequency of seafloor disturbance, and changes in character of sedimentary structures and fabric which record temporal changes in benthic community structure
- Describe present sediment delivery mechanisms and rates by using radioisotopic labelling and X-radiographic methods
- Estimate the quantity and type of sedimentary organic matter, providing evidence for reconstructing paleoclimatic and paleoceanographic change

Theme Marine Biodiversity / Diversity in Time: The objective was to examine the role of the history of the Arctic in generating biodiversity, to uncover cryptic diversity and to benchmark current diversity and genetic structure relative to expected reopening of the Arctic during this century.

Divergence rate and cryptic species (P. Hebert and F. Dufresne): The Arctic Corridor Biodiversity study undertaken by CHONe researchers includes an aggressive sampling program that will result in the assembly of both planktonic and benthic samples. A fraction of the specimens in each sample will be preserved in 95% ethanol or through freezing to ensure that DNA is in good condition. Because of the limited funding, it will not be possible to barcode all groups of organisms. As a result, efforts will focus on three groups that make particularly important contributions to invertebrate biomass in arctic waters- echinoderms, polychaete worms (Hébert) and amphipod crustaceans (Dufresne). Analytical protocols are already available which allow the recovery of barcode sequences for these groups of organisms. As well, pilot studies at two arctic sites, Churchill and Resolute, have shown that DNA barcode sequences regularly deliver species-level resolution in these groups.

Finally, taxonomic experts have indicated their willingness to identify barcoded specimens and two graduate students (one funded by CHONe and one with NSERC support) are ready to commence work.

To assemble a comprehensive barcode library for life in Canada's arctic marine waters, the following actions will be taken:

- Coordinate sample acquisition with all CHONe projects
- Focus on key taxonomic groups
- Target additional sampling areas or taxonomic groups as resources permit
- Strengthen the network of associated taxonomists
- Ensure curation of barcoded specimens in major Canadian museums

Theme Ecosystem Function: The objective was to understand and quantify the role of biodiversity in ecosystem services.

Biodiversity and ecosystem services in Arctic environments (P. Archambault and C. Nozais): Compare the ecosystem services (fluxes) by different trophy levels in areas of high and low complexity and 2) to evaluate the influence of the potential changes in species diversity that will happen with any kind of human activities.

37.2 Methodology

Two methods were used for sampling benthic fauna: 1) A box core to sample fauna living in the sediments (endofauna) at depths down to 20 cm and 2) an Agassiz trawl to collect fauna living at the surface of the sediment (epifauna).

37.2.1 Box core

The box corer (Figure 37.1) was deployed to quantitatively sample diversity and abundance of macrobenthic, meiobenthic and bacterial infauna and to obtain sediment cores. The sediment cores were used to determine sediment pigment and organic carbon concentration and the carbon utilisation and nutrient recycling by the benthic community.

Figure 37.1.Recovery of the box corer used to sampled endofauna and sediments.

One box core was retrieved at each station to sample the diversity and abundance of endobenthic fauna. At some stations, two or three box cores were deployed to assess within-site variance of species' diversity and abundance. Half of the 0.250 m^2 surface area of the box core sediment (usually a surface area of 0.09 m^2), varying from 10 to 15 cm in depth, was sieved through a 0.5-mm mesh to separate sediments from endofauna. Organisms were immediately preserved in 4% buffered formalin for later identification in the laboratory. The volume of sediments sieved from each box core was measured (i.e., depth x width x length, to the nearest cm) to estimate endofauna density in each sediment sample.

In Leg 4a, sediment oxygen demand (SOD) experiments were conducted. Seafloor sediments were collected from box cores with a total of three replicate sub-cores (with a diameter of 10.0 cm, i.e., an area of 0.1 m^2 each, down to sediment depths of 15 to 20 cm) for subsequent on-board SOD incubations. Incubations of sediment sub-cores were performed in a dark and temperature controlled room (ca. 3°C). In all experiments, the decrease in oxygen concentrations in the water overlying the sediment (bottom water collected from the Rosette cast at the same station) in the incubation cores was measured periodically (4-8 h intervals) over 1-3 days to assess SOD (Grant et al. 2002). To distinguish macrofaunal from bacterial respiration, 3 mini-incubations of macrofaunal-cleaned sediments in scintillation vials were carried out in parallel to community SOD.

Nutrient samples from the ambient water were taken at the start of incubations (ca. 100 % oxygen in the water), at midway (ca. 90 % oxygen), and at the end of incubations (ca. 80 % oxygen). Ammonium samples were analysed immediately onboard following Holmes et al. (1999). Nutrient concentrations were determined onboard after two weeks from frozen samples by J.-É. Tremblay's team. Three incubation cores containing water only were used as controls. At the end of the incubations (after 15 to 20% of the oxygen had been consumed), the sediment in the cores was sieved on a 0.5 mm mesh sieve to determine diversity and biomass of infauna. The sieve residue, including the fauna, was preserved in a 4% seawater-formaldehyde solution for later analyses of species composition, abundance and biomass in the lab.

In addition, three sub-cores for chlorophyll *a* (diameter of 2.54 cm each) and three sub-cores for CN analyses (2.54 cm diameter each) were taken from each box core. Sub-cores for chlorophyll *a* were sliced in 1 cm sections down to 9 cm depth. For CN, the top 1 cm was collected. These samples were frozen at -80 °C and transported off the ship for analyses in the lab (Figure 37.2).

In Leg 4a, onboard bioturbation experiments were conducted at Station 408. Six sediment cores, with a 10.0 cm diameter and 15 cm depth, were collected. Three of the six cores were treated with addition of organic matter in form of diluted microalgae paste (30 mg algal biomass). Luminophores were added to the sediment surface and then cores were held with oxygen saturated overlying water for 10 days in the incubation room. At the end, cores were sliced in 0.5 cm slices for the first 3 cm, and the 1 cm slices until the bottom of the core. Samples were frozen and transported to the home lab for further analyses (Figure 37.2).

Figure 37.2. Left: Box core with upper half for diversity/abundance sieving and lower half for SOD/Nutrient cores (white caps), pigment concentration cores and Meiofauna samples (big syringes), CN cores and bacteria samples (medium syringes) and Meiofauna/Microfauna incubation samples (small syringes). Right: Incubation setup in the temperature controlled room with SOD cores, mini-incubations and the Fibox optical oxygen probe.

37.2.2 Agassiz trawl (epifauna)

An Agassiz trawl was deployed to survey macroepibenthic diversity and abundance of species. The trawl was dragged for 10 minutes (at 2 knots) on the seabed at each station to survey macroepibenthic species' diversity and abundance.

Once onboard, samples were washed with seawater in a sieve (0.5 mm mesh), and organisms were counted and identified to the lowest possible taxonomic level (identifiable to the samplers). When taxonomic ID was questionable, specimens were preserved (in formalin or frozen at -20ºC) for later identification in the lab. Where possible, this data should be compared to visual surveys conducted with the ROV. Furthermore, several specimen gained from a trawl sample where preserved in 95% Ethanol for genetic analysis.

Figure 37.3. Agassiz trawl used to collect benthic epifauna.

37.2.3Leg 2a – 16 July to 30 July 2009 – Beaufort Sea

A total of 25 box cores and 18 Agassiz trawls were completed during Leg 2a (Table 37.1).

Table 37.1. Summary of stations visited and samples collected during benthos operations on Leg 2a.

Sample ID	Gear/ mesh	Start coordinates		End coordinates		Volume	Time		Depth (m)		jars (#)	bag (nb)
		Latitude N	Longitude W	Latitude N	Longitude W	box core (cm^2)	Start	End	Start	End		
st_01	B	70°28.992	135°10.083			24 000	08h17	08h20	60	60	1	0
st_01	A	70°29.494	135°08.397	70°29.215	135°07.053	n/a	13h33	13h53	61	61	1	1
st_02	B	70°39.758	135°37.183			19 200	21h48	21h54	161	161	1	0
st_02	A	70°40.057	135°37.259	70°39.703	135°37.877	n/a	22h15	22h52	189	160	1	2
st_03	B	70°43.382	135°47.164			16 500	10h35	10h51	397	400	1	0
st_03	A	70°42.436	135°47.112	70°41.765	135°45.445	n/a	11h13	11h45	400	356	1	0
st_11	B	70°44.123	135°33.843			18 000	03h36	03h52	75	71	1	0
st_11	A	70°44.534	135°31.918	70°44.066	135°30.506	n/a	04h47	05h25	351	315	1	1
st_17	B	70°36.629	136°33.483			18 000	10h41	11h12	788	789	1	0
st_17	A	70°38.132	136°34.823	70°37.128	136°33.724	n/a	12h16	13h20	875	813	1	1
st_14	B	70°34.752	135°58.634			18 000	20h26	20h30	93	93	1	0
st_14	A	70°34.314	135°59.509	70°34.302	135°58.535	n/a	20h46	21h02	92	93	1	1
st_15	B	70°39.020	135°56.241			18 750	04h11	04h21	317	323	1	0
st_15	A	70°40.505	135°53.456	70°41.186	135°53.636	n/a	03h03	03h32	341	381	1	1
st_04	B	70°45.323	136°01.889			17 250	24h39	24h58	667	675	1	0
st_04	A	70°45.116	136°03.645	70°45.418	136°01.844	n/a	01h53	02h32	664	672	1	1
st_10	B	70°47.478	135°33.736			18 000	10h09	10h32	420	420	1	0
st_10	A	70°47.990	135°31.741	70°46.830	135°30.235	n/a	11h02	11h47	456	399	1	2
st_23	B	70°53.602	134°15.887			16 500	20h46	20h49	80	80	1	0
st_23	B	70°53.551	134°15.775			16 500	21h05	21h08	80	80	1	0

Sample ID	Gear/ mesh	Start coordinates		End coordinates		Volume	Time		Depth (m)		jars (#)	bag (nb)
		Latitude N	Longitude W	Latitude N	Longitude W	box core (cm^2)	Start	End	Start	End		
st_23	B	70°53.350	134°15.540			17 250	21h50	21h54	80	80	1	0
st_23	A	70°52.149	134°15.416	70°52.761	134°14.261	n/a	22h09	22h26	79	79	1	0
st_22	B	70°48.957	134°31.674			16 500	03h18	03h20	73	72	1	0
st_22	A	70°48.912	134°31.654	70°49.279	134°31.095	n/a	03h46	03h54	74	73	1	1
st_21	B	71°00.333	134°39.203			16 500	12h25	12h40	320	318	1	0
st_21	A	71°00.250	134°39.613	71°00.817	134°38.577	n/a	13h00	13h32	322	332	1	1
st_18	B	70°53.046	135°23.712			17 250	22h04	22h18	520	520	1	0
st_18	A	70°54.210	135°24.674	70°54.703	135°26.307	n/a	22h39	23h18	560	577	1	1
st_08	B	70°54.976	135°53.975			16 500	04h35	04h57	795	792	1	0
st_08	A	70'54.912	135°53.703	70°54.474	135°55.959	n/a	05h07	05h48	799	808	1	1
st_20	B	71°00.186	135°23.649			17 250	13h19	13h35	648	654	1	0
st_20	A	70°59.259	135°26.806	70°00.203	135°27.367	n/a	14h33	15h35	654	697	1	1
st_16	B	70°47.883	136°38.978			16 500	13h20	14h06	1072	1072	1	0
st_6	B	70°36.195	136°26.173			17 250	02h36	03h15	1018	1018	1	0
st_7	B	70°59.132	136°09.628			17 250	12h50	13h33	1022	1022	1	0
st_9	B	70°44.385	135°54.554			16 500	23h18	23h43			1	0
st_9	A	70°44.310	135°54.765	70°43.531	135°54.190	n/a	00h00	00h44	586	526	3	4
st_5	B	70°50.252	135°05.532			17 250	06h47	07h27	814	819	1	0
st_13	B	70°30.252	135°40.741			16 500	23h26	23h30	67	67	1	0
st_13	A	70°30.320	135°43.267	70°29.964	135°43.806	n/a	23h47	00h01	67	67	2	4
st_12	B	70°38.247	135°05.532			16 500	10h16	10h20	63	63	1	0
st_12	A	70°38.358	135°04.098	70°37.772	135°03.869	n/a	10h52	11h12	63	62	2	1
st_05	B	70°48.083	136°05.381			16 500	22h34		760	745	1	0

37.2.4 Leg 4a – 8 October to 6 November – Beaufort Sea, NW Passage, Baffin Bay

ArcticNet projects

During the ArcticNet 2009 cruise, the aim was to sample "hotspots" such as the Cape Bathurst Polynya area, Viscount Melville Sound, Barrow Strait Pockmarks gas vent, Scott Inlet oil seeps and stations in the North Water Polynya (Table 37.2).

Moreover, samples collected with the box core and Agassiz trawl will complement the ROV dives performed for habitat mapping (see Section 34). While the ROV work targets the visual analysis of the epibenthic macro- and megafauna, the concomitant survey work, using the box corer and Agassiz trawl, allowed to document other smaller sized groups of the benthic assemblages (e.g., endobenthic macrofauna). On a long-term perspective, ROV visual surveys of benthic sentinel sites could at least partially replace invasive sampling.

CHONe projects

Seabed sediment from Amundsen Gulf, Lancaster Sound, northern Baffin Bay and Scott Inlet was collected using a box corer and the Agassiz trawl for the following CHONe projects and researchers (Table 37.2).

Table 37.2. Summary of box cores and Agassiz trawls conducted for benthic communities measurements during Leg 4a.

Station ID	Date in 2009	Depth (m)	Latitude N	Longitude W	Equipment	ANet								CHONe				Comments
						Diversity	SOD/Nutrients	Bioturbation	Nozais (Bacteria)	Nozais (Diversity)	Nozais (Isotopes)	Hebert	Ian	Lovejoy	Bentley (Push core)	Bentley (X-ray)	Dufresne	
437	12/10	322	71°47.806	126°30.272	Box corer	1					8				2	1		bad weather 3 boxcores but only 1 acceptable; 1 filtration failed
		311	71°47.44	126°30.13	Agassiz trawl							13	1				2	
		320	71°48.01	126°32.32	Stop													
408	13/10	152	71°17.16	127°46.93	Box corer		2	2	3	2	2							No Meiofauna isotope sample
		151	71°17.18	127°47.39	Box corer		2	2		2	2							
		151	71°17.20	127°48.00	Box corer		2	2		2	5				2	1		2 Meiofauna isotope samples
		577	70°39.720	122°00.625	Agassiz trawl							5	1				2	
		615	70°38.216	122°00.435	Stop													
437	14/10	320	71°46.73	126°28.64	Box corer		3		3	6	9							
405	16/10	559	70°39.879	122°59.743	Box corer	1	3		3	6	8			1	2	1		1 filtration failed
		577	70°39.720	122°00.625	Agassiz trawl	1												Untied knot
		615	70°38.722	122°00.435	Stop													
450	17/10	97	72°04.721	119°48.815	Agassiz trawl	3						2					2	
		95	72°04.544	119°48.631	Stop													
308	19/10	541	74°06.073	108°50.148	Box corer	1	3		3	6	9			1	2	1		1 Mini-incubation lost
304	23/10	331	74°19.058	091°24.378	Box corer	1	3		3	6	9			1	2	1		
323	25/10	786	74°10.349	080°43.549	Box corer	1	3		3	6	9			1	2	1		BC 122 cable entangled
103	27/10	195	76°18.928	076°38.025	Box corer													Unsuccessful, rocky bottom
105	27/10	313	76°17.601	075°45.828	Box corer	1				2	2	4					1	gravel; No filtration
109	28/10	451	76°17.370	074°08.213	Box corer	1	3		3	6	6			1	2	1		No filtration
		442	76°16.762	074°08.723	Agassiz trawl	2						3	2				1	
		455	76°17.335	074°05.636	Stop													
111	28/10	565	76°17.087	073°13.063	Box corer	1				6	4				2	1		No filtration and only 1 corning (surf sed)
		566	76°17.699	073°13.053	Agassiz trawl													Didn't reach the bottom (high wind)
		558	76°15.706	073°07.132	Stop													
115	29/10	669	76°20.095	071°14.258	Box corer	1	3		3	6	8				2	1		Only 2 corning
		666	76°20.298	071°16.293	Agassiz trawl	1						4					2	
		655	76°19.880	071°14.610	Stop													
136	30/10	810	74°41.217	073°20.915	Box corer	1	3		3	6	8			1	2	1		Only 2 corning
141	01/11	397	71°23.038	070°09.139	Box corer										2	1		only box core 132 worked, next 3 didn't

For the Bentley (MUN) project, two sediment cores were obtained from the box core using push cores, and one sediment-filled X-ray tray was taken from each box core (Table 37.2). Immediately after collecting the sediment, the push cores and X-ray trays were processed and prepared on board. For subsequent lab analyses at the Memorial University, one and a half push cores were sliced into 1 cm sections in the upper 10 cm, and 2 cm sections below 10 cm, for the analysis of radioisotopes (^{234}Th, ^{210}Pb, ^{137}Cs, ^{7}Be) and organic compounds. Half of the second core was sliced into 1 cm sections for the analysis of stable isotopes ($\delta^{13}C$, $\delta^{15}N$), total organic carbon, total nitrogen, and total sulfur. Sediment samples for chlorophyll *a* and phaeopigment analyses were taken from each centimetre in the upper 10 cm of one push core.

The sediment samples for chlorophyll *a* and phaeopigments, stable isotopes, and organic compound analyses were then stored in a -20°C freezer. The X-ray trays were sealed water tight with electric tape and stored in a 4°C refrigerator, along with the samples for radioisotope and grain size analyses.

37.2.5 Leg 4b – 6 November to 18 November – Labrador fjords

Seabed sediment from the Labrador Fjords was collected using a box corer. Sediment cores were obtained from the box core using push cores, and sediment-filled X-ray trays were taken from each box core. At some stations syringes were used to collect sediment from the box core (Table 37.3).

Table 37.3. Box coring stations and number of sediment samples collected in the Labrador fjords in Leg 4b.

				Position		Subsamples			
Station ID	Type	Date	Depth (m)	Latitude N	Longitude W	Bentley	Archambault	Pienitz	Brown
600	Basic	08/11/09	204	59°05.32	063°25.88	3	1	1	
602	Basic	08/11/09	151	59°03.14	063°52.10	3	-	1	
615	Basic	09/11/09	138	58°19.40	063°32.42	3	-	1	
617	Basic	10/11/09	134	58°29.93	062°41.28	3	1	1	
633	Basic	11/11/09	182	57°36.40	061°53.77	3	1	1	
632	Box core	11/11/09	83	57°34.00	062°03.30	3	-	1	
631	Basic	11/11/09	92	57°29.60	062°11.68	-	-	-	-
630	Basic	11/11/09	50	57°28.31	062°26.56	3	-	1	
634	Basic	12/11/09	101	57°34.16	061°56.45	3	-	1	
620	Basic	12/11/09	94	56°23.79	061°12.99	-	-	-	1
624	Basic	13/11/09	115	56°26.17	061°59.31	3	-	1	

For the Bentley sub-project, immediately after collecting the sediment, the push cores and X-ray trays were processed and prepared on board. For subsequent lab analyses at the Memorial University, push cores were sliced into 1 cm sections in the upper 10 cm, and into 1 and 2 cm sections below 10 cm, for the analysis of radioisotopes (^{234}Th, ^{210}Pb, ^{137}Cs, ^{7}Be), grain sizes, organic compounds, stable isotopes ($\delta^{13}C$, $\delta^{15}N$), total organic carbon, total nitrogen, and total sulfur. Sediment samples for chlorophyll *a* and phaeopigment analyses were taken from each centimetre in the upper 10 cm of one push core or one syringe.

The sediment samples for chlorophyll *a* and phaeopigments, stable isotopes, and organic compound analyses were then stored in a -20°C freezer. The X-ray trays were sealed water tight with electric tape and stored in a 4°C refrigerator, along with the samples for radioisotope and grain size analyses.

At the mouth of the four fjords, the Agassiz trawl (Figure 37.3) was successfully deployed to survey macroepibenthic diversity (Table 37.4). Species were estimated in abundance and identified to the lowest possible taxonomic level. Some specimens were preserved for further identification in the lab. Where possible, this data should be compared to visual surveys conducted by future ROV dives. Furthermore, several specimen gained from a trawl sample were preserved in 95% Ethanol for genetic analysis.

Table 37.4. Benthic sampling stations during Leg 4b, with numbers of samples collected for diversity and genetic analysis (CHONe project).

Station ID	Type	Date in 2009	Depth (m)	Latitude N	Longitude W	Equipment	CHONe				Comment
							Nozais (Bacteria)	Hebert	Ian	Dufresne	
600	Basic	08/11	204	59°05.324	063°25.885	Box corer					
Nachvak			204	59°05.329	063°25.823	Box corer	3				
			196	59°05.799	063°25.892	Agassiz trawl	21		2	4	
			205	59°05.406	063°26.166	Stop					
617	Basic	10/11	136	58°30.027	062°41.377	Agassiz trawl					Hole in the net
Saglek			76	58°30.596	062°40.697	Stop			1		See T. Brown for number of Hebert's samples
			134	58°29.931	062°41.286	Box corer					Dufresne samples were kept from next station (same species found)
			134	58°29.924	062°41.273	Box corer	3				
633	Basic	11/11	182	57°36.401	061°53.771	Box corer					
Okak			182	57°36.402	061°53.720	Box corer	3				
			183	57°36.459	061°53.597	Agassiz trawl					Net repaired but hole re-opened on deck
			182	57°36.501	061°53.545	Stop			2	5	See T. Brown for number of Hebert's samples
620	Basic	12/11/	94	56°23.816	061°12.927	Agassiz trawl					Net repaired and hole did not open again

Station ID	Type	Date in 2009	Depth (m)	Latitude N	Longitude W	Equipment	CHONe Nozais (Bacteria)	Hebert	Ian	Dufresne	Comment
Anakta lak			90	56°23.586	061°13.711	Stop			8	7	See T. Brown for number of Hebert's samples

37.3 Preliminary results

37.3.1 Leg 2a – 16 July to 30 July 2009 – Beaufort Sea

In general, species abundance and diversity was greater at shallower depths. Sampling stations located on expulsions features (i.e., those with sediments having a distinct H_2S odor) had a seemingly lower abundance and diversity of organisms (e.g., only a few polycheate worms found in the box core sediments).

The box core sample over the expulsion feature at Station 10 had a high gas content as shown by the presence of outgassing bubbles at the surface (Figure 37.4). The concentration of H_2S was also evident from the odor emitted by the sediments when the box core was brought on the foredeck. Safety measures were taken to monitor gas levels before and during sample manipulation. Thanks to Imperial Oil for putting together these measures.

Figure 37.4. Outgassing of bubbles at the surface from the box core sample collected over the expulsion feature at Station 10.

37.3.2 Leg 4a – 8 October to 6 November – Beaufort Sea, NW Passage, Baffin Bay

<u>Diversity</u>

Composition and abundance of species varied considerably among stations. For more detailed results, samples need to be analysed especially for taxonomy. At this point of the analysis, highest benthic diversity was observed at Station 109 (central North Water Polynya), but further taxonomic analysis will allow to confirm this observation. For the first time on the ArcticNet transect, one station was sampled in Prince of Whales Strait (Station 450), a hot spot identified by the presence of beluga pods.

<u>SOD</u>

Preliminary results suggest that benthic respiration was highest at Stations 408 (Cape Bathurst Polynya), 304 (Barrow Strait Pockmarks area) and 109 (central North Water Polynya), coinciding with expected highest sedimentation rates in the study area. However, data still need to be analysed more thoroughly, taking temperature and benthic biomass changes into account.

37.3.3 Leg 4b – 6 November to 18 November – Labrador fjords

Composition and abundance of species varied considerably among stations. For more detailed results, samples need to be analysed for taxonomy in the home labs. At this point of the analysis, highest benthic diversity was observed at Station 617 (Saglek Fjord), but further taxonomic analysis will allow to confirm it. The hard substrate found there could have an effect on this observation (Figure 37.5).

Figure 37.5. Picture of the species assemblage at the mouth of Saglek Fjord (Station 617). The Agassiz net caught a rock, which created a hole in the net, which could explain the fact that no mud was present: only species and shells.

Station 633 (Okak Fjord) was characterized by a very high concentration of ophiuroids. Station 620 (Anaktalak Fjord) recorded the highest catch of crustaceans (crabs and shrimp) and fish compared to all other Agassiz trawls of both Legs 4a and 4b. Station 600 (Nachvak Fjord) was not particularly striking in terms of species dominance.

References

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Holmes, R.M. (1999). A simple and precise method for measuring ammonium in marine and freshwater ecosystems. Canadian Journal of Fisheries and Aquatic Sciences 56:1801-1808.

38 Paleoceanography and paleo-river discharge – Leg 4b and BaySys

ArcticNet Phase 2 – Project titled *Understanding and Responding to the Effects of Climate Change and Modernization in Nunatsiavut.* ArcticNet/Phase2/Reimer_Nunatsiavut_nuluak

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Cruise participants Leg 4b: Peter Huelse[1] and Thomas Richerol[2]
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38.1 Introduction

38.1.1 Leg 4b – 6 November to 18 November – Labrador fjords

<u>Paleoceanography</u>

This project is part of the ArcticNet Project titled *Nunatsiavut Nuluak: understanding and responding to the effects of climate change and modernization in a northern environment*. Labrador Inuit depend on the sea and sea ice, among other things, for their harvesting and travelling activities. They are concerned about the ecological integrity of the marine environment in northern Labrador, especially with respect to the effects of climate change, industrialization (modernization) and contaminants.

The main objective during Leg 4b was to take a piston-core in Nachvak Fjord to determine long-term and recent environmental change in northern Labrador fjords by using the microfossil record preserved in sedimentary deposits to reconstruct long-term paleoceanographic variability in a pristine fjord. In addition to this, surface sediments were sampled in each box core taken during this leg. Those samples give information about the modern assemblages of microfossils associated with modern environmental parameters, which permit to do reconstructions by the best analog method.

<u>Paleo-River discharge</u>

This project focuses on river water and sediment discharge due to climatic variations. The aim is to place recent variations in river discharge (past 200 yr) in a larger climatic context by studying paleo sediment and water discharge and its relation to past climatic events such as the Little Ice Age and the Medieval Warm Period and further back. This will fill the gap in understanding of the response of terrestrial drainage to the Labrador Fjords on modern climate change.

38.1.2 BaySys – 27 July to 5 August 2009 – Hudson Bay

This project aims to reconstruct variations in freshwater runoff into the Hudson Bay on a decadal resolution during the past centuries to millennia. The aim of the cruise was to recover six cores at the Great Whale River study site and two cores in the Nelson River estuary.

38.2 Methodology

38.2.1 Leg 4b – 6 November to 18 November – Labrador fjords

To collect samples, a piston core was deployed 6 times, using a gravity core as trigger. Samples were cut to 1-m length, and stored at 4°C for subsequent transport.

For the surface sediment samples, a glass microscopy slide was used to take the first 1 cm on the box-cores and put in a labeled Whirlpak bag to store it at 4°C.

Table 38.1. Piston cores and box cores sampling conducted for paleoceanographic analyses during Leg 4b.

Station #	Locality	Habitat	Date	Latitude N	Longitude W	Depth (m)	Notes
AM09 606	Nachvak	Fjord	11/8/2009	59°25.698	63°42.282	158	PC and GC
AM09 602	Nachvak	Fjord	11/8/2009	59°31.590	63°52.704	151	PC and GC
AM09 618	Saglek	Fjord	11/9/2009	58°28.812	63°13.416	241	PC and GC
AM09 631	Okak	Fjord	11/11/2009	57°33.960	62°32.790	90	PC and GC
AM09 634	Okak	Fjord	11/12/2009	57°34.182	61°56.442	100	PC and GC
AM09 624	Anaktalak	Fjord	11/13/2009	56°26.172	61°59.292	115	PC and GC

38.2.2 BaySys – 27 July to 5 August 2009 – Hudson Bay

A gravity corer (50 kg) with up to 120 kg additional weight and PVC pipes of 4 feet length and 4 inch diameter each were used to sample the seafloor sediment. Ten cores ranging from 137 cm to 255 cm depth in seabed were recovered from the Great Whale River study site and two cores of 105 cm and 145 cm depth in the seabed from the Nelson River estuary. The cores were cut in 1 m sections for storage and transport.

One coring attempt at the Great whale River failed probably due to hard sediment at approximately 135 cm depth in seabed with the result of one lost pipe and core catcher. A second try could recover 135 cm of sediment. At Stations P2 and P3, depth data is uncertain due to problems with the echosounder.

Table 38.2. Gravity core sampling conducted during BaySys cruise in Hudson Bay.

Core ID	Date	Time (24h)	Latitude N	Longitude W	Depth (m)	Depth in seabed (cm)	Comments
GW-1-P8	27-07-09	18:33	55°15.7807	77°53.6321	89.31	252	3 sections
P9	28-07-09	06:45	55°17.2133	77°497904	71.71	0	failed (broken)
GW-2-P9	28-07-09	07:03	55°17.2078	77°49.8219	69.61	135	2 sections, pipe broken
GW-3-P6	28-07-09	07:31	55°19.3520	77°47.7182	73.91	135	2 sections
GW-4-P3	28-07-09	08:38	55°19.7560	77°48.8360	71.71	210	3 sections
GW-5-P2	28-07-09	09:07	55°18.8926	77°51.3534	71.71	170	2 sections
GW-6-P4	28-07-09	09:36	55°17.5919	77°52.4971	83.91	230	3 sections
GW-7- P10	28-07-09	09:59	55°16.0570	77°51.8140	68.51	220	3 sections
GW-8-P5	28-07-09	10:37	55°18.1989	77°49.3210	79.31	256	3 sections
GW-9-P1	28-07-09	11:14	55°17.4520	77°55.5990	89.01	252	3 sections
GW-10- P7	28-07-09	11:43	55°14.7110	77°56.5950	101.41	197	2 sections
P15	2-08-09	07:01	57°39.5467	91°35.9277	64.0	0	failed, no penetration
N-1-P15	2-08-09	07:12	57°39.4840	91°35.6970	74.3	105	2 sections, pipe bended
N-2-P17	2-08-09	11:32	52°26.0197	91°52.4123	39.7	145	2 sections

38.3 Preliminary results

38.3.1 Leg 4b – 6 November to 18 November – Labrador fjords

A total of ~40 m of sediment cores were recovered that will be analysed for a range of physical, chemical, sedimentological and microfossils parameters.

Appendix 1 - List of stations sampled during the 2009 ArcticNet Expedition

Leg	Station ID	Station Type	Local Date	Local Time	UTC to local	Latitude (N)	Longitude (W)	Depth (m)
Leg 1a								
1a	N/A	ROV	05/Jun/2009	10h22	UTC-4	48°44.300	068°09.970	151
1a	N/A	Piston Core	05/Jun/2009	14h02	UTC-4	48°44.490	068°10.180	160
Leg 1b								
1b	N/A	Water Sampling	11/Jul/2009	08h40	UTC-7	67°45.110	168°13.900	50
1b	N/A	Water Sampling	12/Jul/2009	13h10	UTC-7	71°42.800	157°13.400	67
1b	N/A	Water Sampling	13/Jul/2009	13h06	UTC-7	70°39.360	143°34.620	350
1b	N/A	Water Sampling	14/Jul/2009	13h20	UTC-7	70°38.020	135°37.440	87
1b	N/A	Weather	14/Jul/2009	21h05	UTC-7	70°37.600	136°02.900	260
Leg 2a								
2a	1	Biophysical	18/Jul/2009	02h24	UTC-6	70°29.160	135°05.790	61
2a	C-09	Mooring	18/Jul/2009	12h42	UTC-6	70°29.787	135°07.819	61
2a	2	Biophysical	18/Jul/2009	18h16	UTC-6	70°39.350	135°38.237	144
2a	11	Biophysical	19/Jul/2009	00h20	UTC-6	70°44.148	135°33.682	368
2a	3	Biophysical	19/Jul/2009	06h56	UTC-6	70°42.344	135°47.166	405
2a	N/A	Weather	19/Jul/2009	12h25	UTC-6	70°39.587	135°37.720	129
2a	B-09	Mooring	19/Jul/2009	15h15	UTC-6	70°40.031	135°35.919	162
2a	14	Biophysical	19/Jul/2009	18h25	UTC-6	70°34.825	135°57.278	94
2a	15	Biophysical	20/Jul/2009	00h17	UTC-6	70°39.260	135°55.874	293
2a	N/A	Weather	20/Jul/2009	04h45	UTC-6	70°36.600	135°57.300	180
2a	17	Biophysical	20/Jul/2009	06h42	UTC-6	70°36.580	136°28.476	730
2a	N/A	N/A	20/Jul/2009	14h45	UTC-6	70°38.029	136°16.737	579
2a	A1-09	Mooring	20/Jul/2009	19h34	UTC-6	70°45.791	136°00.106	688
2a	4	Biophysical	20/Jul/2009	20h30	UTC-6	70°45.780	136°01.185	688
2a	N/A	Weather	21/Jul/2009	05h58	UTC-6	70°48.300	135°32.600	N/A
2a	10	Biophysical	21/Jul/2009	06h40	UTC-6	70°47.236	135°31.720	434
2a	N/A	Weather	21/Jul/2009	15h24	UTC-6	70°48.891	134°32.658	74
2a	I-09	Mooring	21/Jul/2009	15h28	UTC-6	70°48.876	134°32.641	72
2a	J-09	Mooring	21/Jul/2009	18h30	UTC-6	70°53.897	134°15.649	83
2a	23	Biophysical	21/Jul/2009	18h46	UTC-6	70°53.816	134°16.072	83
2a	22	Biophysical	22/Jul/2009	01h40	UTC-6	70°49.088	134°30.588	72
2a	21	Biophysical	22/Jul/2009	09h11	UTC-6	71°00.986	134°38.139	334
2a	H-09	Mooring	22/Jul/2009	16h06	UTC-6	71°01.239	134°41.208	367
2a	18	Biophysical	22/Jul/2009	19h02	UTC-6	70°52.512	135°21.415	496
2a	8	Biophysical	23/Jul/2009	01h40	UTC-6	70°55.244	135°51.844	786
2a	20	Biophysical	23/Jul/2009	09h48	UTC-6	71°00.941	135°20.775	645
2a	N/A	N/A	23/Jul/2009	16h15	UTC-6	71°00.207	135°27.731	693
2a	G-09	Mooring	23/Jul/2009	18h51	UTC-6	71°00.118	135°28.785	699
2a	N/A	Weather	24/Jul/2009	06h40	UTC-6	70°47.330	136°34.330	1004
2a	16	Biophysical	24/Jul/2009	08h10	UTC-6	70°47.687	136°39.491	1097
2a	N/A	Weather	24/Jul/2009	21h00	UTC-6	70°55.870	136°24.287	1012
2a	F-09	Mooring	24/Jul/2009	21h47	UTC-6	70°55.861	136°24.659	1010
2a	6	Biophysical	24/Jul/2009	23h02	UTC-6	70°55.355	136°27.306	1009
2a	N/A	Weather	25/Jul/2009	07h05	UTC-6	70°55.861	136°16.334	N/A
2a	7	Biophysical	25/Jul/2009	08h14	UTC-6	70°59.327	136°07.633	1018
2a	N/A	Weather	25/Jul/2009	15h03	UTC-6	70°57.588	136°10.837	N/A
2a	A2-09	Mooring	25/Jul/2009	18h35	UTC-6	70°44.777	135°55.164	618
2a	9	Biophysical	25/Jul/2009	20h49	UTC-6	70°44.246	135°55.126	583
2a	5	Biophysical	26/Jul/2009	06h47	UTC-6	70°50.011	136°05.287	814
2a	LF03	Hydrophone	26/Jul/2009	10h06	UTC-6	70°45.180	135°55.624	642
2a	LF02	Hydrophone	26/Jul/2009	12h40	UTC-6	70°45.124	136°16.201	619
2a	LF01	Hydrophone	26/Jul/2009	13h40	UTC-6	70°45.121	136°38.248	1204
2a	LF06	Hydrophone	26/Jul/2009	14h44	UTC-6	70°39.060	136°27.825	830
2a	LF07	Hydrophone	26/Jul/2009	16h54	UTC-6	70°38.970	136°06.663	453
2a	LF11	Hydrophone	26/Jul/2009	18h45	UTC-6	70°33.113	135°55.971	70
2a	13	Biophysical	26/Jul/2009	21h51	UTC-6	70°30.349	135°40.370	66
2a	LF12	Hydrophone	27/Jul/2009	01h37	UTC-6	70°32.872	135°35.339	67

Appendix 1 - List of stations sampled during the 2009 ArcticNet Expedition

Leg	Station ID	Station Type	Local Date	Local Time	UTC to local	Latitude (N)	Longitude (W)	Depth (m)
2a	LF04	Hydrophone	27/Jul/2009	05h03	UTC-6	70°33.171	135°13.508	61
2a	N/A	Weather	27/Jul/2009	06h04	UTC-6	70°38.311	135°06.050	62
2a	12	Biophysical	27/Jul/2009	08h09	UTC-6	70°38.392	135°05.988	61
2a	LF09	Biophysical	27/Jul/2009	14h30	UTC-6	70°38.326	135°22.284	71
2a	LF08	Hydrophone	27/Jul/2009	19h09	UTC-6	70°39.340	135°45.595	465
2a	LF05	Hydrophone	27/Jul/2009	21h04	UTC-6	70°45.190	135°34.383	396
2a	LF10	Hydrophone	28/Jul/2009	00h06	UTC-6	70°45.221	135°13.942	86
2a	N/A	ROV	28/Jul/2009	14h52	UTC-6	70°47.818	135°32.193	575
2a	5	Biophysical	28/Jul/2009	22h34	UTC-6	70°48.083	136°05.381	760
Leg 2b								
2b	390	Malina	31/Jul/2009	13h58	UTC-6	70°11.051	133°45.233	40
2b	690	Malina	01/Aug/2009	06h22	UTC-6	69°29.262	137°56.563	54
2b	680	Malina	02/Aug/2009	04h13	UTC-6	69°36.406	138°13.804	125
2b	690	Malina	02/Aug/2009	23h55	UTC-6	69°25.885	137°59.375	53
2b	394	Malina	03/Aug/2009	14h28	UTC-6	69°50.831	133°29.570	14
2b	290	Malina	04/Aug/2009	06h15	UTC-6	70°40.386	130°26.049	33
2b	280	Malina	04/Aug/2009	08h50	UTC-6	70°52.163	130°30.428	N/A
2b	270	Malina	04/Aug/2009	13h50	UTC-6	71°04.416	130°32.871	56
2b	260	Malina	04/Aug/2009	15h21	UTC-6	71°16.142	130°36.642	59
2b	250	Malina	04/Aug/2009	22h20	UTC-6	71°28.315	130°41.721	219
2b	240	Malina	04/Aug/2009	00h15	UTC-6	71°40.354	130°44.418	462
2b	230	Malina	05/Aug/2009	02h00	UTC-6	71°51.979	130°50.142	704
2b	220	Malina	05/Aug/2009	04h10	UTC-6	72°03.495	130°53.527	899
2b	240	Malina	05/Aug/2009	15h42	UTC-6	72°40.507	130°44.632	N/A
2b	110	Malina	05/Aug/2009	05h04	UTC-6	71°42.067	126°28.953	401
2b	120	Malina	06/Aug/2009	16h51	UTC-6	71°33.875	126°54.581	419
2b	130	Malina	06/Aug/2009	18h46	UTC-6	71°25.628	127°21.980	311
2b	140	Malina	07/Aug/2009	03h00	UTC-6	71°17.033	127°47.357	151
2b	150	Malina	07/Aug/2009	05h11	UTC-6	71°09.668	128°09.650	66
2b	160	Malina	07/Aug/2009	06h35	UTC-6	71°03.044	128°29.812	43
2b	170	Malina	07/Aug/2009	08h35	UTC-6	70°54.845	128°55.101	35
2b	150	Malina	07/Aug/2009	16h10	UTC-6	71°09.716	128°08.727	68
2b	390	Malina	08/Aug/2009	05h31	UTC-6	70°10.643	133°33.635	47
2b	380	Malina	08/Aug/2009	07h07	UTC-6	70°23.782	133°36.552	63
2b	370	Malina	08/Aug/2009	13h03	UTC-6	70°35.950	133°38.967	75
2b	360	Malina	08/Aug/2009	15h02	UTC-6	70°48.093	133°42.964	78
2b	350	Malina	08/Aug/2009	22h18	UTC-6	70°58.291	133°44.036	91
2b	340	Malina	09/Aug/2009	00h16	UTC-6	71°10.368	133°49.865	575
2b	330	Malina	09/Aug/2009	02h00	UTC-6	71°22.377	133°53.373	1086
2b	320	Malina	09/Aug/2009	04h07	UTC-6	71°34.322	133°56.131	1156
2b	310	Malina	09/Aug/2009	06h31	UTC-6	71°44.551	133°57.056	1614
2b	330	Malina	09/Aug/2009	15h25	UTC-6	71°22.219	133°53.081	1082
2b	340	Malina	09/Aug/2009	17h44	UTC-6	71°10.341	133°49.554	578
2b	680	Malina	10/Aug/2009	10h40	UTC-6	69°36.351	138°14.094	125
2b	670	Malina	10/Aug/2009	12h55	UTC-6	69°47.924	138°26.046	174
2b	660	Malina	10/Aug/2009	18h42	UTC-6	69°59.127	138°39.368	268
2b	650	Malina	10/Aug/2009	23h32	UTC-6	70°10.115	138°54.506	375
2b	640	Malina	10/Aug/2009	01h30	UTC-6	70°20.394	139°08.624	564
2b	630	Malina	11/Aug/2009	03h06	UTC-6	71°31.962	139°22.725	839
2b	620	Malina	11/Aug/2009	05h04	UTC-6	70°42.197	139°36.514	1708
2b	610	Malina	11/Aug/2009	08h23	UTC-6	70°47.690	139°36.212	1823
2b	630	Malina	11/Aug/2009	18h47	UTC-6	70°31.880	139°22.486	838
2b	640	Malina	11/Aug/2009	20h45	UTC-6	70°20.362	139°08.302	573
2b	760	Malina	12/Aug/2009	07h44	UTC-6	70°33.231	140°47.828	578
2b	770	Malina	12/Aug/2009	16h57	UTC-6	70°20.946	140°48.415	223
2b	780	Malina	12/Aug/2009	19h10	UTC-6	70°09.074	140°48.162	50
2b	N/A	N/A	13/Aug/2009	08h57	UTC-6	70°16.613	140°19.781	N/A

Appendix 1 - List of stations sampled during the 2009 ArcticNet Expedition

Leg	Station ID	Station Type	Local Date	Local Time	UTC to local	Latitude (N)	Longitude (W)	Depth (m)
2b	N/A	N/A	13/Aug/2009	20h00	UTC-6	70°18.421	140°18.556	N/A
2b	N/A	N/A	14/Aug/2009	09h29	UTC-6	71°20.177	132°33.804	493
2b	345	Malina	14/Aug/2009	10h22	UTC-6	71°19.801	132°33.560	479
2b	N/A	N/A	16/Aug/2009	10h45	UTC-6	71°49.128	132°20.472	N/A
2b	570	CTD	17/Aug/2009	04h38	UTC-6	70°12.301	137°15.350	55
2b	560	CTD	17/Aug/2009	06h07	UTC-6	70°23.326	137°28.732	400
2b	550	CTD	17/Aug/2009	08h04	UTC-6	70°34.306	137°42.616	1076
2b	540	Malina	17/Aug/2009	11h05	UTC-6	70°45.102	137°53.544	1514
2b	530	CTD	17/Aug/2009	22h28	UTC-6	70°56.427	138°08.766	1602
2b	430	Malina	18/Aug/2009	08h57	UTC-6	71°13.171	136°42.772	1351
2b	440	CTD	18/Aug/2009	18h05	UTC-6	71°02.101	136°27.614	1149
2b	450	CTD	18/Aug/2009	20h25	UTC-6	70°51.346	136°14.323	840
2b	470	CTD	18/Aug/2009	00h00	UTC-6	70°28.311	135°54.763	70
2b	480	CTD	19/Aug/2009	01h25	UTC-6	70°16.664	135°45.084	60
2b	460	Malina	19/Aug/2009	04h45	UTC-6	70°40.187	136°05.581	453
2b	100	Malina	20/Aug/2009	08h20	UTC-6	71°48.475	127°25.063	426
2b	N/A	N/A	20/Aug/2009	11h39	UTC-6	71°18.820	127°29.579	228
2b	135	Malina	20/Aug/2009	12h36	UTC-6	71°18.555	127°29.025	228
2b	N/A	N/A	21/Aug/2009	18h17	UTC-6	71°12.841	127°20.734	216
2b	235	Malina	22/Aug/2009	02h30	UTC-6	71°46.868	130°50.069	619
Leg 3a								
3a	N/A	Weather	28/Aug/2009	21h00	UTC-6	70°41.600	126°01.800	190
3a	S1	Short	29/Aug/2009	18h00	UTC-6	69°30.050	137°59.820	60
3a	S1.1	Short	30/Aug/2009	04h42	UTC-6	69°40.170	138°09.130	126
3a	S1.2	Short	30/Aug/2009	07h27	UTC-6	69°49.890	138°19.570	189
3a	S2	Short	30/Aug/2009	11h06	UTC-6	70°00.000	138°30.200	259
3a	L1	Long	31/Aug/2009	14h18	UTC-6	71°05.550	139°00.590	1911
3a	L1	Long	01/Sep/2009	01h33	UTC-6	71°05.940	139°08.870	1981
3a	L1	Long	02/Sep/2009	04h33	UTC-6	71°06.400	139°21.330	2050
3a	L1.5	Long	03/Sep/2009	08h50	UTC-6	73°19.000	139°23.100	3251
3a	L2	Long	03/Sep/2009	18h09	UTC-6	74°39.150	137°22.920	3370
3a	L2	Long	04/Sep/2009	07h24	UTC-6	74°36.130	137°07.650	3336
3a	L2	Long	04/Sep/2009	19h30	UTC-6	74°30.750	136°44.190	3293
3a	L2	Long	05/Sep/2009	09h50	UTC-6	74°24.000	136°25.000	3228
3a	L2	Long	06/Sep/2009	09h42	UTC-6	74°25.300	133°54.300	3236
3a	L2	Long	07/Sep/2009	00h15	UTC-6	74°33.830	134°53.900	2464
3a	L3	Long	07/Sep/2009	08h04	UTC-6	75°19.500	137°39.600	3490
3a	L3	Long	07/Sep/2009	10h40	UTC-6	75°16.900	137°35.000	3490
3a	N/A	N/A	08/Sep/2009	09h29	UTC-6	73°16.600	135°34.800	3527
3a	N/A	N/A	08/Sep/2009	15h05	UTC-6	72°40.400	136°02.600	2458
3a	N/A	N/A	08/Sep/2009	17h06	UTC-6	72°30.520	136°34.820	2530
3a	L1.1	Ice	08/Sep/2009	17h10	UTC-6	72°30.580	136°35.130	2527
3a	L1.1	Long	09/Sep/2009	08h32	UTC-6	72°30.900	136°47.400	2543
3a	L1.1	Long	10/Sep/2009	02h26	UTC-6	72°32.700	136°59.100	2557
3a	L1.1	Long	10/Sep/2009	18h42	UTC-6	72°38.800	137°21.200	2636
3a	S4	Short	11/Sep/2009	11h44	UTC-6	71°11.100	132°56.500	317
Leg 3b								
3b	Area-1	CTD	14/Sep/2009	03h46	UTC-6	70°49.000	136°16.500	745
3b	Area-1	Mapping	14/Sep/2009	04h50	UTC-6	70°48.730	136°03.050	767
3b	Area-1	Mapping	14/Sep/2009	07h05	UTC-6	70°41.440	136°38.850	971
3b	Area-1	Mapping	14/Sep/2009	07h40	UTC-6	70°41.250	136°20.260	652
3b	Area-1	Mapping	14/Sep/2009	09h40	UTC-6	70°50.100	136°02.700	794
3b	Area-2	CTD	14/Sep/2009	09h49	UTC-6	70°50.100	136°02.800	794
3b	Area-2	Mapping	14/Sep/2009	10h34	UTC-6	70°49.400	136°05.160	797
3b	Area-2	Mapping	14/Sep/2009	12h40	UTC-6	70°38.500	136°09.400	481
3b	Area-2	Mapping	14/Sep/2009	12h55	UTC-6	70°49.300	136°06.000	451
3b	Area-2	Mapping	14/Sep/2009	14h39	UTC-6	70°49.200	136°06.000	797

Appendix 1 - List of stations sampled during the 2009 ArcticNet Expedition

Leg	Station ID	Station Type	Local Date	Local Time	UTC to local	Latitude (N)	Longitude (W)	Depth (m)
3b	Area-2	Mapping	14/Sep/2009	15h08	UTC-6	70°47.500	136°14.300	761
3b	Area-2	Mapping	14/Sep/2009	15h45	UTC-6	70°44.900	136°09.800	616
3b	Area-2	Mapping	14/Sep/2009	15h45	UTC-6	70°44.900	136°09.800	616
3b	Area-2	Mapping	14/Sep/2009	17h03	UTC-6	70°39.000	135°52.400	242
3b	Area-2	Mapping	14/Sep/2009	17h03	UTC-6	70°39.000	135°52.400	242
3b	Area-2	Mapping	14/Sep/2009	17h31	UTC-6	70°37.200	135°44.500	102
3b	Area-2	Mapping	14/Sep/2009	17h31	UTC-6	70°37.200	135°44.500	102
3b	Area-2	Mapping	14/Sep/2009	17h38	UTC-6	70°35.400	135°41.500	67
3b	Area-2	Mapping	14/Sep/2009	17h48	UTC-6	70°35.400	135°41.000	65
3b	Area-2	Mapping	14/Sep/2009	17h54	UTC-6	70°34.900	135°39.400	65
3b	Area-3	CTD	14/Sep/2009	18h07	UTC-6	70°34.900	135°38.700	66
3b	Area-3	Mapping	14/Sep/2009	18h47	UTC-6	70°36.700	135°40.000	70
3b	Area-3	Mapping	14/Sep/2009	22h15	UTC-6	70°48.700	136°32.500	1000
3b	Area-4	CTD	14/Sep/2009	22h30	UTC-6	70°48.800	136°32.700	993
3b	Area-4	Mapping	14/Sep/2009	23h20	UTC-6	70°46.700	136°34.800	1015
3b	Area-4	Mapping	15/Sep/2009	02h18	UTC-6	70°47.100	135°45.300	568
3b	Area-4	Mapping	15/Sep/2009	02h18	UTC-6	70°47.100	135°45.300	568
3b	Area-4	Mapping	15/Sep/2009	03h15	UTC-6	70°47.900	135°27.800	431
3b	Area-4	Mapping	15/Sep/2009	03h41	UTC-6	70°46.200	135°41.100	517
3b	Area-4	Mapping	15/Sep/2009	06h10	UTC-6	70°45.980	136°26.520	809
3b	Area-5	CTD	15/Sep/2009	09h48	UTC-6	70°44.300	135°26.700	262
3b	Area-5	Met/Ocean Buoy	15/Sep/2009	13h44	UTC-6	70°43.900	136°00.900	546
3b	Area-5	Mapping	16/Sep/2009	02h03	UTC-6	70°41.800	136°43.800	1080
3b	Area-5	Mapping	16/Sep/2009	02h53	UTC-6	70°44.200	136°26.400	918
3b	Area-5	Mapping	16/Sep/2009	04h00	UTC-6	70°47.530	136°11.430	734
3b	Area-5	Mapping	16/Sep/2009	04h07	UTC-6	70°46.810	136°09.960	693
3b	Area-5	Mapping	16/Sep/2009	05h30	UTC-6	70°41.280	136°27.640	795
3b	Area-5	Mapping	16/Sep/2009	06h15	UTC-6	70°42.000	136°10.500	555
3b	Area-5	Mapping	16/Sep/2009	07h15	UTC-6	70°45.560	136°07.640	724
3b	Area-6	CTD	16/Sep/2009	07h21	UTC-6	70°46.540	136°06.790	727
3b	A	Mixed Layer Buoy	16/Sep/2009	09h41	UTC-6	70°43.700	136°01.600	560
3b	B	Mixed Layer Buoy	16/Sep/2009	11h10	UTC-6	70°39.500	135°36.400	132
3b	B-09	Mooring	16/Sep/2009	11h30	UTC-6	70°39.300	135°36.500	117
3b	Area-6	Mapping	16/Sep/2009	13h35	UTC-6	70°38.800	135°36.200	93
3b	Area-6	Mapping	16/Sep/2009	14h29	UTC-6	70°44.800	135°42.900	469
3b	Area-6	Mapping	16/Sep/2009	14h45	UTC-6	70°44.000	135°44.300	509
3b	Area-6	Mapping	16/Sep/2009	15h53	UTC-6	70°48.800	136°00.800	772
3b	Area-7	Mooring	16/Sep/2009	16h09	UTC-6	70°44.690	136°22.530	764
3b	Area-7	CTD	16/Sep/2009	22h30	UTC-6	70°44.500	136°21.700	764
3b	Area-7	Mapping	16/Sep/2009	22h35	UTC-6	70°48.800	136°07.300	788
3b	Area-7	Mapping	16/Sep/2009	22h56	UTC-6	70°44.500	136°21.800	751
3b	Area-7	Mapping	17/Sep/2009	00h19	UTC-6	70°47.100	135°58.900	708
3b	Area-7	Mapping	17/Sep/2009	00h19	UTC-6	70°47.100	135°58.900	708
3b	Area-7	Mapping	17/Sep/2009	00h47	UTC-6	70°44.400	135°52.800	593
3b	Area-7	Mapping	17/Sep/2009	00h47	UTC-6	70°44.400	135°52.800	593
3b	Area-7	Mapping	17/Sep/2009	00h55	UTC-6	70°43.800	135°52.200	550
3b	Area-7	Mapping	17/Sep/2009	00h55	UTC-6	70°43.800	135°52.200	550
3b	Area-7	Mapping	17/Sep/2009	01h54	UTC-6	70°36.800	135°50.800	138
3b	Area-7	Mapping	17/Sep/2009	02h48	UTC-6	70°37.200	136°16.900	564
3b	Area-7	Mapping	17/Sep/2009	04h38	UTC-6	70°43.110	135°48.190	450
3b	Area-7	Mapping	17/Sep/2009	05h25	UTC-6	70°49.820	135°29.420	469
3b	Area-7	Mapping	17/Sep/2009	06h53	UTC-6	70°44.200	135°52.860	572
3b	B-09	Mooring	17/Sep/2009	09h20	UTC-6	70°39.961	135°35.947	N/A
3b	Area-7	Mapping	17/Sep/2009	11h40	UTC-6	70°44.300	136°41.500	1054
3b	Area-7	Mapping	17/Sep/2009	12h13	UTC-6	70°43.800	136°25.300	900
3b	Area-7	Mapping	17/Sep/2009	13h55	UTC-6	70°40.300	136°14.600	555
3b	Area-7	Mapping	17/Sep/2009	15h19	UTC-6	70°44.300	135°51.800	552

Appendix 1 - List of stations sampled during the 2009 ArcticNet Expedition

Leg	Station ID	Station Type	Local Date	Local Time	UTC to local	Latitude (N)	Longitude (W)	Depth (m)
3b	Area-8	CTD	17/Sep/2009	15h45	UTC-6	70°44.600	135°52.000	558
3b	Area-8	Mapping	17/Sep/2009	16h44	UTC-6	70°42.800	135°49.310	449
3b	Area-8	Mapping	17/Sep/2009	18h05	UTC-6	70°49.210	136°10.060	800
3b	Area-8	Piston Core	17/Sep/2009	18h52	UTC-6	70°44.820	136°10.320	613
3b	Area-8	Mapping	17/Sep/2009	21h50	UTC-6	70°43.600	136°29.400	427
3b	Area-8	Mapping	18/Sep/2009	00h41	UTC-6	70°43.100	136°17.800	170
3b	Area-8	Mapping	18/Sep/2009	01h48	UTC-6	70°48.100	135°56.200	709
3b	Area-8	Mapping	18/Sep/2009	04h15	UTC-6	70°47.750	136°41.040	1152
3b	Area-8	Mapping	18/Sep/2009	04h35	UTC-6	70°44.220	136°43.250	1288
3b	Area-8	Mapping	18/Sep/2009	13h00	UTC-6	70°46.700	135°38.400	456
3b	Area-8	Mapping	18/Sep/2009	13h20	UTC-6	70°46.200	135°37.500	460
3b	Area-8	Mapping	18/Sep/2009	14h32	UTC-6	70°39.000	136°11.500	515
3b	Area-8	Mapping	18/Sep/2009	14h49	UTC-6	70°38.600	136°10.300	497
3b	Area-8	Mapping	18/Sep/2009	17h07	UTC-6	70°46.100	135°35.000	126
3b	Area-8	Mapping	18/Sep/2009	17h21	UTC-6	70°45.200	135°36.000	415
3b	Area-8	Mapping	18/Sep/2009	22h00	UTC-6	70°44.400	135°33.900	366
3b	Area-8	Mapping	18/Sep/2009	23h18	UTC-6	70°37.800	136°05.300	347
3b	Area-8	Mapping	18/Sep/2009	23h40	UTC-6	70°36.900	136°06.500	313
3b	Area-8	Mapping	19/Sep/2009	02h22	UTC-6	70°44.200	135°31.600	339
3b	Area-8	Mapping	19/Sep/2009	02h40	UTC-6	70°43.700	135°31.400	306
3b	Area-8	Mapping	19/Sep/2009	03h56	UTC-6	70°36.200	136°06.800	275
3b	Area-8	Mapping	19/Sep/2009	04h10	UTC-6	70°35.880	136°05.360	244
3b	Area-8	Mapping	19/Sep/2009	06h30	UTC-6	70°43.000	135°28.580	214
3b	Area-8	Mapping	19/Sep/2009	06h34	UTC-6	70°42.820	135°29.420	215
3b	Area-8	Mapping	19/Sep/2009	07h55	UTC-6	70°34.720	136°05.040	113
3b	Area-8	Mapping	19/Sep/2009	08h00	UTC-6	70°34.740	136°04.860	73
3b	Area-8	Mapping	19/Sep/2009	10h38	UTC-6	70°42.500	135°27.500	155
3b	Area-8	Mapping	19/Sep/2009	11h00	UTC-6	70°41.900	135°27.700	133
3b	Area-8	Mapping	19/Sep/2009	12h30	UTC-6	70°34.500	136°02.800	118
3b	Area-8	Mapping	19/Sep/2009	12h30	UTC-6	70°34.500	136°02.800	117
3b	Area-8	Mapping	19/Sep/2009	12h55	UTC-6	70°33.060	136°09.700	120
3b	Area-8	Mapping	19/Sep/2009	13h13	UTC-6	70°33.000	136°09.800	120
3b	Area-8	Mapping	19/Sep/2009	15h00	UTC-6	70°26.700	136°41.600	305
3b	Area-8	Box Core	19/Sep/2009	18h54	UTC-6	70°48.070	136°05.920	742
3b	Area-8	Piston Core	19/Sep/2009	20h00	UTC-6	70°48.060	136°05.900	743
3b	Area-9	CTD	19/Sep/2009	21h08	UTC-6	70°47.900	136°06.000	744
3b	Area-9	Mapping	19/Sep/2009	22h35	UTC-6	70°54.400	136°04.000	839
3b	Area-9	Mapping	19/Sep/2009	23h15	UTC-6	70°54.000	136°07.300	866
3b	Area-9	Mapping	20/Sep/2009	00h06	UTC-6	70°57.000	136°07.100	906
3b	Area-9	Mapping	20/Sep/2009	01h32	UTC-6	70°46.200	136°57.800	1393
3b	Area-9	Mapping	20/Sep/2009	01h58	UTC-6	70°44.600	136°54.100	1230
3b	Area-9	Mapping	20/Sep/2009	04h17	UTC-6	70°56.020	136°00.650	884
3b	Area-9	Mapping	20/Sep/2009	04h30	UTC-6	70°54.800	136°00.100	824
3b	Area-9	Mapping	20/Sep/2009	06h30	UTC-6	70°44.380	136°51.560	1145
3b	Area-9	Mapping	20/Sep/2009	06h38	UTC-6	70°42.800	136°50.800	1158
3b	Area-9	Mapping	20/Sep/2009	07h43	UTC-6	70°48.420	136°24.200	800
3b	Area-9	Piston Core	20/Sep/2009	08h35	UTC-6	70°48.000	136°06.100	745
3b	Area-9	Piston Core	20/Sep/2009	11h28	UTC-6	70°48.000	136°05.900	745
3b	Area-9	Mapping	20/Sep/2009	12h34	UTC-6	70°46.700	136°10.100	706
3b	Area-9	Mapping	20/Sep/2009	13h18	UTC-6	70°44.800	136°19.400	628
3b	Area-9	Piston Core	20/Sep/2009	14h16	UTC-6	70°45.800	136°10.800	655
3b	Area-9	Weather	20/Sep/2009	15h12	UTC-6	70°46.200	136°09.100	690
3b	Area-9	Mapping	20/Sep/2009	15h23	UTC-6	70°45.800	136°08.400	686
3b	Area-9	Mapping	20/Sep/2009	15h55	UTC-6	70°44.200	136°15.200	594
3b	Area-9	Piston Core	20/Sep/2009	16h22	UTC-6	70°44.600	136°13.100	620
3b	Area-9	Mapping	20/Sep/2009	18h15	UTC-6	70°48.500	136°07.500	749
3b	Area-9	Mapping	20/Sep/2009	19h46	UTC-6	70°39.430	135°58.210	310

Appendix 1 - List of stations sampled during the 2009 ArcticNet Expedition

Leg	Station ID	Station Type	Local Date	Local Time	UTC to local	Latitude (N)	Longitude (W)	Depth (m)
3b	Area-9	Mapping	20/Sep/2009	20h23	UTC-6	70°33.400	135°57.100	65
3b	Area-9	Mapping	20/Sep/2009	21h26	UTC-6	70°38.650	136°09.800	65
3b	Area-9	Mapping	20/Sep/2009	21h55	UTC-6	70°41.200	136°10.200	N/A
3b	Area-9	Mapping	20/Sep/2009	22h37	UTC-6	70°42.900	136°19.100	N/A
3b	Area-9	Mapping	20/Sep/2009	22h40	UTC-6	70°42.800	136°19.800	791
3b	Area-9	Mapping	20/Sep/2009	23h24	UTC-6	70°42.900	136°33.300	1123
3b	Area-9	Mapping	20/Sep/2009	23h25	UTC-6	70°43.200	136°33.700	1163
3b	Area-9	Mapping	20/Sep/2009	23h36	UTC-6	70°43.800	136°38.400	1247
3b	Area-9	Mapping	20/Sep/2009	23h37	UTC-6	70°43.800	136°38.400	1247
3b	Area-9	Mapping	20/Sep/2009	23h57	UTC-6	70°44.200	136°43.400	1291
3b	Area-9	Mapping	20/Sep/2009	23h57	UTC-6	70°44.200	136°43.400	1291
3b	Area-9	Mapping	21/Sep/2009	00h18	UTC-6	70°45.900	136°49.800	1361
3b	Area-9	Mapping	21/Sep/2009	00h38	UTC-6	70°45.400	136°55.600	1324
3b	Area-9	Mapping	21/Sep/2009	02h11	UTC-6	70°56.600	136°03.200	880
3b	Area-9	Mapping	21/Sep/2009	02h30	UTC-6	70°53.800	135°58.800	799
3b	Area-9	Mapping	21/Sep/2009	03h15	UTC-6	70°48.200	136°25.600	821
3b	Area-9	Mapping	21/Sep/2009	03h33	UTC-6	70°47.000	136°23.700	713
3b	Area-10	CTD	21/Sep/2009	05h38	UTC-6	70°43.800	136°17.100	613
3b	Area-10	Piston Core	21/Sep/2009	06h40	UTC-6	70°43.490	136°15.510	599
3b	Area-10	Mapping	21/Sep/2009	08h00	UTC-6	70°43.300	136°14.230	590
3b	Area-10	Mapping	21/Sep/2009	08h30	UTC-6	70°45.100	136°06.110	595
3b	Area-10	Mapping	21/Sep/2009	08h44	UTC-6	70°45.400	136°07.500	630
3b	Area-10	Mapping	21/Sep/2009	09h24	UTC-6	70°43.500	136°16.400	630
3b	Area-10	Piston Core	21/Sep/2009	09h58	UTC-6	70°43.800	136°15.100	585
3b	Area-10	Mapping	21/Sep/2009	11h50	UTC-6	70°44.250	136°16.180	647
3b	Area-10	Mapping	21/Sep/2009	12h00	UTC-6	70°43.600	136°18.900	647
3b	Area-10	Mapping	21/Sep/2009	12h23	UTC-6	70°42.900	136°18.000	748
3b	Area-10	Mapping	21/Sep/2009	12h52	UTC-6	70°44.300	136°11.500	598
3b	Area-10	Piston Core	21/Sep/2009	13h30	UTC-6	70°42.700	136°17.300	739
3b	Area-10	Box Core	21/Sep/2009	16h09	UTC-6	70°33.400	135°57.200	73
3b	Area-10	Piston Core	21/Sep/2009	18h18	UTC-6	70°33.470	135°57.190	73
3b	N/A	MVP	21/Sep/2009	18h50	UTC-6	70°33.300	135°58.700	73
3b	Area-11	CTD	21/Sep/2009	20h03	UTC-6	70°35.500	136°01.800	185
3b	LF07	Hydrophone	21/Sep/2009	21h30	UTC-6	70°38.900	136°07.300	460
3b	Area-11	Mapping	21/Sep/2009	21h45	UTC-6	70°35.600	136°05.800	244
3b	Area-11	Mapping	21/Sep/2009	22h08	UTC-6	70°34.700	136°03.200	130
3b	Area-11	Mapping	21/Sep/2009	22h11	UTC-6	70°34.800	136°02.700	132
3b	Area-11	Mapping	21/Sep/2009	23h14	UTC-6	70°39.900	135°37.800	176
3b	Area-11	Mapping	21/Sep/2009	23h17	UTC-6	70°39.900	135°37.800	176
3b	Area-11	Mapping	21/Sep/2009	23h25	UTC-6	70°39.500	135°39.800	172
3b	Area-11	Mapping	21/Sep/2009	23h30	UTC-6	70°39.300	135°39.700	160
3b	Area-11	Mapping	21/Sep/2009	23h40	UTC-6	70°39.700	135°37.900	165
3b	Area-11	Mapping	21/Sep/2009	23h45	UTC-6	70°39.700	135°37.400	159
3b	Area-11	Mapping	21/Sep/2009	23h53	UTC-6	70°39.200	135°39.400	146
3b	Area-11	Mapping	22/Sep/2009	00h02	UTC-6	70°39.800	135°39.100	188
3b	Area-11	Mapping	22/Sep/2009	00h28	UTC-6	70°42.200	135°27.400	142
3b	Area-11	Mapping	22/Sep/2009	00h36	UTC-6	70°42.500	135°29.000	183
3b	Area-11	Mapping	22/Sep/2009	02h02	UTC-6	70°35.200	136°03.800	200
3b	Area-11	Mapping	22/Sep/2009	02h11	UTC-6	70°35.700	136°04.400	231
3b	Area-11	Mapping	22/Sep/2009	03h42	UTC-6	70°43.100	135°29.400	253
3b	Area-11	Mapping	22/Sep/2009	03h49	UTC-6	70°43.400	135°30.800	304
3b	Area-11	Mapping	22/Sep/2009	05h20	UTC-6	70°36.220	136°05.600	284
3b	Area-11	Mapping	22/Sep/2009	05h26	UTC-6	70°36.930	136°04.910	278
3b	Area-11	Mapping	22/Sep/2009	06h25	UTC-6	70°41.180	135°43.670	303
3b	Area-12	CTD	22/Sep/2009	07h15	UTC-6	70°33.400	135°57.400	66
3b	Area-12	Piston Core	22/Sep/2009	08h37	UTC-6	70°33.460	135°57.200	75
3b	LF11	Hydrophone	22/Sep/2009	09h46	UTC-6	70°32.900	135°56.480	70

Appendix 1 - List of stations sampled during the 2009 ArcticNet Expedition

Leg	Station ID	Station Type	Local Date	Local Time	UTC to local	Latitude (N)	Longitude (W)	Depth (m)
3b	LF12	Hydrophone	22/Sep/2009	11h14	UTC-6	70°32.800	135°35.500	60
3b	LF05	Hydrophone	22/Sep/2009	12h36	UTC-6	70°33.200	135°13.800	55
3b	LF09	Hydrophone	22/Sep/2009	13h53	UTC-6	70°38.300	135°22.400	70
3b	LF08	Hydrophone	22/Sep/2009	14h49	UTC-6	70°39.300	135°45.800	225
3b	Area-12	Mapping	22/Sep/2009	14h53	UTC-6	70°37.900	135°47.100	195
3b	Area-12	Mapping	22/Sep/2009	15h26	UTC-6	70°35.300	136°01.600	138
3b	Area-12	Box Core	22/Sep/2009	15h38	UTC-6	70°35.500	136°02.600	210
3b	Area-12	Piston Core	22/Sep/2009	16h10	UTC-6	70°35.520	136°02.540	210
3b	LF06	Hydrophone	22/Sep/2009	18h16	UTC-6	70°39.230	136°27.850	611
3b	Area-13	CTD	22/Sep/2009	21h04	UTC-6	70°45.100	136°38.900	1212
3b	Area-13	Mapping	22/Sep/2009	21h50	UTC-6	70°45.500	136°41.100	1233
3b	Area-13	Mapping	22/Sep/2009	22h12	UTC-6	70°43.200	136°51.800	1175
3b	Area-13	Mapping	22/Sep/2009	22h29	UTC-6	70°42.400	136°49.700	1169
3b	Area-13	Mapping	22/Sep/2009	23h56	UTC-6	70°53.600	135°56.400	783
3b	Area-13	Mapping	23/Sep/2009	00h02	UTC-6	70°52.900	135°57.200	756
3b	Area-13	Mapping	23/Sep/2009	02h18	UTC-6	70°41.900	136°49.200	1139
3b	Area-13	Mapping	23/Sep/2009	02h24	UTC-6	70°41.500	136°47.900	1155
3b	Area-13	Mapping	23/Sep/2009	04h45	UTC-6	70°52.570	135°55.900	805
3b	Area-13	Mapping	23/Sep/2009	04h49	UTC-6	70°52.060	135°55.320	758
3b	Area-13	Mapping	23/Sep/2009	05h56	UTC-6	70°46.630	135°20.850	673
3b	Area-13	Mapping	23/Sep/2009	07h30	UTC-6	70°47.270	136°12.980	718
3b	Area-13	Mapping	23/Sep/2009	08h03	UTC-6	70°45.200	136°22.500	771
3b	Area-13	Mapping	23/Sep/2009	08h11	UTC-6	70°44.800	136°21.200	718
3b	Area-13	Mapping	23/Sep/2009	08h47	UTC-6	70°47.000	136°10.800	767
3b	Area-13	Piston Core	23/Sep/2009	09h20	UTC-6	70°46.900	136°12.300	702
3b	LF02	Hydrophone	23/Sep/2009	11h42	UTC-6	70°45.100	136°16.600	618
3b	LF03	Hydrophone	23/Sep/2009	13h13	UTC-6	70°45.100	135°56.000	628
3b	LF04	Hydrophone	23/Sep/2009	14h30	UTC-6	70°45.000	135°34.600	395
3b	LF10	Hydrophone	23/Sep/2009	15h35	UTC-6	70°45.200	135°14.000	82
3b	Area-13	Piston Core	23/Sep/2009	16h25	UTC-6	70°47.570	135°33.742	412
3b	Area-14	Piston Core	23/Sep/2009	19h05	UTC-6	70°47.570	135°33.750	420
3b	Area-14	CTD	23/Sep/2009	19h52	UTC-6	70°47.500	135°33.900	418
3b	Area-14	Mapping	23/Sep/2009	20h40	UTC-6	70°47.200	135°38.600	489
3b	Area-14	Mapping	23/Sep/2009	22h50	UTC-6	70°35.000	136°36.300	674
3b	Area-14	Mapping	23/Sep/2009	22h59	UTC-6	70°35.500	136°36.200	731
3b	Area-14	Mapping	24/Sep/2009	00h25	UTC-6	70°43.800	135°58.900	559
3b	Area-14	Mapping	24/Sep/2009	00h42	UTC-6	70°43.400	136°03.900	561
3b	Area-14	Mapping	24/Sep/2009	01h17	UTC-6	70°41.100	136°14.500	579
3b	Area-14	Mapping	24/Sep/2009	01h29	UTC-6	70°41.300	136°14.600	583
3b	Area-14	Mapping	24/Sep/2009	02h04	UTC-6	70°43.500	136°04.200	558
3b	Area-14	Mapping	24/Sep/2009	02h17	UTC-6	70°43.500	135°59.000	537
3b	Area-14	Mapping	24/Sep/2009	02h50	UTC-6	70°43.800	135°43.800	558
3b	Area-14	Mapping	24/Sep/2009	03h10	UTC-6	70°47.000	135°38.200	477
3b	Area-14	Mapping	24/Sep/2009	04h18	UTC-6	70°40.120	136°11.190	495
3b	Area-14	Mapping	24/Sep/2009	04h22	UTC-6	70°39.770	136°09.520	505
3b	Area-14	Mapping	24/Sep/2009	05h30	UTC-6	70°46.840	135°35.870	465
3b	Area-14	Mapping	24/Sep/2009	05h35	UTC-6	70°46.260	135°35.640	440
3b	Area-14	Weather	24/Sep/2009	06h20	UTC-6	70°39.650	136°07.250	469
3b	Area-14	Mapping	24/Sep/2009	06h30	UTC-6	70°39.160	136°09.59	489
3b	Area-15	CTD	24/Sep/2009	07h25	UTC-6	70°35.680	136°02.710	194
3b	Area-15	Piston Core	24/Sep/2009	08h42	UTC-6	70°35.500	136°02.600	198
3b	Area-15	Box Core	24/Sep/2009	09h56	UTC-6	70°37.300	135°58.500	221
3b	Area-15	Piston Core	24/Sep/2009	10h38	UTC-6	70°37.200	135°58.600	221
3b	Area-15	Mapping	24/Sep/2009	11h37	UTC-6	70°35.100	136°00.500	122
3b	Area-15	Mapping	24/Sep/2009	11h49	UTC-6	70°36.300	135°54.700	135
3b	Area-15	Mapping	24/Sep/2009	11h54	UTC-6	70°36.000	135°54.900	112
3b	Area-15	Mapping	24/Sep/2009	12h05	UTC-6	70°34.800	136°00.400	106

Appendix 1 - List of stations sampled during the 2009 ArcticNet Expedition

Leg	Station ID	Station Type	Local Date	Local Time	UTC to local	Latitude (N)	Longitude (W)	Depth (m)
3b	Area-15	Piston Core	24/Sep/2009	12h42	UTC-6	70°37.300	135°58.600	225
3b	Area-15	Mapping	24/Sep/2009	13h49	UTC-6	70°34.900	136°00.500	113
3b	Area-15	Mapping	24/Sep/2009	14h17	UTC-6	70°36.300	135°54.200	124
3b	Area-15	Box Core	24/Sep/2009	14h47	UTC-6	70°37.300	135°50.900	167
3b	Area-15	Piston Core	24/Sep/2009	16h00	UTC-6	70°37.260	135°50.900	168
3b	Area-15	Mapping	24/Sep/2009	17h03	UTC-6	70°35.900	135°54.400	108
3b	Area-15	Mapping	24/Sep/2009	17h15	UTC-6	70°34.700	136°00.200	97
3b	Area-15	Mapping	24/Sep/2009	17h25	UTC-6	70°35.100	136°01.800	134
3b	Area-15	Mapping	24/Sep/2009	17h51	UTC-6	70°38.650	135°56.800	262
3b	Area-15	Piston Core	24/Sep/2009	18h35	UTC-6	70°38.910	135°56.790	213
3b	Area-16	CTD	24/Sep/2009	19h18	UTC-6	70°38.970	135°56.700	279
3b	N/A	MVP	24/Sep/2009	19h45	UTC-6	70°38.810	135°57.480	277
3b	Area-16	Mapping	24/Sep/2009	20h55	UTC-6	70°41.400	135°43.400	321
3b	Area-16	Mapping	24/Sep/2009	21h52	UTC-6	70°46.100	135°21.000	234
3b	Area-16	Mapping	24/Sep/2009	21h58	UTC-6	70°46.600	135°21.900	272
3b	Area-16	Mapping	24/Sep/2009	11h14	UTC-6	70°37.000	136°07.300	338
3b	Area-16	Mapping	24/Sep/2009	11h20	UTC-6	70°37.500	136°08.000	395
3b	Area-16	Mapping	25/Sep/2009	01h05	UTC-6	70°47.100	135°22.500	305
3b	Area-16	Mapping	25/Sep/2009	01h16	UTC-6	70°47.400	135°24.300	335
3b	Area-16	Mapping	25/Sep/2009	02h33	UTC-6	70°37.900	136°09.400	436
3b	Area-16	Mapping	25/Sep/2009	02h43	UTC-6	70°38.400	136°09.600	487
3b	Area-16	Mapping	25/Sep/2009	04h30	UTC-6	70°47.880	135°24.920	370
3b	Area-16	Mapping	25/Sep/2009	04h36	UTC-6	70°48.170	135°25.220	386
3b	Area-16	Mapping	25/Sep/2009	05h52	UTC-6	70°38.490	136°12.300	517
3b	Area-16	Mapping	25/Sep/2009	05h58	UTC-6	70°38.340	136°14.840	548
3b	Area-16	Mapping	25/Sep/2009	06h55	UTC-6	70°38.740	136°10.180	496
3b	Area-17	CTD	25/Sep/2009	07h07	UTC-6	70°38.820	136°10.460	496
3b	Area-17	Piston Core	25/Sep/2009	08h30	UTC-6	70°38.500	136°09.200	475
3b	Area-17	Mapping	25/Sep/2009	09h19	UTC-6	70°39.100	136°12.500	527
3b	Area-17	Mapping	25/Sep/2009	09h28	UTC-6	70°38.300	136°16.400	564
3b	Area-17	Mapping	25/Sep/2009	09h39	UTC-6	70°38.700	136°17.630	574
3b	Area-17	Mapping	25/Sep/2009	09h47	UTC-6	78°39.600	136°13.400	536
3b	Area-17	Piston Core	25/Sep/2009	10h30	UTC-6	70°38.100	136°09.600	475
3b	Area-17	Mapping	25/Sep/2009	11h39	UTC-6	70°42.700	136°07.800	587
3b	Area-17	Mapping	25/Sep/2009	12h14	UTC-6	70°41.600	136°15.400	643
3b	Area-17	Piston Core	25/Sep/2009	12h46	UTC-6	70°40.380	136°14.130	554
3b	Area-17	Weather	25/Sep/2009	13h04	UTC-6	70°40.300	136°14.100	554
3b	Area-17	Piston Core	25/Sep/2009	14h35	UTC-6	70°41.100	136°10.040	530
3b	Area-17	Piston Core	25/Sep/2009	16h32	UTC-6	70°44.340	136°08.660	613
3b	Area-17	Mapping	25/Sep/2009	18h10	UTC-6	70°44.030	136°07.110	611
3b	Area-17	Mapping	25/Sep/2009	18h48	UTC-6	70°41.890	136°17.570	595
3b	Area-18	CTD	25/Sep/2009	18h58	UTC-6	70°41.330	136°16.540	591
3b	Area-18	Mapping	25/Sep/2009	20h21	UTC-6	70°36.000	136°37.400	797
3b	Area-18	Mapping	25/Sep/2009	22h20	UTC-6	70°47.300	135°44.300	569
3b	Area-18	Mapping	25/Sep/2009	22h24	UTC-6	70°47.400	135°46.900	601
3b	Area-18	Mapping	26/Sep/2009	00h12	UTC-6	70°36.400	136°38.800	866
3b	Area-18	Mapping	26/Sep/2009	00h18	UTC-6	70°37.000	136°38.900	882
3b	Area-18	Mapping	26/Sep/2009	02h11	UTC-6	70°48.000	135°46.600	625
3b	Area-18	Mapping	26/Sep/2009	02h19	UTC-6	70°48.400	135°48.100	629
3b	Area-18	Mapping	26/Sep/2009	04h14	UTC-6	70°38.060	136°40.240	933
3b	Area-18	Mapping	26/Sep/2009	04h08	UTC-6	70°37.950	136°37.950	654
3b	Area-18	Mapping	26/Sep/2009	06h05	UTC-6	70°48.770	135°49.560	661
3b	Area-18	Mapping	26/Sep/2009	06h10	UTC-6	70°49.960	135°46.460	664
3b	N/A	Weather	26/Sep/2009	06h32	UTC-6	70°46.990	136°01.170	721
3b	Area-19	CTD	26/Sep/2009	07h04	UTC-6	70°44.780	136°11.880	614
3b	Area-19	Piston Core	26/Sep/2009	08h23	UTC-6	70°41.300	136°06.100	640
3b	Area-19	Mapping	26/Sep/2009	09h18	UTC-6	70°45.700	136°08.000	683

Appendix 1 - List of stations sampled during the 2009 ArcticNet Expedition

Leg	Station ID	Station Type	Local Date	Local Time	UTC to local	Latitude (N)	Longitude (W)	Depth (m)
3b	Area-19	Mapping	26/Sep/2009	09h55	UTC-6	70°43.400	136°18.800	678
3b	Area-19	Piston Core	26/Sep/2009	10h30	UTC-6	70°44.900	136°28.300	1005
3b	Area-19	Mapping	26/Sep/2009	11h43	UTC-6	70°42.500	136°17.100	719
3b	Area-19	Mapping	26/Sep/2009	12h18	UTC-6	70°44.800	136°06.300	659
3b	Area-19	Mapping	26/Sep/2009	12h25	UTC-6	70°44.500	136°05.900	641
3b	Area-19	Mapping	26/Sep/2009	13h02	UTC-6	70°42.200	136°16.800	703
3b	Area-19	Piston Core	26/Sep/2009	13h35	UTC-6	70°39.500	136°05.600	448
3b	Area-19	Box Core	26/Sep/2009	15h12	UTC-6	70°40.500	136°01.100	432
3b	Area-19	Piston Core	26/Sep/2009	16h18	UTC-6	70°40.400	136°01.150	440
3b	Area-19	Mapping	26/Sep/2009	17h07	UTC-6	70°39.400	136°01.500	355
3b	Area-19	Mapping	26/Sep/2009	17h26	UTC-6	70°36.800	135°57.800	212
3b	Area-19	Mapping	26/Sep/2009	17h36	UTC-6	70°36.530	135°59.330	210
3b	Area-19	Mapping	26/Sep/2009	17h55	UTC-6	70°39.610	136°03.590	220
3b	Area-19	Piston Core	26/Sep/2009	18h26	UTC-6	70°40.480	136°01.190	440
3b	Area-20	CTD	26/Sep/2009	19h14	UTC-6	70°40.560	136°02.540	457
3b	Area-20	Mapping	26/Sep/2009	20h00	UTC-6	70°41.770	136°05.690	500
3b	Area-20	Mapping	26/Sep/2009	21h18	UTC-6	70°38.300	136°42.100	973
3b	Area-20	Mapping	26/Sep/2009	21h25	UTC-6	70°39.000	136°43.600	1081
3b	Area-20	Mapping	26/Sep/2009	23h16	UTC-6	78°50.300	135°51.400	687
3b	Area-20	Mapping	26/Sep/2009	23h23	UTC-6	70°49.800	135°50.500	672
3b	Area-20	Mapping	27/Sep/2009	00h39	UTC-6	70°42.700	136°24.000	861
3b	Area-20	Mapping	27/Sep/2009	00h50	UTC-6	70°43.800	136°25.000	950
3b	Area-20	Mapping	27/Sep/2009	02h19	UTC-6	70°50.800	135°51.800	694
3b	Area-20	Mapping	27/Sep/2009	02h26	UTC-6	70°51.200	135°53.300	699
3b	Area-20	Mapping	27/Sep/2009	04h17	UTC-6	70°40.030	136°46.140	1152
3b	Area-20	Mapping	27/Sep/2009	04h23	UTC-6	70°39.480	136°47.340	1147
3b	Area-20	Mapping	27/Sep/2009	04h45	UTC-6	70°34.310	136°38.420	643
3b	Area-20	Piston Core	27/Sep/2009	06h43	UTC-6	70°40.210	135°42.210	246
3b	Area-20	Box Core	27/Sep/2009	08h51	UTC-6	70°35.400	135°45.100	76
3b	Area-20	Piston Core	27/Sep/2009	09h50	UTC-6	70°35.400	135°45.100	76
3b	Area-21	CTD	27/Sep/2009	10h23	UTC-6	70°35.400	135°44.900	74
3b	Area-21	Piston Core	27/Sep/2009	11h00	UTC-6	70°35.400	135°45.100	74
3b	Area-21	Mapping	27/Sep/2009	11h20	UTC-6	70°35.200	135°46.600	70
3b	Area-21	Mapping	27/Sep/2009	11h37	UTC-6	70°34.400	135°51.500	65
3b	Area-21	Mapping	27/Sep/2009	11h40	UTC-6	70°34.500	135°51.400	66
3b	Area-21	Mapping	27/Sep/2009	11h58	UTC-6	70°36.300	135°40.300	67
3b	Area-21	Mapping	27/Sep/2009	12h02	UTC-6	70°36.400	135°41.000	68
3b	Area-21	Mapping	27/Sep/2009	12h19	UTC-6	70°34.600	135°52.300	66
3b	Area-21	Mapping	27/Sep/2009	12h23	UTC-6	70°34.800	135°51.700	68
3b	Area-21	Mapping	27/Sep/2009	12h41	UTC-6	70°36.600	135°40.300	68
3b	Area-21	Mapping	27/Sep/2009	12h46	UTC-6	70°36.200	135°40.300	67
3b	Area-21	Mapping	27/Sep/2009	12h55	UTC-6	70°35.200	135°46.600	67
3b	Area-21	Box Core	27/Sep/2009	13h25	UTC-6	70°37.400	135°45.100	110
3b	Area-21	Piston Core	27/Sep/2009	14h08	UTC-6	70°37.400	135°45.100	110
3b	Area-21	Mapping	27/Sep/2009	14h43	UTC-6	70°37.600	135°46.500	145
3b	Area-21	Mapping	27/Sep/2009	15h34	UTC-6	70°40.600	136°05.600	460
3b	Area-22	CTD	27/Sep/2009	15h47	UTC-6	70°40.500	136°05.900	461
3b	Area-22	Mapping	27/Sep/2009	17h00	UTC-6	70°43.660	136°21.150	700
3b	Area-22	Mapping	27/Sep/2009	17h38	UTC-6	70°46.370	136°07.600	620
3b	Area-22	Mapping	27/Sep/2009	18h30	UTC-6	70°43.960	136°21.840	617
3b	Area-22	Mapping	27/Sep/2009	19h18	UTC-6	70°46.010	136°08.850	717
3b	Area-22	Mapping	27/Sep/2009	19h22	UTC-6	70°46.640	136°09.470	671
3b	Area-22	Mapping	27/Sep/2009	19h55	UTC-6	70°44.100	136°21.600	747
3b	Area-22	Mapping	27/Sep/2009	20h01	UTC-6	70°44.400	136°20.800	674
3b	Area-22	Mapping	27/Sep/2009	20h09	UTC-6	70°45.000	136°18.500	627
3b	Area-22	Mapping	27/Sep/2009	20h24	UTC-6	70°44.700	136°21.400	719
3b	Area-22	Mapping	27/Sep/2009	21h00	UTC-6	70°47.100	136°10.400	714

Appendix 1 - List of stations sampled during the 2009 ArcticNet Expedition

Leg	Station ID	Station Type	Local Date	Local Time	UTC to local	Latitude (N)	Longitude (W)	Depth (m)
3b	Area-22	Mapping	27/Sep/2009	21h10	UTC-6	70°47.300	136°10.400	721
3b	Area-22	Mapping	27/Sep/2009	21h47	UTC-6	70°44.900	136°21.700	759
3b	Area-22	Mapping	27/Sep/2009	21h50	UTC-6	70°45.200	136°22.200	717
3b	Area-22	Mapping	27/Sep/2009	22h32	UTC-6	70°47.500	136°11.600	732
3b	Area-22	Mapping	27/Sep/2009	22h40	UTC-6	70°47.400	136°13.000	732
3b	Area-22	Mapping	27/Sep/2009	23h17	UTC-6	70°45.300	136°22.700	732
3b	Area-22	Mapping	27/Sep/2009	23h30	UTC-6	70°46.200	136°20.700	659
3b	Area-22	Mapping	28/Sep/2009	00h00	UTC-6	70°48.000	136°12.400	753
3b	Area-22	Mapping	28/Sep/2009	00h08	UTC-6	70°47.800	136°14.700	753
3b	Area-22	Mapping	28/Sep/2009	00h45	UTC-6	70°45.800	136°23.400	680
3b	Area-22	Mapping	28/Sep/2009	00h58	UTC-6	70°46.000	136°23.500	689
3b	Area-22	Mapping	28/Sep/2009	01h32	UTC-6	70°48.300	136°12.900	742
3b	Area-22	Mapping	28/Sep/2009	01h41	UTC-6	70°48.400	136°13.500	755
3b	Area-22	Mapping	28/Sep/2009	02h17	UTC-6	70°46.100	136°24.200	702
3b	Area-22	Mapping	28/Sep/2009	02h27	UTC-6	70°46.300	136°24.400	724
3b	Area-22	Mapping	28/Sep/2009	02h33	UTC-6	70°46.600	136°22.600	689
3b	Area-22	Mapping	28/Sep/2009	02h45	UTC-6	70°47.000	136°23.900	707
3b	Area-22	Mapping	28/Sep/2009	02h50	UTC-6	70°46.700	136°25.500	716
3b	Area-22	Mapping	28/Sep/2009	03h00	UTC-6	70°46.600	136°24.900	714
3b	Area-22	Mapping	28/Sep/2009	03h36	UTC-6	70°48.900	136°14.100	755
3b	Area-22	Mapping	28/Sep/2009	03h44	UTC-6	70°48.700	136°13.900	760
3b	Area-22	Mapping	28/Sep/2009	04h19	UTC-6	70°46.420	136°24.970	699
3b	Area-22	Mapping	28/Sep/2009	04h30	UTC-6	70°46.060	136°23.600	688
3b	Area-22	Mapping	28/Sep/2009	05h30	UTC-6	70°40.890	136°48.040	1079
3b	Area-22	Mapping	28/Sep/2009	05h41	UTC-6	70°40.490	136°46.790	1079
3b	Area-22	Mapping	28/Sep/2009	06h22	UTC-6	70°45.570	136°22.870	673
3b	Area-22	Mapping	28/Sep/2009	06h22	UTC-6	70°45.570	136°22.870	675
3b	Area-22	Mapping	28/Sep/2009	07h02	UTC-6	70°47.960	136°11.870	749
3b	Area-23	CTD	28/Sep/2009	07h07	UTC-6	70°47.960	136°11.810	749
3b	Area-23	Piston Core	28/Sep/2009	08h45	UTC-6	70°43.200	136°02.800	550
3b	Area-23	Piston Core	28/Sep/2009	11h20	UTC-6	70°43.200	135°51.600	511
3b	Area-23	Mapping	28/Sep/2009	12h18	UTC-6	70°44.400	136°00.000	586
3b	Area-23	Mapping	28/Sep/2009	12h30	UTC-6	70°45.900	136°01.500	689
3b	Area-23	Mapping	28/Sep/2009	12h38	UTC-6	70°45.500	136°03.000	666
3b	Area-23	Mapping	28/Sep/2009	12h47	UTC-6	70°44.400	136°02.110	596
3b	Area-23	Piston Core	28/Sep/2009	13h40	UTC-6	70°43.200	135°53.400	495
3b	Area-23	Piston Core	28/Sep/2009	15h27	UTC-6	70°40.200	135°37.800	202
3b	Area-23	Mapping	28/Sep/2009	16h45	UTC-6	70°46.000	135°20.000	196
3b	Area-23	Mapping	28/Sep/2009	17h01	UTC-6	70°43.000	135°29.700	250
3b	Area-23	Mapping	28/Sep/2009	17h07	UTC-6	70°43.400	135°29.500	276
3b	Area-23	Mapping	28/Sep/2009	17h24	UTC-6	70°45.400	135°19.700	170
3b	Area-23	Piston Core	28/Sep/2009	18h00	UTC-6	70°45.200	135°33.150	377
3b	Area-24	CTD	28/Sep/2009	19h03	UTC-6	70°45.460	135°33.860	392
3b	Area-24	MVP	28/Sep/2009	19h28	UTC-6	70°45.360	135°33.660	385
3b	Area-24	Mapping	28/Sep/2009	19h49	UTC-6	70°43.740	135°30.910	339
3b	Area-24	Mapping	28/Sep/2009	20h12	UTC-6	70°46.000	135°19.800	192
3b	Area-24	Mapping	28/Sep/2009	20h26	UTC-6	70°45.700	135°20.100	186
3b	Area-24	Mapping	28/Sep/2009	20h55	UTC-6	70°43.500	135°30.600	303
3b	Area-24	Mapping	28/Sep/2009	20h57	UTC-6	70°43.200	135°30.800	285
3b	Area-24	Mapping	28/Sep/2009	21h17	UTC-6	70°40.900	135°25.300	92
3b	Area-24	Mapping	28/Sep/2009	21h19	UTC-6	70°40.600	135°25.400	83
3b	Area-24	Mapping	28/Sep/2009	23h31	UTC-6	70°25.500	136°42.000	82
3b	Area-24	Mapping	28/Sep/2009	23h54	UTC-6	70°26.400	136°43.700	301
3b	Area-24	Mapping	29/Sep/2009	01h06	UTC-6	70°35.000	136°03.100	158
3b	Area-24	Mapping	29/Sep/2009	01h14	UTC-6	70°35.300	136°04.800	223
3b	Area-24	Mapping	29/Sep/2009	02h22	UTC-6	70°26.700	136°45.500	346
3b	Area-24	Mapping	29/Sep/2009	02h29	UTC-6	70°27.300	136°45.400	387

Appendix 1 - List of stations sampled during the 2009 ArcticNet Expedition

Leg	Station ID	Station Type	Local Date	Local Time	UTC to local	Latitude (N)	Longitude (W)	Depth (m)
3b	Area-24	Mapping	29/Sep/2009	03h40	UTC-6	70°35.900	136°04.800	257
3b	Area-24	Mapping	29/Sep/2009	03h48	UTC-6	70°36.300	136°06.400	271
3b	Area-24	Mapping	29/Sep/2009	04h55	UTC-6	70°27.530	136°48.540	440
3b	Area-24	Mapping	29/Sep/2009	05h03	UTC-6	70°28.130	136°47.830	458
3b	Area-24	Mapping	29/Sep/2009	06h15	UTC-6	70°36.920	136°06.430	320
3b	Area-24	Mapping	29/Sep/2009	06h22	UTC-6	70°37.490	136°08.360	390
3b	Area-24	Mapping	29/Sep/2009	06h52	UTC-6	70°33.230	136°08.360	484
3b	Area-25	CTD	29/Sep/2009	07h08	UTC-6	70°33.280	136°28.840	487
3b	Area-25	Mapping	29/Sep/2009	08h12	UTC-6	70°37.300	136°07.500	366
3b	Area-25	Mapping	29/Sep/2009	09h02	UTC-6	70°32.100	136°34.900	495
3b	Area-25	Mapping	29/Sep/2009	09h05	UTC-6	70°32.100	136°34.600	496
3b	Area-25	Mapping	29/Sep/2009	09h48	UTC-6	70°37.600	136°08.800	426
3b	Area-25	Mapping	29/Sep/2009	10h59	UTC-6	70°35.700	136°04.800	228
3b	Area-25	Mapping	29/Sep/2009	11h05	UTC-6	70°35.000	136°08.900	240
3b	Area-25	ROV	29/Sep/2009	16h49	UTC-6	70°37.500	136°00.840	N/A
3b	Area-25	Met/Ocean Buoy	29/Sep/2009	18h34	UTC-6	70°43.600	136°00.700	547
3b	Area-25	Mapping	29/Sep/2009	22h15	UTC-6	70°32.100	136°18.300	317
3b	Area-25	Mapping	29/Sep/2009	22h40	UTC-6	70°35.100	136°04.000	200
3b	Area-25	Mapping	29/Sep/2009	22h46	UTC-6	70°34.700	136°03.900	133
3b	Area-25	Mapping	29/Sep/2009	23h57	UTC-6	70°26.200	136°43.500	274
3b	Area-25	Mapping	30/Sep/2009	00h02	UTC-6	70°25.800	136°42.000	150
3b	Area-25	Mapping	30/Sep/2009	01h09	UTC-6	70°34.300	136°02.100	111
3b	Area-25	Mapping	30/Sep/2009	01h19	UTC-6	70°33.500	136°01.200	81
3b	Area-25	Mapping	30/Sep/2009	02h28	UTC-6	70°25.000	136°41.600	67
3b	Area-25	Mapping	30/Sep/2009	02h34	UTC-6	70°25.000	136°44.300	106
3b	Area-25	Mapping	30/Sep/2009	02h49	UTC-6	70°27.800	136°42.800	446
3b	Area-25	Mapping	30/Sep/2009	02h55	UTC-6	70°28.600	136°48.300	468
3b	Area-25	Mapping	30/Sep/2009	03h20	UTC-6	70°31.590	136°34.500	460
3b	Area-25	Mapping	30/Sep/2009	03h23	UTC-6	70°32.100	136°34.860	470
3b	Area-25	Mapping	30/Sep/2009	03h48	UTC-6	70°28.970	136°49.930	497
3b	Area-25	Mapping	30/Sep/2009	03h51	UTC-6	70°29.050	136°50.820	494
3b	Area-25	Mapping	30/Sep/2009	05h05	UTC-6	70°38.520	136°08.140	469
3b	Area-25	Mapping	30/Sep/2009	05h10	UTC-6	70°38.720	136°10.050	494
3b	Area-25	Mapping	30/Sep/2009	05h50	UTC-6	70°33.700	136°33.190	532
3b	Area-25	Mapping	30/Sep/2009	05h54	UTC-6	70°33.790	136°30.840	553
3b	Area-25	Mapping	30/Sep/2009	07h50	UTC-6	70°42.420	135°28.220	154
3b	N/A	MVP	30/Sep/2009	06h57	UTC-6	70°37.730	135°50.560	191
3b	N/A	MVP	30/Sep/2009	07h27	UTC-6	70°39.950	135°40.000	205
3b	Area-25	Mapping	30/Sep/2009	07h58	UTC-6	70°41.600	135°28.800	146
3b	Area-25	Mapping	30/Sep/2009	08h12	UTC-6	70°40.100	135°36.300	170
3b	B	Mixed Layer Buoy	30/Sep/2009	08h45	UTC-6	70°39.400	135°36.200	126
3b	Area-25	Mapping	30/Sep/2009	11h30	UTC-6	70°28.600	135°27.100	60
3b	Area-25	Mapping	30/Sep/2009	13h38	UTC-6	70°00.200	135°16.500	27
3b	Area-25	Mapping	30/Sep/2009	13h48	UTC-6	70°00.500	135°18.200	28
3b	Area-25	Mapping	30/Sep/2009	14h06	UTC-6	70°04.800	135°26.400	35
3b	Area-25	Mapping	30/Sep/2009	14h36	UTC-6	70°07.500	135°31.000	48
3b	Area-25	Mapping	30/Sep/2009	15h14	UTC-6	70°08.400	135°05.500	45
3b	Area-25	Weather	30/Sep/2009	14h55	UTC-6	70°08.200	135°11.300	45
3b	Area-25	Mapping	30/Sep/2009	15h49	UTC-6	70°10.100	135°14.000	50
3b	Area-25	Mapping	30/Sep/2009	16h24	UTC-6	70°10.580	135°35.030	50
3b	Area-25	Mapping	30/Sep/2009	16h30	UTC-6	70°11.290	135°33.940	55
3b	Area-25	Mapping	30/Sep/2009	17h00	UTC-6	70°12.160	135°13.470	44
3b	Area-25	Mapping	30/Sep/2009	17h10	UTC-6	70°14.130	135°14.280	48
3b	Area-25	Mapping	30/Sep/2009	18h20	UTC-6	70°12.470	136°00.510	43
3b	Area-25	Mapping	30/Sep/2009	18h30	UTC-6	70°10.610	135°56.380	40
3b	Area-25	Mapping	30/Sep/2009	21h00	UTC-6	70°33.200	136°00.100	70
3b	Area-25	Mapping	30/Sep/2009	22h09	UTC-6	70°24.600	136°40.400	62

Appendix 1 - List of stations sampled during the 2009 ArcticNet Expedition

Leg	Station ID	Station Type	Local Date	Local Time	UTC to local	Latitude (N)	Longitude (W)	Depth (m)
3b	Area-25	Mapping	30/Sep/2009	22h13	UTC-6	70°24.700	136°41.100	64
3b	Area-25	Mapping	30/Sep/2009	22h23	UTC-6	78°33.400	136°00.400	81
3b	Area-25	Mapping	30/Sep/2009	23h28	UTC-6	70°33.900	136°01.000	88
3b	Area-25	Mapping	01/Oct/2009	00h37	UTC-6	70°25.100	136°42.500	73
3b	Area-25	Mapping	01/Oct/2009	00h44	UTC-6	70°25.100	136°46.100	190
3b	Area-25	Mapping	01/Oct/2009	01h05	UTC-6	70°28.900	136°53.800	573
3b	Area-25	Mapping	01/Oct/2009	01h14	UTC-6	70°30.000	136°50.500	531
3b	Area-25	Mapping	01/Oct/2009	01h47	UTC-6	70°34.000	136°31.900	532
3b	Area-25	Mapping	01/Oct/2009	01h54	UTC-6	70°34.600	136°35.300	605
3b	Area-25	Mapping	01/Oct/2009	02h24	UTC-6	70°30.900	136°52.800	619
3b	Area-25	Mapping	01/Oct/2009	02h30	UTC-6	70°30.500	136°51.300	550
3b	Area-25	Mapping	01/Oct/2009	03h17	UTC-6	70°36.100	136°24.900	670
3b	Area-25	Mapping	01/Oct/2009	03h56	UTC-6	70°38.400	136°48.500	1041
3b	Area-25	Mapping	01/Oct/2009	04h19	UTC-6	70°43.220	136°51.940	1266
3b	Area-25	Mapping	01/Oct/2009	04h22	UTC-6	70°43.250	136°51.810	1192
3b	Area-25	Mapping	01/Oct/2009	05h52	UTC-6	70°54.590	135°58.590	814
3b	Area-25	Mapping	01/Oct/2009	06h00	UTC-6	70°55.340	136°01.070	849
3b	Area-25	Mapping	01/Oct/2009	07h27	UTC-6	70°44.300	136°53.070	1212
3b	Area-25	Weather	01/Oct/2009	06h18	UTC-6	70°52.370	136°16.320	865
3b	Area-26	CTD	01/Oct/2009	08h33	UTC-6	70°45.000	136°38.300	1205
3b	A1-09	CTD	01/Oct/2009	10h26	UTC-6	70°45.600	136°00.500	669
3b	A1-09	Mooring	01/Oct/2009	11h51	UTC-6	70°45.400	136°00.900	656
3b	A	Mixed Layer Buoy	01/Oct/2009	14h50	UTC-6	70°39.800	136°14.200	546
3b	Area-26	Mapping	01/Oct/2009	19h20	UTC-6	70°47.760	136°14.490	737
3b	Area-26	Mapping	01/Oct/2009	20h45	UTC-6	70°55.600	135°32.200	625
3b	Area-26	Mapping	01/Oct/2009	20h50	UTC-6	70°55.500	135°32.900	625
3b	Area-26	Mapping	01/Oct/2009	21h24	UTC-6	70°44.300	135°40.800	701
3b	Area-26	Mapping	01/Oct/2009	21h29	UTC-6	70°50.800	135°51.800	681
3b	Area-26	Mapping	01/Oct/2009	22h11	UTC-6	70°55.500	135°29.500	611
3b	Area-26	Mapping	01/Oct/2009	22h17	UTC-6	70°55.000	135°28.900	611
3b	Area-26	Mapping	01/Oct/2009	23h00	UTC-6	70°50.400	135°50.700	674
3b	Area-26	Mapping	01/Oct/2009	23h04	UTC-6	70°49.800	135°50.300	673
3b	Area-26	Mapping	01/Oct/2009	23h50	UTC-6	70°54.400	135°27.800	574
3b	Area-26	Mapping	01/Oct/2009	23h53	UTC-6	70°54.000	135°27.900	564
3b	Area-26	Mapping	02/Oct/2009	00h31	UTC-6	70°49.400	135°49.400	637
3b	Area-26	Mapping	02/Oct/2009	00h37	UTC-6	70°49.000	135°48.000	639
3b	Area-26	Mapping	02/Oct/2009	01h32	UTC-6	70°55.100	135°19.300	539
3b	Area-26	Mapping	02/Oct/2009	01h38	UTC-6	70°54.600	135°18.900	514
3b	Area-26	Mapping	02/Oct/2009	02h28	UTC-6	70°48.500	135°48.000	661
3b	Area-26	Mapping	02/Oct/2009	02h34	UTC-6	70°48.100	135°46.600	614
3b	Area-26	Mapping	02/Oct/2009	03h28	UTC-6	70°54.300	135°17.000	495
3b	Area-26	Mapping	02/Oct/2009	03h34	UTC-6	70°53.800	135°16.700	457
3b	Area-26	Mapping	02/Oct/2009	04h25	UTC-6	70°47.760	135°45.490	579
3b	Area-26	Mapping	02/Oct/2009	04h28	UTC-6	70°48.000	135°44.310	583
3b	Area-26	Mapping	02/Oct/2009	04h53	UTC-6	70°49.020	135°35.460	501
3b	Area-26	ROV	02/Oct/2009	06h30	UTC-6	70°47.440	136°05.530	785
3b	A1-09	Mooring	02/Oct/2009	13h28	UTC-6	70°45.600	136°00.500	666
3b	Area-26	Weather	02/Oct/2009	14h50	UTC-6	70°44.500	136°22.500	789
3b	Area-26	ROV	02/Oct/2009	15h31	UTC-6	70°44.500	136°22.600	800
3b	Area-26	Mapping	02/Oct/2009	22h01	UTC-6	70°43.800	135°30.700	303
3b	Area-26	Mapping	02/Oct/2009	23h05	UTC-6	70°36.600	136°05.100	282
3b	Area-26	Mapping	02/Oct/2009	23h10	UTC-6	70°36.900	136°06.200	325
3b	Area-26	Mapping	03/Oct/2009	00h39	UTC-6	70°46.400	135°21.300	272
3b	Area-26	Mapping	03/Oct/2009	00h46	UTC-6	70°46.700	135°22.800	288
3b	Area-26	Mapping	03/Oct/2009	02h09	UTC-6	70°37.300	136°07.700	365
3b	Area-26	Mapping	03/Oct/2009	02h16	UTC-6	70°37.800	136°08.200	433
3b	Area-26	Mapping	03/Oct/2009	03h44	UTC-6	70°47.300	135°23.100	324

Appendix 1 - List of stations sampled during the 2009 ArcticNet Expedition

Leg	Station ID	Station Type	Local Date	Local Time	UTC to local	Latitude (N)	Longitude (W)	Depth (m)
3b	Area-26	Mapping	03/Oct/2009	03h51	UTC-6	70°47.600	135°24.700	352
3b	Area-26	Mapping	03/Oct/2009	05h10	UTC-6	70°38.200	136°09.600	468
3b	Area-26	Mapping	03/Oct/2009	05h25	UTC-6	70°35.910	136°05.390	249
3b	Area-26	Mapping	03/Oct/2009	06h33	UTC-6	70°43.440	135°29.410	280
3b	Area-26	Mapping	03/Oct/2009	06h40	UTC-6	70°42.630	135°30.410	220
3b	C-09	CTD	03/Oct/2009	08h10	UTC-6	70°35.100	136°05.500	213
3b	C-09	ROV	03/Oct/2009	10h15	UTC-6	70°29.400	135°07.900	57
3b	C-09	Mooring	03/Oct/2009	13h31	UTC-6	70°29.800	135°08.100	60
3b	Area-26	Piston Core	03/Oct/2009	15h45	UTC-6	70°45.900	136°04.200	697
3b	Area-26	Piston Core	03/Oct/2009	18h15	UTC-6	70°48.730	136°06.050	782
3b	Area-26	Mapping	03/Oct/2009	21h02	UTC-6	70°52.900	135°14.600	403
3b	Area-26	Mapping	03/Oct/2009	21h44	UTC-6	70°47.800	135°39.200	513
3b	Area-26	Mapping	03/Oct/2009	21h49	UTC-6	70°47.400	135°37.800	483
3b	Area-26	Mapping	03/Oct/2009	22h33	UTC-6	70°52.300	135°14.200	381
3b	Area-26	Mapping	03/Oct/2009	22h38	UTC-6	70°52.000	135°12.900	341
3b	Area-26	Mapping	03/Oct/2009	23h19	UTC-6	70°47.100	135°36.200	465
3b	Area-26	Mapping	03/Oct/2009	23h24	UTC-6	70°46.500	135°35.800	477
3b	Area-26	Mapping	04/Oct/2009	00h39	UTC-6	70°51.500	135°11.800	315
3b	Area-26	Mapping	04/Oct/2009	00h46	UTC-6	70°51.000	135°11.500	291
3b	Area-26	Mapping	04/Oct/2009	01h17	UTC-6	70°47.300	135°29.500	398
3b	Area-26	Mapping	04/Oct/2009	01h21	UTC-6	70°47.300	135°30.900	418
3b	Area-26	Mapping	04/Oct/2009	01h36	UTC-6	70°48.600	135°39.600	536
3b	Area-26	Mapping	04/Oct/2009	01h36	UTC-6	70°48.600	135°39.600	536
3b	Area-26	Mapping	04/Oct/2009	02h23	UTC-6	70°55.900	135°35.600	644
3b	Area-26	Mapping	04/Oct/2009	02h30	UTC-6	70°56.300	135°35.500	652
3b	Area-26	Mapping	04/Oct/2009	03h03	UTC-6	70°52.400	135°53.900	733
3b	Area-26	Mapping	04/Oct/2009	03h12	UTC-6	70°52.600	135°52.500	748
3b	Area-26	Mapping	04/Oct/2009	03h47	UTC-6	70°56.900	135°35.400	666
3b	Area-26	Mapping	04/Oct/2009	03h50	UTC-6	70°57.400	135°36.500	660
3b	Area-26	Mapping	04/Oct/2009	04h25	UTC-6	70°53.150	135°56.090	759
3b	Area-26	Mapping	04/Oct/2009	04h33	UTC-6	70°53.510	135°57.270	776
3b	Area-26	Mapping	04/Oct/2009	04h56	UTC-6	70°56.310	135°45.290	707
3b	Area-26	Mapping	04/Oct/2009	05h02	UTC-6	70°56.080	135°48.470	729
3b	Area-26	Mapping	04/Oct/2009	06h20	UTC-6	70°56.040	135°46.140	718
3b	Area-26	Mapping	04/Oct/2009	06h25	UTC-6	70°56.200	135°44.710	732
3b	Area-26	Mapping	04/Oct/2009	06h50	UTC-6	70°59.240	135°32.890	677
3b	Area-26	Mapping	04/Oct/2009	06h57	UTC-6	71°00.020	135°35.680	733
3b	Area-26	Mapping	04/Oct/2009	07h40	UTC-6	70°54.400	136°02.150	816
3b	Area-26	Piston Core	04/Oct/2009	08h30	UTC-6	70°52.300	136°12.200	890
3b	Area-26	Piston Core	04/Oct/2009	10h55	UTC-6	70°48.100	136°03.900	779
3b	Area-26	Piston Core	04/Oct/2009	13h15	UTC-6	70°44.000	136°01.500	575
3b	Area-26	Piston Core	04/Oct/2009	14h30	UTC-6	70°47.900	136°18.700	692
3b	Area-27	CTD	04/Oct/2009	15h33	UTC-6	70°47.900	136°18.700	687
3b	Area-27	Mapping	04/Oct/2009	16h40	UTC-6	70°50.970	136°27.570	938
3b	Area-27	Mapping	04/Oct/2009	17h26	UTC-6	70°56.300	136°02.300	870
3b	Area-27	Mapping	04/Oct/2009	17h37	UTC-6	70°58.170	136°05.370	919
3b	Area-27	Mapping	04/Oct/2009	19h06	UTC-6	70°46.890	136°58.970	1400
3b	Area-27	Mapping	04/Oct/2009	19h10	UTC-6	70°48.220	136°55.540	1344
3b	Area-27	Mapping	04/Oct/2009	20h43	UTC-6	70°58.400	136°07.300	931
3b	Area-27	Mapping	04/Oct/2009	20h47	UTC-6	70°58.900	136°07.900	977
3b	Area-27	Mapping	04/Oct/2009	21h32	UTC-6	70°53.500	136°33.800	1005
3b	Area-27	Mapping	04/Oct/2009	21h36	UTC-6	70°54.000	136°34.300	1033
3b	Area-27	Mapping	04/Oct/2009	22h21	UTC-6	70°59.300	136°09.200	1032
3b	Area-27	Mapping	04/Oct/2009	22h26	UTC-6	70°59.700	136°10.200	1062
3b	Area-27	Mapping	04/Oct/2009	22h32	UTC-6	70°54.400	136°35.400	1039
3b	Area-27	Mapping	04/Oct/2009	23h36	UTC-6	70°54.700	136°37.000	1054
3b	Area-27	Mapping	05/Oct/2009	00h21	UTC-6	71°00.300	136°10.500	1064

Appendix 1 - List of stations sampled during the 2009 ArcticNet Expedition

Leg	Station ID	Station Type	Local Date	Local Time	UTC to local	Latitude (N)	Longitude (W)	Depth (m)
3b	Area-27	Mapping	05/Oct/2009	00h28	UTC-6	71°00.600	136°12.100	1089
3b	Area-27	Mapping	05/Oct/2009	01h27	UTC-6	70°55.100	136°38.100	1051
3b	Area-27	Mapping	05/Oct/2009	01h32	UTC-6	70°55.500	136°39.300	1098
3b	Area-27	Mapping	05/Oct/2009	02h18	UTC-6	71°01.200	136°11.900	1090
3b	Area-27	Mapping	05/Oct/2009	02h18	UTC-6	71°01.200	136°11.900	1094
3b	Area-27	Mapping	05/Oct/2009	03h13	UTC-6	70°57.300	135°37.600	722
3b	Area-27	Mapping	05/Oct/2009	03h15	UTC-6	70°57.300	135°36.400	676
3b	Area-27	Mapping	05/Oct/2009	03h24	UTC-6	70°58.900	135°30.700	700
3b	Area-27	Mapping	05/Oct/2009	03h33	UTC-6	70°59.100	135°34.100	700
3b	Area-27	Mapping	05/Oct/2009	03h43	UTC-6	70°58.900	135°38.500	700
3b	Area-27	Mapping	05/Oct/2009	03h46	UTC-6	70°59.300	135°39.500	714
3b	Area-27	Mapping	05/Oct/2009	03h58	UTC-6	70°59.900	135°34.900	725
3b	Area-27	Mapping	05/Oct/2009	04h05	UTC-6	71°01.060	135°34.460	772
3b	Area-27	Mapping	05/Oct/2009	04h42	UTC-6	70°55.240	135°01.500	842
3b	Area-27	Mapping	05/Oct/2009	04h46	UTC-6	70°55.850	136°01.470	861
3b	Area-27	Mapping	05/Oct/2009	05h20	UTC-6	70°59.340	135°48.160	781
3b	Area-27	Mapping	05/Oct/2009	05h50	UTC-6	70°56.520	135°04.280	890
3b	Area-27	Mapping	05/Oct/2009	06h10	UTC-6	70°59.700	135°52.600	822
3b	Area-27	Weather	05/Oct/2009	06h15	UTC-6	71°00.040	135°50.950	811
3b	Area-27	Mapping	05/Oct/2009	06h20	UTC-6	70°59.580	135°51.370	828
3b	Area-27	Mapping	05/Oct/2009	07h18	UTC-6	70°52.580	135°26.090	940
3b	Area-27	Mapping	05/Oct/2009	07h24	UTC-6	70°53.290	135°25.660	945
3b	Area-27	Mapping	05/Oct/2009	07h50	UTC-6	70°55.600	136°13.500	945
3b	Area-27	Piston Core	05/Oct/2009	08h28	UTC-6	70°55.600	136°13.500	952
3b	Area-27	Piston Core	05/Oct/2009	10h05	UTC-6	70°46.100	136°18.800	648
3b	Area-27	Piston Core	05/Oct/2009	11h19	UTC-6	70°41.400	136°27.100	794
3b	Area-27	Piston Core	05/Oct/2009	13h15	UTC-6	70°43.900	136°39.800	1262
3b	Area-27	Piston Core	05/Oct/2009	15h07	UTC-6	70°47.800	136°38.900	1073
3b	Area-27	Piston Core	05/Oct/2009	18h32	UTC-6	70°42.920	136°32.460	1118
3b	Area-27	MVP	05/Oct/2009	21h25	UTC-6	70°34.000	135°59.200	82
3b	Area-27	MVP	05/Oct/2009	22h24	UTC-6	70°30.000	136°18.400	71
3b	Area-27	Mapping	05/Oct/2009	23h09	UTC-6	70°25.300	136°41.800	78
3b	Area-27	Mapping	06/Oct/2009	00h20	UTC-6	70°34.000	136°01.300	94
3b	Area-27	Mapping	06/Oct/2009	00h25	UTC-6	70°33.500	136°00.800	83
3b	Area-27	Mapping	06/Oct/2009	01h35	UTC-6	70°24.800	136°41.500	65
3b	Area-27	Mapping	06/Oct/2009	01h42	UTC-6	70°25.600	136°42.400	92
3b	Area-27	Mapping	06/Oct/2009	02h55	UTC-6	70°34.400	136°01.200	108
3b	Area-27	Mapping	06/Oct/2009	02h59	UTC-6	70°34.500	136°02.000	110
3b	Area-27	Mapping	06/Oct/2009	03h18	UTC-6	70°32.100	136°13.000	122
3b	Area-27	Mapping	06/Oct/2009	03h21	UTC-6	70°32.300	136°14.400	154
3b	Area-27	Mapping	06/Oct/2009	03h42	UTC-6	70°34.700	136°02.600	123
Leg 4a								
4a	408	Full	09/Oct/2009	09h35	UTC-6	71°18.700	127°34.800	213
4a	CA05-08	Mooring	09/Oct/2009	10h20	UTC-6	71°18.800	127°35.200	212
4a	CA05-MMP-08	Mooring	09/Oct/2009	12h50	UTC-6	71°24.460	127°38.549	242
4a	N/A	Ice	10/Oct/2009	12h15	UTC-6	71°35.975	134°24.057	1400
4a	437	Full	11/Oct/2009	23h01	UTC-6	71°47.060	126°29.160	315
4a	CA16-08	Mooring	12/Oct/2009	10h50	UTC-6	71°47.500	126°29.330	307
4a	437	Full	12/Oct/2009	10h53	UTC-6	71°46.960	126°29.260	329
4a	CA16-08	Mooring	12/Oct/2009	11h30	UTC-6	71°47.650	126°29.120	302
4a	N/A	Mapping	12/Oct/2009	22h10	UTC-6	71°46.520	126°36.280	405
4a	N/A	Mapping	13/Oct/2009	03h55	UTC-6	71°18.470	127°34.716	204
4a	408	Full	13/Oct/2009	04h09	UTC-6	71°18.435	127°35.155	201
4a	CA05-09	Mooring	13/Oct/2009	19h10	UTC-6	71°19.720	127°35.602	206
4a	416	Nutrient	13/Oct/2009	23h50	UTC-6	71°18.120	127°44.220	167
4a	415	CTD	14/Oct/2009	01h03	UTC-6	71°21.690	127°33.299	242
4a	414	Nutrient	14/Oct/2009	01h50	UTC-6	71°25.326	127°21.664	306

Appendix 1 - List of stations sampled during the 2009 ArcticNet Expedition

Leg	Station ID	Station Type	Local Date	Local Time	UTC to local	Latitude (N)	Longitude (W)	Depth (m)
4a	413	CTD	14/Oct/2009	03h13	UTC-6	71°29.687	127°08.074	375
4a	412	Nutrient	14/Oct/2009	04h11	UTC-6	71°33.847	126.55.549	418
4a	411	CTD	14/Oct/2009	05h50	UTC-6	71°37.786	126°42.516	438
4a	410	Nutrient	14/Oct/2009	06h57	UTC-6	71°41.920	126°29.327	408
4a	410	Box Core	14/Oct/2009	08h35	UTC-6	71°46.730	126°28.640	320
4a	CA16-MMP-08	Mooring	14/Oct/2009	13h50	UTC-6	71°45.134	126°30.331	354
4a	437	Full	14/Oct/2009	14h51	UTC-6	71°47.200	126°29.429	313
4a	CA16-MMP-09	Mooring	14/Oct/2009	20h00	UTC-6	71°45.210	126°30.500	354
4a	405	Full	15/Oct/2009	05h32	UTC-6	70°39.881	122°59.841	560
4a	CA05-MMP-09	Mooring	15/Oct/2009	20h35	UTC-6	71°24.790	127°38.890	237
4a	N/A	MVP (Start)	15/Oct/2009	21h45	UTC-6	71°24.341	127°09.110	237
4a	N/A	MVP (End)	16/Oct/2009	04h00	UTC-6	70°54.950	124°11.200	560
4a	CA18-08	Mooring	16/Oct/2009	05h15	UTC-6	70°46.213	123°39.635	578
4a	405	Full	16/Oct/2009	08h24	UTC-6	70°39.840	123°00.430	573
4a	446	CTD	17/Oct/2009	01h30	UTC-6	71°38.976	119°41.518	142
4a	450	Basic	17/Oct/2009	05h01	UTC-6	72°05.555	119°47.497	95
4a	308	Full	19/Oct/2009	17h05	UTC-6	74°06.153	108°49.614	545
4a	N/A	ROV	20/Oct/2010	08h22	UTC-6	74°05.878	108°52.866	532
4a	N/A	Ice	21/Oct/2012	20h03	UTC-6	74°19.720	102°47.747	200
4a	334	Nutrient	22/Oct/2012	11h05	UTC-6	74°17.845	102°45.044	223
4a	304	Full	23/Oct/2012	17h22	UTC-6	74°18.738	091°20.014	340
4a	330	Nutrient	24/Oct/2012	05h42	UTC-6	74°08.399	087°51.368	419
4a	325	Nutrient	24/Oct/2012	21h40	UTC-6	73°49.083	080°29.813	680
4a	324	Nutrient	25/Oct/2012	00h33	UTC-6	73°58.831	080°30.199	767
4a	323	Full	25/Oct/2012	04h01	UTC-6	74°09.413	080°31.553	774
4a	300	Nutrient	25/Oct/2012	20h05	UTC-6	74°19.544	080°30.732	674
4a	322	Nutrient	25/Oct/2012	23h25	UTC-6	74°29.595	080°36.709	660
4a	103	Full	26/Oct/2012	18h43	UTC-6	76°21.277	076°32.194	155
4a	105	Basic	27/Oct/2012	11h32	UTC-6	76°18.710	075°46.144	327
4a	106	CTD	27/Oct/2012	20h38	UTC-6	76°18.468	075°21.270	380
4a	107	Nutrient	27/Oct/2012	21h40	UTC-6	76°16.837	074°59.328	438
4a	108	CTD	27/Oct/2012	23h05	UTC-6	76°15.764	074°36.123	447
4a	109	Full	28/Oct/2012	01h08	UTC-6	76°17.226	074°06.454	450
4a	110	Nutrient	28/Oct/2012	13h10	UTC-6	76°17.712	073°37.510	526
4a	111	Basic	28/Oct/2012	14h43	UTC-6	76°18.065	073°12.598	580
4a	112	CTD	28/Oct/2012	21h42	UTC-6	76°18.896	072°42.335	560
4a	113	Nutrient	28/Oct/2012	22h58	UTC-6	76°19.315	072°13.717	550
4a	114	CTD	29/Oct/2012	00h40	UTC-6	76°19.428	072°46.751	613
4a	115	Full	29/Oct/2012	02h07	UTC-6	76°19.897	071°11.543	671
4a	136	Basic	30/Oct/2012	09h55	UTC-6	74°46.617	073°34.124	785
4a	141	Full	31/Oct/2012	20h00	UTC-6	71°27.910	070°02.581	615
4a	N/A	Weather	02/Nov/2012	12h50	UTC-5	68°37.350	063°37.120	1508
4a	N/A	Surface Skimmer	05/Nov/2012	13h45	UTC-5	63°07.853	067°47.810	541
Leg 4b								
4b	352	Nutrient	07/Nov/2012	09h10	UTC-5	61°15.935	064°45.228	274
4b	354	Nutrient	07/Nov/2012	11h36	UTC-5	61°00.517	064°44.272	496
4b	600	Basic	08/Nov/2012	02h05	UTC-5	59°05.342	063°25.895	204
4b	601	Nutrient	08/Nov/2012	09h03	UTC-5	59°02.976	063°36.388	165
4b	606 (off McCormick)	Piston Core	08/Nov/2012	14h48	UTC-5	59°02.575	063°42.284	158
4b	602	Basic	08/Nov/2012	16h50	UTC-5	59°03.205	063°52.164	151
4b	602 (off McCormick)	Piston Core	08/Nov/2012	20h38	UTC-5	59°03.159	063°52.206	151
4b	604	Nutrient	08/Nov/2012	22h45	UTC-5	58°59.587	063°53.697	62
4b	612	CTD	09/Nov/2012	06h36	UTC-5	58°28.162	062°59.090	44
4b	613	Nutrient	09/Nov/2012	08h15	UTC-5	58°28.999	063°13.172	240
4b	618	Piston Core	09/Nov/2012	15h20	UTC-5	58°28.813	063°13.417	241

Appendix 1 - List of stations sampled during the 2009 ArcticNet Expedition

Leg	Station ID	Station Type	Local Date	Local Time	UTC to local	Latitude (N)	Longitude (W)	Depth (m)
4b	614	CTD	09/Nov/2012	16h42	UTC-5	58°24.122	063°23.391	100
4b	615	Basic	09/Nov/2012	18h11	UTC-5	58°19.381	063°32.505	138
4b	N/A	MVP	09/Nov/2012	21h03	UTC-5	58°19.661	063°32.216	137
4b	N/A	MVP	09/Nov/2012	23h47	UTC-5	58°26.604	063°20.042	183
4b	610	Nutrient	10/Nov/2012	02h22	UTC-5	58°31.260	062°50.402	134
4b	617	Basic	10/Nov/2012	03h28	UTC-5	58°30.000	062°41.375	136
4b	633	Basic	10/Nov/2012	22h43	UTC-5	57°36.352	061°53.800	181
4b	632	Nutrient	11/Nov/2012	05h13	UTC-5	57°39.999	062°03.391	83
4b	631	Nutrient	11/Nov/2012	14h20	UTC-5	57°29.722	062°11.191	91
4b	630	Basic	11/Nov/2012	18h07	UTC-5	57°28.337	062°26.501	51
4b	634	CTD	12/Nov/2012	01h51	UTC-5	57°34.134	061°56.419	193
4b	620	Basic	12/Nov/2012	15h43	UTC-5	56°23.830	061°12.980	163
4b	621	CTD	12/Nov/2012	22h17	UTC-5	56°24.901	061°31.073	113
4b	622	Nutrient	12/Nov/2012	23h10	UTC-5	56°24.973	061°43.938	85
4b	623	CTD	13/Nov/2012	00h25	UTC-5	56°26.839	061°56.442	118
4b	624	Basic	13/Nov/2012	01h30	UTC-5	56°25.209	062°04.330	71
BaySys								
BaySys	AN03-07	Mooring	27/Jul/2009	14h36		55°24.558	077°55.308	121
BaySys	702	Full	27/Jul/2009	16h18		55°24.481	077°55.678	127
BaySys	P8	Coring	27/Jul/2009	18h31		55°15.769	077°53.621	80.6
BaySys	P9	Coring	28/Jul/2009	06h42		55°17.202	077°49.751	64.8
BaySys	P6	Coring	28/Jul/2009	07h30		55°19.349	077°47.720	66.5
BaySys	P3	Coring	28/Jul/2009	08h37		55°19.756	077°48.843	64.8
BaySys	P2	Coring	28/Jul/2009	09h07		55°18.893	077°51.353	64.8
BaySys	P4	Coring	28/Jul/2009	09h36		55°17.592	077°52.497	77
BaySys	P10	Coring	28/Jul/2009	09h59		55°16.057	077°51.814	61.6
BaySys	P5	Coring	28/Jul/2009	10h37		55°18.989	077°49.321	72.4
BaySys	P1	Coring	28/Jul/2009	11h14		55°17.457	077°55.599	82.1
BaySys	P7	Coring	28/Jul/2009	11h43		55°14.711	077°56.595	94.5
BaySys	GW02	Net	28/Jul/2009	15h22		55°16.685	077°49.438	40.7
BaySys	AN03-09	Mooring	28/Jul/2009	17h47		55°24.516	077°55.836	137
BaySys	703	CTD	29/Jul/2009	06h35		54°40.694	079°57.450	41
BaySys	709	CTD	29/Jul/2009	10h01		54°42.705	080°46.703	90.4
BaySys	704	CTD	29/Jul/2009	14h58		54°45.700	081°42.400	28.5
BaySys	709	CTD	29/Jul/2009	19h47		54°42.739	080°46.773	90.3
BaySys	HB01	Net	30/Jul/2009	13h03		57°05.039	081°55.233	120
BaySys	HB02	Water Sampling	30/Jul/2009	18h38		57°55.286	082°17.309	125
BaySys	HB03	Water Sampling	31/Jul/2009	08h16		58°54.627	085°35.756	74
BaySys	HB04	Water Sampling	31/Jul/2009	18h43		59°24.250	089°15.360	140
BaySys	AN01-07	Mooring	01/Aug/2009	07h00		59°58.460	091°56.829	102
BaySys	707	Full	01/Aug/2009	07h10		59°58.441	091°56.564	102
BaySys	706	Full	01/Aug/2009	15h54		58°47.016	091°31.451	77.3
BaySys	P15	Coring	02/Aug/2009	07h00		57°39.565	091°35.909	57.1
BaySys	705	Full	02/Aug/2009	07h25		57°39.360	091°35.834	64.9
BaySys	AN04-07A	Mooring	02/Aug/2009	07h37		57°34.294	091°35.817	63.4
BaySys	AN04-07B	Mooring	02/Aug/2009	08h35		57°39.298	091°35.672	64.4
BaySys	715	Basic	02/Aug/2009	11h03		57°26.418	091°54.519	29.6
BaySys	P17	Coring	02/Aug/2009	11h31		57°26.016	091°52.431	32.9
BaySys	713	CTD	03/Aug/2009	08h09		57°42.382	090°46.421	38.4
BaySys	713	CTD	03/Aug/2009	08h12		57°42.361	090°46.363	38.7
BaySys	713 (3mn)	CTD	03/Aug/2009	13h26		57°42.147	090°52.475	35
BaySys	AN04-09A	Mooring	03/Aug/2009	17h07		57°40.210	091°36.195	54.1
BaySys	705	Full	03/Aug/2009	17h20		57°40.074	091°36.178	53.5
BaySys	714	CTD	03/Aug/2009	18h56		57°34.638	091°20.465	33.2
BaySys	AN02-09	Mooring	04/Aug/2009	06h44		58°46.721	091°32.035	76
BaySys	706	Full	04/Aug/2009	07h18		58°46.722	091°32.349	75.7
BaySys	AN01-09	Mooring	04/Aug/2009	16h00		59°58.165	091°57.116	104

Appendix 1 - List of stations sampled during the 2009 ArcticNet Expedition

Leg	Station ID	Station Type	Local Date	Local Time	UTC to local	Latitude (N)	Longitude (W)	Depth (m)
BaySys	707	Full	04/Aug/2009	16h33		59°58.032	091°57.072	106

Appendix 2 - Scientific log of activities conducted during the 2009 ArcticNet Expedition

Leg	Station ID	Station Type	Local Date	Local Time	UTC to local	Latitude (N)	Longitude (W)	Activity	Depth (m)	Heading (°)	Wind		Air (ºC)	Water (ºC)	Pr Baro	Hum (%)	Ice
											Dir	Speed					
Leg 1a																	
1a	N/A	ROV	05/Jun/2009	10h22	UTC-4	48°44.300	068°09.970	ROV (test) ↓	151	270	230	22	9.5	5.8	1013.0	N/A	0/10
1a	N/A	ROV	05/Jun/2009	11h50	UTC-4	48°44.100	068°09.900	ROV (test) ↑	151	270	230	10/15	9.3	5.8	1012.7	N/A	0/10
1a	N/A	Piston Core	05/Jun/2009	14h02	UTC-4	48°44.490	068°10.180	Piston Core (test)↓	160	325	230	10	10.9	6.2	1011.7	N/A	0/10
1a	N/A	Piston Core	05/Jun/2009	14h30	UTC-4	48°44.560	068°09.940	Piston Core (test) ↑	343	N/A	250	10	11.0	6.2	1011.5	N/A	0/10
Leg 1b																	
1b	N/A	N/A	11/Jul/2009	08h40	UTC-7	67°45.110	168°13.900	PMW	50	10	160	12	3.8	3.3	1019.3	N/A	0/10
1b	N/A	N/A	12/Jul/2009	13h10	UTC-7	71°42.800	157°13.400	Water Sampling ↓	67	100	100	10/15	3.4	1.8	1017.9	94	2/10
1b	N/A	N/A	12/Jul/2009	13h27	UTC-7	71°42.980	157°14.000	Water Sampling ↑	61	350	110	10/15	3.5	3.5	1018.1	94	2/10
1b	N/A	N/A	13/Jul/2009	13h06	UTC-7	70°39.360	143°34.620	Water Sampling ↓	350	175	105	17	8.7	8.4	1018.6	90	1/10
1b	N/A	N/A	13/Jul/2009	13h15	UTC-7	70°39.360	143°34.620	Water Sampling ↑	342	150	110	14	8.9	8.5	1018.9	90	1/10
1b	N/A	N/A	14/Jul/2009	13h20	UTC-7	70°38.020	135°37.440	Water Sampling ↓	87	270	30	20	0.8	2.3	1018.1	98	2/10
1b	N/A	N/A	14/Jul/2009	13h30	UTC-7	70°38.040	135°37.950	Water Sampling ↑	90	285	25	16	1.3	2.3	1018.0	98	2/10
1b	N/A	Weather	14/Jul/2009	21h05	UTC-7	70°37.600	136°02.900	Weather Balloon	260	123	35	20	1.3	1.3	1029.3	92	8/10
Leg 2a																	
2a	1	Biophysical	18/Jul/2009	02h24	UTC-6	70°29.160	135°05.790	Horizontal Net Tow	61	136	85	6	-0.1	1.74	1014.62	98	1/10
2a	1	Biophysical	18/Jul/2009	02h43	UTC-6	70°29.107	135°03.405	Horizontal Net Tow	61	47	85	6	-0.1	2	1014.56	99	1/10
2a	1	Biophysical	18/Jul/2009	03h15	UTC-6	70°29.214	135°03.338	Vertical Net Tow	61	139	85	6	0.1	2.1	1012.2	98	1/10
2a	1	Biophysical	18/Jul/2009	03h25	UTC-6	70°29.223	135°03.570	Vertical Net Tow	61	211	85	6	-0.1	2.12	1012.16	99	1/10
2a	1	Biophysical	18/Jul/2009	03h50	UTC-6	70°29.216	135°04.187	Water Pumping ↓	60	166	85	8	-0.7	2.16	1012.09	99	1/10
2a	1	Biophysical	18/Jul/2009	05h30	UTC-6	70°28.923	135°06.251	Water Pumping ↑	62	159	103	7	-0.7	2.41	1014.14	97	1/10
2a	1	Biophysical	18/Jul/2009	05h46	UTC-6	70°20.000	135°06.000	CTD-Rosette Test ↓	62	329	82	3	-0.7	2.44	1014.14	97	1/10
2a	1	Biophysical	18/Jul/2009	06h24	UTC-6	70°28.862	135°07.485	CTD-Rosette Test ↑	62	334	110	1.3	-0.1	2.45	1014.16	97	1/10
2a	1	Biophysical	18/Jul/2009	07h40	UTC-6	70°28.903	135°09.631	Box Core ↓	60	245	112	8.4	-0.1	2.37	1013.55	95	1/10
2a	1	Biophysical	18/Jul/2009	07h42	UTC-6	70°28.903	135°09.631	Box Core ↑	60	232	112	8.4	0.1	2.37	1013.55	95	1/10
2a	1	Biophysical	18/Jul/2009	08h17	UTC-6	70°28.992	135°10.083	Box Core ↓	60	220	60	10	-0.6	2.35	1013.63	96	1/10
2a	1	Biophysical	18/Jul/2009	08h20	UTC-6	70°29.004	135°10.141	Box Core ↑	60	228	80	9	-1.1	2.35	1013.57	96	1/10
2a	1	Biophysical	18/Jul/2009	09h02	UTC-6	70°29.024	135°11.169	Box Core ↓	61	250	80	8	-0.2	2.33	1013.5	95	1/10
2a	1	Biophysical	18/Jul/2009	09h06	UTC-6	70°29.030	135°11.214	Box Core ↑	61	242	70	6	-0.2	2.33	1013.5	95	1/10
2a	C-09	Mooring	18/Jul/2009	12h42	UTC-6	70°29.787	135°07.819	Mooring C-09 Deployed	61	247	55	8	0	2.6	1011.17	98	1/10
2a	1	Biophysical	18/Jul/2009	13h33	UTC-6	70°29.494	135°08.397	Agassiz Trawl ↓	60	242	55	8	-0.2	2.6	1011.24	97	1/10
2a	1	Biophysical	18/Jul/2009	13h53	UTC-6	70°29.215	135°07.053	Agassiz Trawl ↑	61	66	55	8	-0.3	2.59	1011.34	97	1/10
2a	2	Biophysical	18/Jul/2009	18h16	UTC-6	70°39.350	135°38.237	Zodiac Deployed	144	280	155	10	1.5	1.12	1011.59	96	2/10
2a	2	Biophysical	18/Jul/2009	18h24	UTC-6	70°39.338	135.38.242	CTD-Rosette ↓	144	288	155	10	1.5	1.13	1011.44	96	2/10
2a	2	Biophysical	18/Jul/2009	18h44	UTC-6	70°39.386	135°38.590	Water Pumping ↓	146	315	90	7.6	1.8	1.17	1013.93	95	2/10
2a	2	Biophysical	18/Jul/2009	18h53	UTC-6	70°39.376	135°38.595	CTD-Rosette ↑	144	276	120	10	1.7	1.19	1013.93	96	2/10
2a	2	Biophysical	18/Jul/2009	19h30	UTC-6	70°39.431	135°38.996	Zodiac Recovered	144	302	120	10	1.6	1.22	1013.78	96	2/10
2a	2	Biophysical	18/Jul/2009	19h45	UTC-6	70°39.469	135°39.205	Water Pumping ↑	165	300	110	10	1.5	1.22	1011.43	95	2/10
2a	2	Biophysical	18/Jul/2009	20h04	UTC-6	70°39.307	135°37.905	Horizontal Net Tow ↓	140	229	60	10	0.6	1.21	1013.66	98	2/10
2a	2	Biophysical	18/Jul/2009	20h16	UTC-6	70°39.300	135°37.570	Horizontal Net Tow ↑	142	305	55	10	0.4	1.21	1013.63	98	2/10
2a	2	Biophysical	18/Jul/2009	20h50	UTC-6	70°39.404	135°38.161	Vertical Net Tow ↓	141	105	53	10	0.2	1.31	1013.66	99	2/10
2a	2	Biophysical	18/Jul/2009	21h04	UTC-6	70°39.398	135°38.204	Vertical Net Tow ↑	148	159	58	9	-0.1	1.32	1013.67	99	2/10
2a	2	Biophysical	18/Jul/2009	21h48	UTC-6	70°39.749	135°37.193	Box Core ↓	160	43	40	7	-0.2	1.32	1013.58	99	2/10
2a	2	Biophysical	18/Jul/2009	21h51	UTC-6	70°39.758	135°37.183	Box Core (bottom)	161	39	43	7	-0.2	1.32	1013.68	99	2/10
2a	2	Biophysical	18/Jul/2009	21h54	UTC-6	70°39.771	135°37.171	Box Core ↑	161	40	40	6	-0.2	1.32	1013.68	99	2/10

Appendix 2 - Scientific log of activities conducted during the 2009 ArcticNet Expedition

Leg	Station ID	Station Type	Local Date	Local Time	UTC to local	Latitude (N)	Longitude (W)	Activity	Depth (m)	Heading (°)	Wind		Air (ºC)	Water (ºC)	Pr Baro	Hum (%)	Ice
											Dir	Speed					
2a	2	Biophysical	18/Jul/2009	22h15	UTC-6	70°40.057	135°37.259	Agassiz Trawl ↓	189	356	40	8	-0.2	1.32	1013.68	99	2/10
2a	2	Biophysical	18/Jul/2009	22h52	UTC-6	70°39.703	135°37.877	Agassiz Trawl ↑	160	137	43	9	-0.8	1.33	1011.58	99	2/10
2a	11	Biophysical	19/Jul/2009	00h20	UTC-6	70°44.148	135°33.682	CTD-Rosette ↓	368	280	32	10	-0.6	1.4	1011.84	99	1/10
2a	11	Biophysical	19/Jul/2009	00h33	UTC-6	70°44.197	135°33.635	CTD-Rosette ↑ (canceled)	368	287	32	10	-0.4	1.42	1011.79	99	1/10
2a	11	Biophysical	19/Jul/2009	00h49	UTC-6	70°43.967	135°33.518	Horizontal Net Tow ↓	370	258	60	4	-0.9	1.43	1011.74	99	1/10
2a	11	Biophysical	19/Jul/2009	01h12	UTC-6	70°43.676	135°31.655	Horizontal Net Tow ↑	335	106	60	10	-1	1.45	1011.71	99	1/10
2a	11	Biophysical	19/Jul/2009	01h36	UTC-6	70°44.282	135°33.781	Vertical Net Tow ↓	378	85	34	7	-0.8	1.6	1011.8	99	1/10
2a	11	Biophysical	19/Jul/2009	02h03	UTC-6	70°44.320	135°33.429	Vertical Net Tow ↑	372	121	31	4	-1.1	1.51	1011.87	99	1/10
2a	11	Biophysical	19/Jul/2009	02h20	UTC-6	70°44.265	135°33.324	CTD-Rosette ↓	372	244	52	3	-0.8	1.45	1011.87	99	1/10
2a	11	Biophysical	19/Jul/2009	03h10	UTC-6	70°44.494	135°33.338	CTD-Rosette ↑	375	311	25	4	-0.7	1.33	1011.85	99	1/10
2a	11	Biophysical	19/Jul/2009	03h36	UTC-6	70°44.123	135°33.843	Box Core	375	160	23	4	-1.1	1.31	1011.79	99	1/10
2a	11	Biophysical	19/Jul/2009	03h52	UTC-6	70°44.219	135°33.837	Box Core	371	181	23	4	-1	1.32	1011.82	99	1/10
2a	11	Biophysical	19/Jul/2009	04h06	UTC-6	70°44.260	135°33.808	Agassiz Trawl ↓	365	86	270	4.4	0.1	1.31	1014.27	99	1/10
2a	11	Biophysical	19/Jul/2009	04h40	UTC-6	70°44.380	135°31.750	Agassiz Trawl ↑	365	N/A	N/A	6.5	-1.3	1.31	1014.54	99	1/10
2a	11	Biophysical	19/Jul/2009	04h47	UTC-6	70°44.534	135°31.918	Agassiz Trawl ↓	351	245	170	2.3	-1.3	1.31	1014.54	99	1/10
2a	11	Biophysical	19/Jul/2009	05h25	UTC-6	70°44.066	135°30.506	Agassiz Trawl ↑	315	106	114	6.9	-1.2	1.31	1014.55	99	1/10
2a	3	Biophysical	19/Jul/2009	06h56	UTC-6	70°42.344	135°47.166	CTD-Rosette ↓	405	270	120	6	0.5	1.04	1014.82	99	1/10
2a	3	Biophysical	19/Jul/2009	07h10	UTC-6	70°42.341	135°48.850	Water Pumping ↓	406	306	80	5	0.1	0.99	1014.86	99	1/10
2a	3	Biophysical	19/Jul/2009	08h12	UTC-6	70°42.348	135°48.467	CTD-Rosette ↑	410	286	18	5	0.2	0.86	1014.79	99	4/10
2a	3	Biophysical	19/Jul/2009	08h14	UTC-6	70°42.346	135°48.470	Water Pumping ↑	409	281	18	6	0.2	0.87	1014.8	99	4/10
2a	3	Biophysical	19/Jul/2009	08h55	UTC-6	70°42.270	135°48.112	Horizontal Net Tow ↓	397	141	20	4	0.2	0.82	1014.83	99	4/10
2a	3	Biophysical	19/Jul/2009	09h03	UTC-6	70°42.003	135°47.102	Horizontal Net Tow ↑	376	114	0	7	-0.2	0.81	1014.82	99	4/10
2a	3	Biophysical	19/Jul/2009	09h35	UTC-6	70°42.238	135°47.632	Vertical Net Tow ↓	392	49	352	6	-0.1	0.88	1014.95	99	4/10
2a	3	Biophysical	19/Jul/2009	10h01	UTC-6	70°42.221	135°47.224	Vertical Net Tow ↑	386	40	345	5	-0.3	0.86	1015.12	99	4/10
2a	3	Biophysical	19/Jul/2009	10h35	UTC-6	70°42.368	135°47.257	Box Core ↓	397	13	351	4	-0.4	0.85	1015.08	99	4/10
2a	3	Biophysical	19/Jul/2009	10h42	UTC-6	70°42.382	135°47.164	Box Core (bottom)	400	25	351	3	-0.3	0.85	1015.14	98	4/10
2a	3	Biophysical	19/Jul/2009	10h51	UTC-6	70°42.390	135°47.048	Box Core ↑	400	40	338	3	-0.4	0.84	1015.22	99	4/10
2a	3	Biophysical	19/Jul/2009	11h13	UTC-6	70°42.436	135°47.112	Agassiz Trawl ↓	400	168	307	2	0	0.82	1015.3	98	4/10
2a	3	Biophysical	19/Jul/2009	11h45	UTC-6	70°41.765	135°45.445	Agassiz Trawl ↑	356	133	336	3	0	0.83	1015.53	98	5/10
2a	N/A	Weather	19/Jul/2009	12h25	UTC-6	70°39.587	135°37.720	Weather Balloon	129	140	308	2	0.1	0.88	1013.32	98	9/10
2a	B-09	Mooring	19/Jul/2009	15h15	UTC-6	70°40.031	135°35.919	Mooring B-09 Deployed	162	0	321	3	-0.6	0.97	1014.33	97	3/10
2a	B-09	Mooring	19/Jul/2009	15h37	UTC-6	70°39.964	135°35.908	Mooring B-09 Deployed (end)	152	53	306	4	-0.6	1.01	1014.35	97	3/10
2a	14	Biophysical	19/Jul/2009	18h25	UTC-6	70°34.825	135°57.278	CTD-Rosette ↓	94	222	130	1.5	0.9	1.28	1014.57	98	1/10
2a	14	Biophysical	19/Jul/2009	18h50	UTC-6	70°34.723	135°57.581	CTD-Rosette ↑	92	279	100	2.1	0.4	1.28	1014.71	98	1/10
2a	14	Biophysical	19/Jul/2009	19h17	UTC-6	70°34.794	135°58.595	Horizontal Net Tow ↓	94	198	160	1.9	0.5	1.26	1017.19	98	1/10
2a	14	Biophysical	19/Jul/2009	19h24	UTC-6	70°34.813	135°58.067	Horizontal Net Tow ↑	95	351	335	1.9	0.5	1.23	1017.28	98	1/10
2a	14	Biophysical	19/Jul/2009	19h45	UTC-6	70°34.883	135°58.340	Vertical Net Tow ↓	95	177	190	8	0.8	1.24	1017.32	97	1/10
2a	14	Biophysical	19/Jul/2009	19h55	UTC-6	70°34.866	135°58.442	Vertical Net Tow ↑	94	144	23	7	-1	1.23	1017.34	98	3/10
2a	14	Biophysical	19/Jul/2009	20h26	UTC-6	70°34.750	135°58.642	Box Core ↓	93	63	22	6	-0.8	1.1	1017.23	98	3/10
2a	14	Biophysical	19/Jul/2009	20h28	UTC-6	70°34.752	135°58.634	Box Core (bottom)	93	51	22	6	-0.8	1.1	1017.23	98	3/10
2a	14	Biophysical	19/Jul/2009	20h30	UTC-6	70°34.756	135°58.628	Box Core ↑	93	58	38	6	-1	1.08	1017.23	98	3/10
2a	14	Biophysical	19/Jul/2009	20h46	UTC-6	70°34.314	135°59.509	Agassiz Trawl ↓	92	143	39	6	-1	1.1	1017.23	98	4/10
2a	14	Biophysical	19/Jul/2009	21h02	UTC-6	70°34.302	135°58.535	Agassiz Trawl ↑	93	4	52	7	-1	1.12	1017.17	99	4/10
2a	14	Biophysical	19/Jul/2009	23h09	UTC-6	70°38.820	135°56.540	Bottom Mapping	272	328	67	6	-0.1	0.27	1017.62	99	9/10
2a	14	Biophysical	19/Jul/2009	23h40	UTC-6	70°39.130	135°57.210	Bottom Mapping	293	100	65	7	-0.2	0.14	1019.63	99	9/10

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Leg	Station ID	Station Type	Local Date	Local Time	UTC to local	Latitude (N)	Longitude (W)	Activity	Depth (m)	Heading (°)	Wind		Air (ºC)	Water (ºC)	Pr Baro	Hum (%)	Ice
											Dir	Speed					
2a	N/A	N/A	20/Jul/2009	N/A	UTC-6	N/A	N/A	Helicopter Deployed (ice profile)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2a	15	Biophysical	20/Jul/2009	00h17	UTC-6	70°39.260	135°55.874	CTD-Rosette ↓	293	5	78	5	-1	0.1	1015.15	99	3/10
2a	15	Biophysical	20/Jul/2009	01h00	UTC-6	70°39.372	135°55.764	CTD-Rosette ↑	299	309	54	0	-0.5	0.23	1015.34	99	3/10
2a	15	Biophysical	20/Jul/2009	01h14	UTC-6	70°39.474	135°55.729	Horizontal Net Tow ↓	305	14	55	6	-0.7	0.23	1015.33	99	3/10
2a	15	Biophysical	20/Jul/2009	01h25	UTC-6	70°39.795	135°55.433	Horizontal Net Tow ↑	325	334	63	5	-0.3	0.23	1015.32	99	4/10
2a	15	Biophysical	20/Jul/2009	01h43	UTC-6	70°39.869	135°54.873	Vertical Net Tow ↓	321	77	61	4	-1.4	0.35	1015.41	99	4/10
2a	15	Biophysical	20/Jul/2009	02h05	UTC-6	70°39.927	135°54.871	Vertical Net Tow ↑	327	156	61	5	-1.5	0.45	1015.44	99	4/10
2a	15	Biophysical	20/Jul/2009	02h29	UTC-6	70°40.200	135°55.200	Agassiz Trawl ↓	326	145	82	5	-1.4	0.49	1015.38	99	4/10
2a	15	Biophysical	20/Jul/2009	03h03	UTC-6	70°40.505	135°53.456	Agassiz Trawl ↓	341	0	73	6	-1.2	0.67	1015.44	99	4/10
2a	15	Biophysical	20/Jul/2009	03h32	UTC-6	70°41.186	135°53.636	Agassiz Trawl ↑	381	303	85	7	-1.4	0.77	1015.54	99	4/10
2a	15	Biophysical	20/Jul/2009	03h57	UTC-6	70°40.438	135°53.646	Agassiz Trawl (canceled)	338	315	84	5	-1.3	0.61	1015.44	99	4/10
2a	15	Biophysical	20/Jul/2009	04h11	UTC-6	70°39.020	135°56.841	Box Core ↓	284	317	191	6	-1.8	0.71	1017.96	99	4/10
2a	15	Biophysical	20/Jul/2009	04h21	UTC-6	70°39.045	135°56.798	Box Core ↑	283	323	82	6	-1.3	0.78	1017.02	99	4/10
2a	N/A	Weather	20/Jul/2009	04h45	UTC-6	70°36.600	135°57.300	Weather Balloon	180	160	135	5	-1.9	0.79	1018.05	99	4/10
2a	17	Biophysical	20/Jul/2009	06h42	UTC-6	70°36.580	136°28.476	CTD-Rosette ↓	730	246	60	8	-1.9	0.71	1017.88	98	1/10
2a	17	Biophysical	20/Jul/2009	06h57	UTC-6	70°36.571	136°28.677	Water Pumping ↓	730	231	67	7	-2.1	0.72	1015.42	98	1/10
2a	17	Biophysical	20/Jul/2009	08h02	UTC-6	70°36.345	136°29.615	Water Pumping ↑	729	294	58	8	0	0.68	1017.75	97	4/10
2a	17	Biophysical	20/Jul/2009	08h04	UTC-6	70°36.336	136°29.657	CTD-Rosette ↑	729	296	59	7	0	0.68	1017.75	97	4/10
2a	17	Biophysical	20/Jul/2009	08h17	UTC-6	70°37.171	136°32.390	Horizontal Net Tow ↓	792	181	65	7	-1.1	0.68	1017.92	96	4/10
2a	17	Biophysical	20/Jul/2009	09h02	UTC-6	70°36.795	136°32.228	Horizontal Net Tow ↑	774	157	62	7	-0.9	72	1017.88	96	4/10
2a	17	Biophysical	20/Jul/2009	09h19	UTC-6	70°36.728	136°32.426	Vertical Net Tow ↓	777	135	60	7	-0.9	0.76	1017.89	96	4/10
2a	17	Biophysical	20/Jul/2009	10h14	UTC-6	70°36.678	136°33.268	Vertical Net Tow ↑	786	103	74	6	-0.6	0.84	1018.15	96	4/10
2a	17	Biophysical	20/Jul/2009	10h41	UTC-6	70°36.671	136°33.453	Box Core ↓	788	134	67	6	-0.4	0.85	1018.13	96	4/10
2a	17	Biophysical	20/Jul/2009	10h58	UTC-6	70°36.629	136°33.483	Box Core (bottom)	788	102	43	6	-0.5	0.86	1018.19	96	4/10
2a	17	Biophysical	20/Jul/2009	11h12	UTC-6	70°36.670	136°33.630	Box Core ↑	789	1	61	7	-0.5	0.88	1018.26	96	4/10
2a	17	Biophysical	20/Jul/2009	12h16	UTC-6	70°38.132	136°34.823	Agassiz Trawl ↓	875	283	36	7	-0.6	0.92	1015.94	96	2/10
2a	17	Biophysical	20/Jul/2009	13h20	UTC-6	70°37.128	136°33.729	Agassiz Trawl ↑	813	28	35	7	0.1	1.07	1015.7	97	3/10
2a	N/A	N/A	20/Jul/2009	14h45	UTC-6	70°38.029	136°16.737	Helicopter Deployed (Ice Profiler)	579	94	42	8	0.3	0.97	1016.01	98	6/10
2a	A1-09	Mooring	20/Jul/2009	18h20	UTC-6	N/A	N/A	Zodiac Deployed	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2a	A1-09	Mooring	20/Jul/2009	19h34	UTC-6	70°45.791	136°00.106	Mooring A1-09 Deployed	688	132	51	8	0.8	N/A	N/A	N/A	6/10
2a	4	Biophysical	20/Jul/2009	20h30	UTC-6	70°45.780	136°01.185	CTD-Rosette ↓	688	300	61	8	0.8	0.46	1018.34	98	6/10
2a	4	Biophysical	20/Jul/2009	20h42	UTC-6	70°45.756	136°01.364	Water Pumping ↓	695	313	52	8	1.4	0.52	1018.39	97	6/10
2a	4	Biophysical	20/Jul/2009	21h00	UTC-6	70°45.724	136°01.556	Weather Balloon	691	321	55	6	1.5	0.46	1018.42	97	6/10
2a	4	Biophysical	20/Jul/2009	21h39	UTC-6	70°45.679	136°01.919	CTD-Rosette ↑	696	327	55	8	1.8	0.42	1018.34	96	6/10
2a	4	Biophysical	20/Jul/2009	21h44	UTC-6	70°45.676	136°01.972	Water Pumping ↑	690	323	47	8	1.8	0.42	1018.34	96	6/10
2a	4	Biophysical	20/Jul/2009	22h49	UTC-6	70°45.358	136°03.430	Horizontal Net Tow ↓	672	115	60	5	0.4	0.5	1018.09	98	6/10
2a	4	Biophysical	20/Jul/2009	23h06	UTC-6	70°45.395	136°02.116	Horizontal Net Tow ↑	674	346	42	10	0	0.52	1017.98	99	6/10
2a	4	Biophysical	20/Jul/2009	23h30	UTC-6	70°45.486	136°02.585	Vertical Net Tow ↓	674	47	35	11	0	0.43	1017.9	99	6/10
2a	4	Biophysical	21/Jul/2009	00h10	UTC-6	70°45.241	136°02.528	Vertical Net Tow ↑	657	146	54	12	-1.1	0.48	1015.47	99	6/10
2a	4	Biophysical	21/Jul/2009	00h39	UTC-6	70°45.323	136°01.889	Box Core ↓	667	83	57	4	-0.8	0.47	1015.34	99	6/10
2a	4	Biophysical	21/Jul/2009	00h58	UTC-6	70°45.270	136°02.033	Box Core ↑	675	69	55	7	-0.6	0.45	1015.6	99	6/10
2a	4	Biophysical	21/Jul/2009	01h11	UTC-6	70°45.320	136°01.906	Box Core ↓	667	53	49	6	-0.2	0.44	1015.69	99	6/10
2a	4	Biophysical	21/Jul/2009	01h28	UTC-6	70°45.307	136°02.040	Box Core ↑	668	67	51	7	-0.1	0.44	1015.67	99	6/10
2a	4	Biophysical	21/Jul/2009	01h53	UTC-6	70°45.116	136°03.645	Agassiz Trawl ↓	664	75	52	8	0.3	0.46	1015.64	99	6/10
2a	4	Biophysical	21/Jul/2009	02h32	UTC-6	70°45.418	136°07.844	Agassiz Trawl ↑	672	278	45	7	0.4	0.43	1015.8	99	6/10

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Leg	Station ID	Station Type	Local Date	Local Time	UTC to local	Latitude (N)	Longitude (W)	Activity	Depth (m)	Heading (°)	Wind		Air (ºC)	Water (ºC)	Pr Baro	Hum (%)	Ice
											Dir	Speed					
2a	N/A	Weather	21/Jul/2009	05h58	UTC-6	70°48.300	135°32.600	Weather Balloon	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2a	10	Biophysical	21/Jul/2009	06h40	UTC-6	70°47.236	135°31.720	CTD-Rosette ↓	434	305	37	9	0.8	0.31	1017.09	99	4/10
2a	10	Biophysical	21/Jul/2009	06h50	UTC-6	70°47.241	135°31.674	Water Pumping ↓	432	320	41	8	0.9	0.34	1017.02	99	4/10
2a	10	Biophysical	21/Jul/2009	07h25	UTC-6	70°47.232	135°31.563	Water Pumping ↑	431	298	43	7	0.9	0.36	1017	99	4/10
2a	10	Biophysical	21/Jul/2009	08h30	UTC-6	70°47.310	135°33.300	Horizontal Net Tow ↓	426	138	21	9	0.4	0.43	1017.09	99	5/10
2a	10	Biophysical	21/Jul/2009	08h39	UTC-6	70°47.147	135°32.929	Horizontal Net Tow ↑	438	125	18	6	0.4	0.43	1017.09	99	5/10
2a	10	Biophysical	21/Jul/2009	09h00	UTC-6	70°47.311	135°33.476	Vertical Net Tow ↓	423	136	16	4	0.3	0.48	1017.12	98	5/10
2a	10	Biophysical	21/Jul/2009	09h28	UTC-6	70°47.231	135°33.552	Vertical Net Tow ↑	434	90	355	2	0.5	0.48	1017.18	97	5/10
2a	10	Biophysical	21/Jul/2009	10h09	UTC-6	70°47.489	135°33.780	Box Core ↓	421	330	270	3	0.3	0.44	1017.25	97	6/10
2a	10	Biophysical	21/Jul/2009	10h19	UTC-6	70°47.478	135°33.736	Box Core (bottom)	420	350	280	3	0.3	0.35	1017.2	98	6/10
2a	10	Biophysical	21/Jul/2009	10h32	UTC-6	70°47.473	135°33.731	Box Core ↑	421	336	301	3	0.2	0.27	1017.12	98	6/10
2a	10	Biophysical	21/Jul/2009	11h02	UTC-6	70°47.990	135°31.741	Agassiz Trawl ↓	456	N/A	300	2	0.4	0.29	1016.65	97	6/10
2a	10	Biophysical	21/Jul/2009	11h47	UTC-6	70°46.830	135°30.235	Agassiz Trawl ↑	399	64	310	3	0.9	0.63	1016.72	98	6/10
2a	N/A	Weather	21/Jul/2009	15h24	UTC-6	70°48.891	134°32.658	Weather Balloon	74	108	34	7	0.7	0.55	1013.44	98	8/10
2a	I-09	Mooring	21/Jul/2009	15h28	UTC-6	70°48.876	134°32.641	Mooring I-09 Deployed	72	97	34	7	0.7	0.55	1013.44	98	8/10
2a	I-09	Mooring	21/Jul/2009	15h45	UTC-6	70°48.894	134°32.957	CTD-Rosette ↓	72	140	33	8	0.8	0.31	1013.39	97	8/10
2a	I-09	Mooring	21/Jul/2009	16h30	UTC-6	70°48.836	134°33.630	CTD-Rosette ↑	74	169	130	7	1.5	0.23	1015.55	93	8/10
2a	J-09	Mooring	21/Jul/2009	18h30	UTC-6	70°53.897	134°15.649	Mooring J-09 Deployed	83	151	329	6	0.9	0.33	1014.86	98	6/10
2a	23	Biophysical	21/Jul/2009	18h46	UTC-6	70°53.816	134°16.072	CTD-Rosette ↓	83	249	90	8	1.2	0.33	1014.75	98	4/10
2a	23	Biophysical	21/Jul/2009	19h10	UTC-6	70°53.740	134°16.149	CTD-Rosette ↑	82	229	120	5	2.2	0.42	1014.35	97	4/10
2a	23	Biophysical	21/Jul/2009	19h30	UTC-6	70°53.527	134°15.971	Horizontal Net Tow ↓	80	124	240	6	2.1	0.44	1014.09	97	2/10
2a	23	Biophysical	21/Jul/2009	19h39	UTC-6	70°53.638	134°15.774	Horizontal Net Tow ↑	80	303	239	7	2.1	0.44	1014.12	97	2/10
2a	23	Biophysical	21/Jul/2009	19h57	UTC-6	70°53.535	134°16.021	Vertical Net Tow ↓	80	117	330	8	1.1	0.51	1014.21	98	2/10
2a	23	Biophysical	21/Jul/2009	20h05	UTC-6	70°53.526	134°15.985	Vertical Net Tow ↑	80	87	327	6	0.8	0.54	1014.29	99	2/10
2a	23	Biophysical	21/Jul/2009	20h46	UTC-6	70°53.603	134°15.907	Box Core ↓	80	22	322	7	0.7	0.61	1013.86	99	2/10
2a	23	Biophysical	21/Jul/2009	20h47	UTC-6	70°53.602	134°15.887	Box Core (bottom)	80	27	320	6	0.7	0.61	1013.86	99	2/10
2a	23	Biophysical	21/Jul/2009	20h49	UTC-6	70°53.601	134°15.876	Box Core ↑	80	31	320	5	0.7	0.61	1013.86	99	2/10
2a	23	Biophysical	21/Jul/2009	21h05	UTC-6	70°53.563	134°15.758	Box Core ↓	80	86	337	10	0.8	0.67	1013.68	99	2/10
2a	23	Biophysical	21/Jul/2009	21h07	UTC-6	70°53.551	134°15.775	Box Core (bottom)	80	99	341	9	0.8	0.67	1013.68	99	2/10
2a	23	Biophysical	21/Jul/2009	21h08	UTC-6	70°53.546	134°15.782	Box Core ↑	80	102	345	9	0.8	0.67	1013.68	99	2/10
2a	23	Biophysical	21/Jul/2009	21h25	UTC-6	70°53.459	134°15.672	Box Core ↓	81	152	327	6	0.6	0.71	1013.56	99	2/10
2a	23	Biophysical	21/Jul/2009	21h27	UTC-6	70°53.454	134°15.660	Box Core (bottom)	81	150	330	5	0.6	0.71	1013.56	99	2/10
2a	23	Biophysical	21/Jul/2009	21h29	UTC-6	70°53.447	134°15.646	Box Core ↑	80	149	332	6	0.6	0.71	1013.56	99	2/10
2a	23	Biophysical	21/Jul/2009	21h50	UTC-6	70°53.359	134°15.548	Box Core ↓	80	161	330	6	1	0.72	1013.45	99	2/10
2a	23	Biophysical	21/Jul/2009	21h52	UTC-6	70°53.350	134°15.540	Box Core (bottom)	80	164	332	6	0.8	0.71	1013.45	99	2/10
2a	23	Biophysical	21/Jul/2009	21h54	UTC-6	70°53.342	134°15.532	Box Core ↑	81	167	327	6	0.8	0.71	1013.45	99	2/10
2a	23	Biophysical	21/Jul/2009	22h09	UTC-6	70°53.149	134°15.416	Agassiz Trawl ↓	79	150	339	5	1.5	0.7	1013.3	99	4/10
2a	23	Biophysical	21/Jul/2009	22h26	UTC-6	70°52.761	134°14.261	Agassiz Trawl ↑	79	111	336	7	0.8	0.71	1013.23	99	4/10
2a	22	Biophysical	22/Jul/2009	01h40	UTC-6	70°49.088	134°30.588	CTD-Rosette ↓	72	143	300	6	0.6	0.12	1009.66	99	7/10
2a	22	Biophysical	22/Jul/2009	02h01	UTC-6	70°49.082	134°30.605	CTD-Rosette ↑	73	201	323	7	1.4	0.1	1009.67	99	7/10
2a	22	Biophysical	22/Jul/2009	02h13	UTC-6	70°48.908	134°31.101	Horizontal Net Tow ↓	72	18	311	5	1.4	0.11	1009.69	99	7/10
2a	22	Biophysical	22/Jul/2009	02h27	UTC-6	70°49.182	134°30.828	Horizontal Net Tow ↑	72	57	332	4	0.4	0.12	1009.6	99	7/10
2a	22	Biophysical	22/Jul/2009	02h46	UTC-6	70°48.971	134°31.538	Vertical Net Tow ↓	73	353	312	5	0.4	0.14	1009.48	99	7/10
2a	22	Biophysical	22/Jul/2009	02h54	UTC-6	70°48.982	134°31.543	Vertical Net Tow ↑	71	22	309	4	0.3	0.15	1009.48	99	7/10
2a	22	Biophysical	22/Jul/2009	03h18	UTC-6	70°48.957	134°31.674	Box Core ↓	73	70	297	5	0.2	0.22	1009.41	99	7/10

Appendix 2 - Scientific log of activities conducted during the 2009 ArcticNet Expedition

Leg	Station ID	Station Type	Local Date	Local Time	UTC to local	Latitude (N)	Longitude (W)	Activity	Depth (m)	Heading (°)	Wind		Air (ºC)	Water (ºC)	Pr Baro	Hum (%)	Ice
											Dir	Speed					
2a	22	Biophysical	22/Jul/2009	03h20	UTC-6	70°48.959	134°31.692	Box Core ↑	72	66	299	6	0.2	0.22	1009.41	99	7/10
2a	22	Biophysical	22/Jul/2009	03h46	UTC-6	70°48.912	134°31.654	Agassiz Trawl ↓	74	67	298	5	0.2	0.22	1009.42	99	7/10
2a	22	Biophysical	22/Jul/2009	03h54	UTC-6	70°49.279	134°31.095	Agassiz Trawl ↑	73	40	300	6	0.1	0.28	1009.34	99	7/10
2a	21	Biophysical	22/Jul/2009	09h11	UTC-6	71°00.986	134°38.139	Horizontal Net Tow ↓	334	51	317	7	0.3	1.02	1010.96	99	5/10
2a	21	Biophysical	22/Jul/2009	09h22	UTC-6	71°01.221	134°37.336	Horizontal Net Tow ↑	338	41	329	7	0.4	1.08	1011.03	99	5/10
2a	21	Biophysical	22/Jul/2009	09h41	UTC-6	71°01.301	134°37.928	Vertical Net Tow ↓	343	354	324	7	0.6	1.2	1011.16	99	5/10
2a	21	Biophysical	22/Jul/2009	10h03	UTC-6	71°01.239	134°37.785	Vertical Net Tow ↑	344	43	330	6	0.5	1.21	1011.19	99	5/10
2a	21	Biophysical	22/Jul/2009	10h28	UTC-6	71°01.111	134°37.976	CTD-Rosette ↓	337	273	356	9	0.5	1.22	1011.30	99	5/10
2a	21	Biophysical	22/Jul/2009	10h38	UTC-6	71°01.054	134°38.012	Water Pumping ↓	336	254	2	8	0.8	1.22	1011.30	99	5/10
2a	21	Biophysical	22/Jul/2009	11h26	UTC-6	71°00.740	134°38.375	CTD-Rosette ↑	330	246	11	8	1.1	1.2	1011.47	99	5/10
2a	21	Biophysical	22/Jul/2009	11h39	UTC-6	71°00.631	134°38.831	Water Pumping ↑	337	197	11	8	1.9	1.21	1011.43	99	5/10
2a	21	Biophysical	22/Jul/2009	12h25	UTC-6	71°00.333	134°39.203	Box Core ↓	320	72	11	9	1	1.25	1011.43	97	5/10
2a	21	Biophysical	22/Jul/2009	12h40	UTC-6	71°00.254	134°39.247	Box Core ↑	318	116	10	9	1	1.28	1011.60	97	5/10
2a	21	Biophysical	22/Jul/2009	13h00	UTC-6	71°00.250	134°39.613	Agassiz Trawl ↓	322	38	13	12	0.8	1.23	1011.69	98	4/10
2a	21	Biophysical	22/Jul/2009	13h32	UTC-6	71°00.817	134°38.577	Agassiz Trawl ↑	332	318	11	13	0.4	1.39	1011.78	98	4/10
2a	H-09	Mooring	22/Jul/2009	16h06	UTC-6	71°01.239	134°41.208	Mooring H-09 Deployed	367	317	46	6	0.4	1.42	1012.26	93	4/10
2a	18	Biophysical	22/Jul/2009	19h02	UTC-6	70°52.512	135°21.415	CTD-Rosette ↓	496	261	40	12	0.4	1.94	1011.88	96	1/10
2a	18	Biophysical	22/Jul/2009	19h20	UTC-6	70°52.554	135°21.709	Water Pumping ↓	500	308	124	9	2	1.74	1011.93	92	1/10
2a	18	Biophysical	22/Jul/2009	19h56	UTC-6	70°52.571	135°21.964	CTD-Rosette ↑	506	271	50	8	2.9	1.83	1011.86	90	1/10
2a	18	Biophysical	22/Jul/2009	20h14	UTC-6	70°52.595	135°22.217	Water Pumping ↑	505	310	60	9	2.9	1.87	1011.85	90	1/10
2a	18	Biophysical	22/Jul/2009	20h42	UTC-6	70°52.581	135°22.713	Horizontal Net Tow ↓	512	0	69	9	2	1.95	1012.05	92	2/10
2a	18	Biophysical	22/Jul/2009	20h54	UTC-6	70°53.095	135°23.330	Horizontal Net Tow ↑	522	290	61	8	1.4	1.97	1012.08	94	2/10
2a	18	Biophysical	22/Jul/2009	21h10	UTC-6	70°53.132	135°23.576	Vertical Net Tow ↓	523	188	59	7	0.7	2.06	1012.04	95	2/10
2a	18	Biophysical	22/Jul/2009	21h41	UTC-6	70°53.101	135°23.636	Vertical Net Tow ↑	521	150	56	8	0.1	2.14	1011.87	98	2/10
2a	18	Biophysical	22/Jul/2009	22h04	UTC-6	70°53.060	135°23.694	Box Core ↓	520	156	57	8	0.1	2.2	1011.84	98	2/10
2a	18	Biophysical	22/Jul/2009	22h11	UTC-6	70°53.046	135°23.712	Box Core (bottom)	520	147	53	7	0.1	2.2	1011.83	98	2/10
2a	18	Biophysical	22/Jul/2009	22h18	UTC-6	70°53.029	135°23.721	Box Core ↑	521	146	53	7	0.1	2.22	1011.83	98	4/10
2a	18	Biophysical	22/Jul/2009	22h39	UTC-6	70°54.210	135°25.674	Agassiz Trawl ↓	560	354	56	8	0.5	2.28	1011.74	97	4/10
2a	18	Biophysical	22/Jul/2009	23h18	UTC-6	70°54.703	135°26.307	Agassiz Trawl ↑	577	277	48	7	2.9	2.1	1012.01	86	4/10
2a	8	Biophysical	23/Jul/2009	01h40	UTC-6	70°55.244	135°51.844	CTD-Rosette ↓	786	301	70	10	0.5	1.07	1011.5	97	3/10
2a	8	Biophysical	23/Jul/2009	02h48	UTC-6	70°54.831	135°53.084	CTD-Rosette ↑	783	338	80	10	1.3	1.04	1011.46	93	3/10
2a	8	Biophysical	23/Jul/2009	02h59	UTC-6	70°55.018	135°52.859	Horizontal Net Tow ↓	791	73	73	13	1	1.08	1011.86	95	3/10
2a	8	Biophysical	23/Jul/2009	03h13	UTC-6	70°55.017	135°51.733	Horizontal Net Tow ↑	776	85	68	11	0.4	1.14	1011.11	97	3/10
2a	8	Biophysical	23/Jul/2009	03h28	UTC-6	70°54.944	135°51.983	Vertical Net Tow ↓	781	133	75	11	0.4	1.23	1011.12	97	3/10
2a	8	Biophysical	23/Jul/2009	04h07	UTC-6	70°55.038	135°52.827	Vertical Net Tow ↑	790	267	62	10	0.2	1.37	1011.18	98	3/10
2a	8	Biophysical	23/Jul/2009	04h35	UTC-6	70°54.976	135°53.975	Box Core ↓	795	254	72	9	0.3	1.37	1011.63	96	3/10
2a	8	Biophysical	23/Jul/2009	04h57	UTC-6	70°54.942	135°53.309	Box Core ↑	792	250	68	8	0.7	1.34	1011.02	95	3/10
2a	8	Biophysical	23/Jul/2009	05h07	UTC-6	70°54.912	135°53.705	Agassiz Trawl ↓	799	270	56	8	0.6	1.31	1011.01	95	2/10
2a	8	Biophysical	23/Jul/2009	05h48	UTC-6	70°54.474	135°55.959	Agassiz Trawl ↑	808	176	73	12	0.3	1.35	1010.86	95	2/10
2a	20	Biophysical	23/Jul/2009	09h48	UTC-6	71°00.941	135°20.775	CTD-Rosette ↓	645	282	53	12	0.51	2.1	1009.94	93	4/10
2a	20	Biophysical	23/Jul/2009	11h04	UTC-6	71°00.695	135°22.522	CTD-Rosette ↑	659	301	63	12	0.57	2.3	1009.86	86	4/10
2a	20	Biophysical	23/Jul/2009	11h31	UTC-6	70°59.825	135°23.590	Horizontal Net Tow ↓	643	112	58	14	1.8	0.58	1009.68	91	4/10
2a	20	Biophysical	23/Jul/2009	11h42	UTC-6	70°59.768	135°22.844	Horizontal Net Tow ↑	642	50	67	12	1.5	0.6	1009.54	93	4/10
2a	20	Biophysical	23/Jul/2009	11h51	UTC-6	70°59.730	135°23.086	Vertical Net Tow ↓	638	153	63	11	1.4	0.61	1009.57	94	4/10
2a	20	Biophysical	23/Jul/2009	12h34	UTC-6	70°59.412	135°23.955	Vertical Net Tow ↑	641	157	65	10	1.7	0.73	1009.57	93	4/10

Appendix 2 - Scientific log of activities conducted during the 2009 ArcticNet Expedition

Leg	Station ID	Station Type	Local Date	Local Time	UTC to local	Latitude (N)	Longitude (W)	Activity	Depth (m)	Heading (°)	Wind		Air (ºC)	Water (ºC)	Pr Baro	Hum (%)	Ice
											Dir	Speed					
2a	20	Biophysical	23/Jul/2009	12h56	UTC-6	70°59.746	135°23.677	EM Sampling ↓	643	24	64	12	1.5	0.78	1009.38	95	4/10
2a	20	Biophysical	23/Jul/2009	13h14	UTC-6	71°00.186	135°23.649	Box Core ↓	648	60	62	11	1.4	0.81	1009.4	96	4/10
2a	20	Biophysical	23/Jul/2009	13h35	UTC-6	71°00.170	135°24.007	Box Core ↑	654	42	60	10	1.5	0.81	1009.57	94	4/10
2a	20	Biophysical	23/Jul/2009	13h46	UTC-6	71°00.230	135°24.092	Box Core ↓	646	55	66	11	1.3	0.83	1009.52	96	4/10
2a	20	Biophysical	23/Jul/2009	14h08	UTC-6	71°00.271	135°24.583	Box Core ↑	655	17	59	11	1.3	0.83	1009.32	96	4/10
2a	20	Biophysical	23/Jul/2009	14h33	UTC-6	70°59.259	135°26.806	Agassiz Trawl ↓	654	40	55	13	2.9	0.8	1009.58	89	4/10
2a	20	Biophysical	23/Jul/2009	14h57	UTC-6	70°59.735	135°27.905	EM Sampling ↑	650	73	50	12	1.4	0.84	1009.4	95	4/10
2a	20	Biophysical	23/Jul/2009	15h10	UTC-6	71°00.021	135°26.166	Weather Balloon	664	338	48	13	1.8	0.88	1009.33	94	4/10
2a	20	Biophysical	23/Jul/2009	15h35	UTC-6	70°00.203	135°27.367	Agassiz Trawl ↑	697	264	59	13	3.2	0.88	1009.38	87	4/10
2a	N/A	N/A	23/Jul/2009	16h15	UTC-6	71°00.207	135°27.731	Helicopter ↓	693	142	53	11	1.6	0.82	1009.2	93	4/10
2a	N/A	N/A	23/Jul/2009	17h52	UTC-6	71°00.128	135°28.821	Helicopter ↑	696	75	45	11	3	0.96	1008.76	90	4/10
2a	G-09	Mooring	23/Jul/2009	18h51	UTC-6	71°00.118	135°28.785	Mooring G-09 Deployed	699	225	30	11	2.6	0.84	1008.52	89	2/10
2a	N/A	Weather	24/Jul/2009	06h40	UTC-6	70°47.330	136°34.330	Weather Balloon	1004	245	30	7	0.2	0.36	1009.54	99	4/10
2a	16	Biophysical	24/Jul/2009	08h10	UTC-6	70°47.687	136°39.491	CTD-Rosette ↓	1097	254	35	6	0.7	0.81	1009.89	99	1/10
2a	16	Biophysical	24/Jul/2009	09h28	UTC-6	70°47.436	136°40.594	CTD-Rosette ↑	1125	289	12	5	0.6	0.95	1010.33	98	1/10
2a	16	Biophysical	24/Jul/2009	09h59	UTC-6	70°47.246	136°40.564	Horizontal Net Tow ↓	1164	70	353	6	0.6	0.96	1010.54	97	1/10
2a	16	Biophysical	24/Jul/2009	10h11	UTC-6	70°47.454	136°39.598	Horizontal Net Tow ↑	1152	38	358	6	0.1	0.98	1010.54	97	1/10
2a	16	Biophysical	24/Jul/2009	10h29	UTC-6	70°47.368	136°39.772	Vertical Net Tow ↓	1182	158	34	7	-0.1	1.04	1010.5	98	1/10
2a	16	Biophysical	24/Jul/2009	11h43	UTC-6	70°47.071	136°40.528	Vertical Net Tow ↑	1206	141	15	4	0.1	1.32	1010.8	97	2/10
2a	16	Biophysical	24/Jul/2009	12h22	UTC-6	70°47.880	136°38.990	Box Core ↓	1071	0	36	5	0.5	1.3	1010.91	98	2/10
2a	16	Biophysical	24/Jul/2009	12h36	UTC-6	70°47.873	136°39.027	Box Core (bottom)	1074	2	42	4	0.6	1.28	1011.03	98	2/10
2a	16	Biophysical	24/Jul/2009	12h51	UTC-6	70°47.831	136°39.104	Box Core ↑	1072	321	49	6	0.7	1.31	1010.96	97	2/10
2a	16	Biophysical	24/Jul/2009	13h20	UTC-6	70°47.883	136°39.003	Box Core ↓	1072	359	51	4	0.7	1.33	1011.04	97	2/10
2a	16	Biophysical	24/Jul/2009	13h41	UTC-6	70°47.883	136°38.978	Box Core (bottom)	1072	348	8	3	0.8	1.32	1011.04	97	2/10
2a	16	Biophysical	24/Jul/2009	14h06	UTC-6	70°47.794	136°39.061	Box Core ↑	1073	274	25	5	1.8	1.32	1011.29	95	2/10
2a	N/A	Weather	24/Jul/2009	21h00	UTC-6	70°55.870	136°24.287	Weather Balloon	1012	222	40	5	1.5	1.33	1012.76	93	3/10
2a	F-09	Mooring	24/Jul/2009	21h47	UTC-6	70°55.861	136°24.659	Mooring F-09 Deployed	1010	259	55	5	2.1	1.28	1012.84	89	3/10
2a	6	Biophysical	24/Jul/2009	23h02	UTC-6	70°55.355	136°27.306	Horizontal Net Tow ↓	1009	114	50	5	0.6	1.24	1013.39	98	3/10
2a	6	Biophysical	24/Jul/2009	23h13	UTC-6	70°55.345	136°26.216	Horizontal Net Tow ↑	996	85	42	4	0.6	1.34	1013.42	98	3/10
2a	6	Biophysical	24/Jul/2009	23h31	UTC-6	70°55.315	136°25.533	Vertical Net Tow ↓	1022	82	36	4	0.6	1.55	1013.55	99	4/10
2a	6	Biophysical	25/Jul/2009	00h28	UTC-6	70°56.215	136°25.904	Vertical Net Tow ↑ (canceled)	1023	N/A	55	5	0.3	1.4	1013.62	99	4/10
2a	6	Biophysical	25/Jul/2009	00h51	UTC-6	70°56.157	136°25.783	CTD-Rosette ↓	1014	267	58	4	0.8	1.37	1013.81	99	4/10
2a	6	Biophysical	25/Jul/2009	01h00	UTC-6	70°56.246	136°26.998	Water Pumping ↓	1014	287	76	6	0.9	1.26	1013.87	99	4/10
2a	6	Biophysical	25/Jul/2009	01h55	UTC-6	70°56.180	136°26.241	Water Pumping ↑	1014	338	80	7	0.9	1.28	1013.89	98	4/10
2a	6	Biophysical	25/Jul/2009	02h07	UTC-6	70°56.198	136°26.420	CTD-Rosette ↑	1016	342	44	6	1	1.25	1013.95	97	4/10
2a	6	Biophysical	25/Jul/2009	02h36	UTC-6	70°56.220	136°26.151	Box Core ↓	1020	153	76	7	0.9	1.12	1014.01	98	4/10
2a	6	Biophysical	25/Jul/2009	02h45	UTC-6	70°56.195	136°26.173	Box Core (bottom)	1018	94	75	5	0.4	1.1	1014.04	99	4/10
2a	6	Biophysical	25/Jul/2009	03h15	UTC-6	70°56.197	136°26.454	Box Core ↑	1014	145	81	6	0.5	1.14	1014.22	99	4/10
2a	6	Biophysical	25/Jul/2009	04h16	UTC-6	70°56.192	136°26.562	Vertical Net Tow ↓	1016	262	347	6	0.3	1.17	1014.25	99	4/10
2a	6	Biophysical	25/Jul/2009	05h18	UTC-6	70°56.168	136°27.059	Vertical Net Tow ↑	1020	225	86	5	1.7	1.13	1014.49	93	4/10
2a	N/A	Weather	25/Jul/2009	07h05	UTC-6	70°55.861	136°16.334	Weather Balloon	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2a	7	Biophysical	25/Jul/2009	08h14	UTC-6	70°59.327	136°07.633	CTD-Rosette ↓	1018	321	89	8	1.6	0.32	1015.03	93	4/10
2a	7	Biophysical	25/Jul/2009	09h30	UTC-6	70°59.379	136°08.767	CTD-Rosette ↑	1034	356	95	7	2.9	0.43	1015.58	90	4/10
2a	7	Biophysical	25/Jul/2009	10h19	UTC-6	70°59.270	136°08.333	Vertical Net Tow ↓	1022	134	85	9	1.1	0.58	1015.64	96	5/10
2a	7	Biophysical	25/Jul/2009	11h29	UTC-6	70°59.156	136°09.167	Vertical Net Tow ↑	1022	216	92	6	1	0.67	1015.89	95	5/10

Appendix 2 - Scientific log of activities conducted during the 2009 ArcticNet Expedition

Leg	Station ID	Station Type	Local Date	Local Time	UTC to local	Latitude (N)	Longitude (W)	Activity	Depth (m)	Heading (°)	Wind		Air (ºC)	Water (ºC)	Pr Baro	Hum (%)	Ice
											Dir	Speed					
2a	7	Biophysical	25/Jul/2009	12h50	UTC-6	70°59.264	136°09.548	Box Core ↓	1022	107	74	7	3	0.55	1016.23	89	5/10
2a	7	Biophysical	25/Jul/2009	13h14	UTC-6	70°59.132	136°09.628	Box Core (bottom)	1022	113	72	9	1.2	0.58	1016.35	95	5/10
2a	7	Biophysical	25/Jul/2009	13h33	UTC-6	70°59.052	136°09.912	Box Core ↑	1022	148	76	8	1.2	0.66	1016.4	95	5/10
2a	N/A	Weather	25/Jul/2009	15h03	UTC-6	70°57.588	136°10.837	Weather Balloon	N/A	184	82	8	0.4	1.36	1017.06	95	9/10
2a	A2-09	Mooring	25/Jul/2009	18h35	UTC-6	70°44.777	135°55.164	Mooring A2-09 Deployed	618	225	92	7	1.3	1.18	1018.09	94	1/10
2a	9	Biophysical	25/Jul/2009	20h49	UTC-6	70°44.246	135°55.126	CTD-Rosette ↓	583	6	112	9	2.6	1.59	1018.59	90	1/10
2a	9	Biophysical	25/Jul/2009	21h40	UTC-6	70°44.389	135°55.442	CTD-Rosette ↑	595	34	143	6	3.1	1.68	1018.77	86	1/10
2a	9	Biophysical	25/Jul/2009	21h50	UTC-6	70°44.387	135°55.002	Horizontal Net Tow ↓	596	139	130	7	3.2	1.69	1018.75	87	1/10
2a	9	Biophysical	25/Jul/2009	22h00	UTC-6	70°44.246	135°54.135	Horizontal Net Tow ↑	583	73	144	8	1.9	1.7	1018.67	93	1/10
2a	9	Biophysical	25/Jul/2009	22h20	UTC-6	70°44.373	135°54.342	Vertical Net Tow ↓	589	269	140	6	1.8	1.7	1018.78	92	1/10
2a	9	Biophysical	25/Jul/2009	22h54	UTC-6	70°44.399	135°54.516	Vertical Net Tow ↑	595	192	126	6	1.9	1.68	1018.97	91	1/10
2a	9	Biophysical	25/Jul/2009	23h18	UTC-6	70°44.392	135°54.547	Box Core ↓	592	178	122	6	1.8	1.68	1019.2	92	1/10
2a	9	Biophysical	25/Jul/2009	23h27	UTC-6	70°44.385	135°54.554	Box Core (bottom)	592	177	115	7	1.8	1.69	1019.17	92	1/10
2a	9	Biophysical	25/Jul/2009	23h43	UTC-6	70°44.374	135°54.643	Box Core ↑	592	225	135	9	1.7	1.74	1019.15	92	1/10
2a	9	Biophysical	26/Jul/2009	00h00	UTC-6	70°44.310	135°54.765	Agassiz Trawl ↓	586	186	136	8	2	1.78	1019.3	90	1/10
2a	9	Biophysical	26/Jul/2009	00h44	UTC-6	70°43.531	135°54.190	Agassiz Trawl ↑	526	83	135	8	1.4	1.71	1019.2	92	1/10
2a	5	Biophysical	26/Jul/2009	06h47	UTC-6	70°50.011	136°05.287	Box Core ↓	814	315	311	13	1.4	0.59	1019.77	82	4/10
2a	5	Biophysical	26/Jul/2009	07h27	UTC-6	70°50.027	136°06.050	Box Core ↑	819	14	143	13	6.2	0.64	1019.18	79	4/10
2a	LF03	Hydrophone	26/Jul/2009	10h06	UTC-6	70°45.180	135°55.624	MARU Buoy Deployed	642	210	138	15	4.3	0.6	1019.04	90	2/10
2a	LF02	Hydrophone	26/Jul/2009	12h40	UTC-6	70°45.124	136°16.201	MARU Buoy Deployed	619	136	127	14	3.7	1.07	1018.87	89	3/10
2a	LF01	Hydrophone	26/Jul/2009	13h40	UTC-6	70°45.121	136°38.248	MARU Buoy Deployed	1204	156	124	13	4.4	1.14	1018.47	86	4/10
2a	LF06	Hydrophone	26/Jul/2009	14h44	UTC-6	70°39.060	136°27.825	MARU Buoy Deployed	830	110	111	15	4.6	0.78	1018.1	87	4/10
2a	LF07	Hydrophone	26/Jul/2009	16h54	UTC-6	70°38.970	136°06.663	MARU Buoy Deployed	453	247	97	16	5.2	0.42	1017.86	81	8/10
2a	LF11	Hydrophone	26/Jul/2009	18h45	UTC-6	70°33.113	135°55.971	MARU Buoy Deployed	70	146	120	18	5.1	0.72	1017.24	85	8/10
2a	13	Biophysical	26/Jul/2009	21h51	UTC-6	70°30.349	135°40.370	CTD-Rosette ↓	66	94	95	18	6	1.62	1016.52	87	6/10
2a	13	Biophysical	26/Jul/2009	22h14	UTC-6	70°30.482	135°40.599	CTD-Rosette ↑	65	342	99	19	6.1	1.92	1016.44	86	6/10
2a	13	Biophysical	26/Jul/2009	22h20	UTC-6	70°30.420	135°40.659	Horizontal Net Tow ↓	68	196	95	20	6.4	1.94	1016.96	85	6/10
2a	13	Biophysical	26/Jul/2009	22h42	UTC-6	70°30.115	135°41.044	Horizontal Net Tow ↑	66	183	99	20	5.8	2.23	1016.35	87	6/10
2a	13	Biophysical	26/Jul/2009	22h58	UTC-6	70°30.117	135°40.627	Vertical Net Tow ↓	68	289	97	17	6.5	2.49	1016.41	84	5/10
2a	13	Biophysical	26/Jul/2009	23h09	UTC-6	70°30.165	135°40.770	Vertical Net Tow ↑	64	305	94	19	7	2.65	1016.43	83	5/10
2a	13	Biophysical	26/Jul/2009	23h26	UTC-6	70°30.244	135°40.714	Box Core ↓	65	289	100	18	6.5	2.41	1016.38	86	5/10
2a	13	Biophysical	26/Jul/2009	23h28	UTC-6	70°30.252	135°40.741	Box Core (bottom)	66	286	101	17	6.5	2.41	1016.35	86	5/10
2a	13	Biophysical	26/Jul/2009	23h30	UTC-6	70°30.259	135°40.746	Box Core ↑	67	297	94	17	6.5	2.41	1016.38	86	5/10
2a	13	Biophysical	26/Jul/2009	23h47	UTC-6	70°30.320	135°43.267	Agassiz Trawl ↓	67	220	98	17	6.9	2.25	1016.45	84	5/10
2a	13	Biophysical	27/Jul/2009	00h01	UTC-6	70°29.964	135°43.806	Agassiz Trawl ↑	67	163	96	17	5.2	2.72	1016.15	90	5/10
2a	LF12	Hydrophone	27/Jul/2009	01h37	UTC-6	70°32.872	135°35.339	MARU Buoy Deployed	67	193	91	17	4.1	2.25	1016.02	90	8/10
2a	LF04	Hydrophone	27/Jul/2009	05h03	UTC-6	70°33.171	135°13.508	MARU Buoy Deployed	61	172	190	35	4	0.56	1016.42	92	10/10
2a	N/A	Weather	27/Jul/2009	06h04	UTC-6	70°38.311	135°06.050	Weather Balloon	62	129	102	17	3.8	0.19	1016.26	93	8/10
2a	12	Biophysical	27/Jul/2009	08h09	UTC-6	70°38.392	135°05.988	CTD-Rosette ↓	61	86	122	12	4.6	0.18	1016.67	90	8/10
2a	12	Biophysical	27/Jul/2009	08h27	UTC-6	70°38.438	135°06.024	CTD-Rosette ↑	62	31	126	14	4.9	0.18	1016.63	90	8/10
2a	12	Biophysical	27/Jul/2009	09h11	UTC-6	70°38.406	135°06.296	Horizontal Net Tow ↓	60	150	117	17	5.1	0.19	1016.59	90	8/10
2a	12	Biophysical	27/Jul/2009	09h25	UTC-6	70°38.269	135°05.525	Horizontal Net Tow ↑	62	72	121	17	5.2	0.19	1016.48	90	8/10
2a	12	Biophysical	27/Jul/2009	09h46	UTC-6	70°38.205	135°05.122	Vertical Net Tow ↓	62	303	126	13	4.9	0.19	1016.55	91	8/10
2a	12	Biophysical	27/Jul/2009	09h54	UTC-6	70°38.196	135°05.173	Vertical Net Tow ↑	62	299	130	13	6.5	0.19	1016.73	82	8/10
2a	12	Biophysical	27/Jul/2009	10h16	UTC-6	70°38.248	135°05.511	Box Core ↓	62	309	114	11	9.6	0.16	1016.89	74	8/10

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Leg	Station ID	Station Type	Local Date	Local Time	UTC to local	Latitude (N)	Longitude (W)	Activity	Depth (m)	Heading (°)	Wind		Air (ºC)	Water (ºC)	Pr Baro	Hum (%)	Ice
											Dir	Speed					
2a	12	Biophysical	27/Jul/2009	10h18	UTC-6	70°38.247	135°05.532	Box Core (bottom)	62	319	113	10	9.6	0.16	1016.89	74	8/10
2a	12	Biophysical	27/Jul/2009	10h20	UTC-6	70°38.250	135°05.558	Box Core ↑	62	313	112	10	9.6	0.16	1016.89	74	8/10
2a	12	Biophysical	27/Jul/2009	10h30	UTC-6	70°38.261	135°05.708	Box Core ↓	62	317	114	11	6.6	0.17	1016.92	86	8/10
2a	12	Biophysical	27/Jul/2009	10h32	UTC-6	70°38.267	135°05.741	Box Core (bottom)	62	329	114	12	6.6	0.17	1016.92	86	8/10
2a	12	Biophysical	27/Jul/2009	10h34	UTC-6	70°38.266	135°05.747	Box Core ↑	63	333	118	12	6.6	0.17	1016.92	86	8/10
2a	12	Biophysical	27/Jul/2009	10h52	UTC-6	70°38.358	135°04.098	Agassiz Trawl ↓	63	180	105	9	5.3	0.17	1017.1	90	7/10
2a	12	Biophysical	27/Jul/2009	11h12	UTC-6	70°37.772	135°03.869	Agassiz Trawl ↑	62	145	94	13	6.3	0.17	1017.2	87	7/10
2a	LF09	Biophysical	27/Jul/2009	14h30	UTC-6	70°38.326	135°22.284	MARU Buoy Deployed	71	237	91	10	6.8	0.1	1018.0	83	7/10
2a	LF08	Hydrophone	27/Jul/2009	19h09	UTC-6	70°39.340	135°45.595	MARU Buoy Deployed	465	29	28	7	3.7	0.26	1019.35	89	8/10
2a	LF05	Hydrophone	27/Jul/2009	21h04	UTC-6	70°45.190	135°34.383	MARU Buoy Deployed	396	174	26	10	2.9	0.42	1019.9	91	9/10
2a	LF10	Hydrophone	28/Jul/2009	00h06	UTC-6	70°45.221	135°13.942	MARU Buoy Deployed	86	20	25	10	2.3	0.2	1020.5	93	8/10
2a	N/A	ROV	28/Jul/2009	14h52	UTC-6	70°47.818	135°32.193	ROV ↓	575	356	85	12	2.6	-0.1	1021.6	93	9/10
2a	N/A	ROV	28/Jul/2009	16h13	UTC-6	70°47.837	135°33.068	ROV (bottom)	N/A	328	80	16	3.0	0.0	1021.8	91	9/10
2a	N/A	ROV	28/Jul/2009	19h00	UTC-6	70°47.548	135°36.334	ROV ↑	N/A	337	77	16	4.0	0.1	1021.2	87	9/10
2a	5	Biophysical	28/Jul/2009	22h34	UTC-6	70°48.083	136°05.381	Box Core ↓	760	221	85	16	2.4	-0.1	1020.5	94	7/10
2a	5	Biophysical	28/Jul/2009	22h44	UTC-6	70°48.073	136°05.619	Box Core (bottom)	746	172	68	16	2.3	-0.1	1020.5	94	7/10
2a	5	Biophysical	28/Jul/2009	22h56	UTC-6	70°47.978	136°05.980	Box Core ↑	745	239	84	15	2.7	0.0	1020.6	93	7/10
Leg 2b																	
2b	390	Malina	31/Jul/2009	13h58	UTC-6	70°11.051	133°45.233	Barge Deployed (optics)	40	002	76	16	6.5	4.9	1009.3	95	0/10
2b	390	Malina	31/Jul/2009	15h03	UTC-6	70°10.787	133°33.614	CTD-Rosette ↓	58	005	68	15	6.6	5.1	1010.2	98	0/10
2b	390	Malina	31/Jul/2009	15h17	UTC-6	70°10.762	133°34.140	CTD-Rosette ↑	55	231	69	17	6.9	5.2	1010.2	98	0/10
2b	390	Malina	31/Jul/2009	16h00	UTC-6	70°10.900	133°35.200	Barge Recovered (optics)	N/A	N/A	70	18	6.4	5.1	1010.1	92	0/10
2b	390	Malina	31/Jul/2009	17h00	UTC-6	70°10.503	133°34.066	CTD-Rosette ↓	48	283	90	10	6.6	5.0	1010.3	98	0/10
2b	390	Malina	31/Jul/2009	17h16	UTC-6	70°10.424	133°34.269	CTD-Rosette ↑	50	239	90	13	8.9	4.9	1010.3	91	0/10
2b	390	Malina	31/Jul/2009	18h29	UTC-6	70°10.697	133.34.690	CTD-Rosette ↓	38	244	70	13	9.4	4.8	1010.4	80	0/10
2b	390	Malina	31/Jul/2009	18h44	UTC-6	70°10.648	133°35.008	CTD-Rosette ↑	38	236	65	17	9.6	4.7	1010.3	79	0/10
2b	390	Malina	31/Jul/2009	19h53	UTC-6	70°10.653	133°34.096	Box Core ↓	47	242	64	16	7.4	5.1	1009.8	89	0/10
2b	390	Malina	31/Jul/2009	19h56	UTC-6	70°10.653	133°34.127	Box Core ↑	47	247	62	17	7.4	5.1	1009.8	89	0/10
2b	690	Malina	01/Aug/2009	06h22	UTC-6	69°29.262	137°56.563	CTD-Rosette ↓	54	169	297	17	11.2	6.2	1010.2	95	0/10
2b	690	Malina	01/Aug/2009	06h35	UTC-6	69°29.239	137°56.476	CTD-Rosette ↑	55	180	301	15	10.7	6.1	1010.3	93	0/10
2b	690	Malina	01/Aug/2009	07h02	UTC-6	69°29.179	137°56.486	Box Core ↓	55	112	285	12	11.0	5.5	1010.6	88	0/10
2b	690	Malina	01/Aug/2009	07h06	UTC-6	69°29.161	137°56.491	Box Core ↑	55	114	285	12	11.0	5.5	1010.6	88	0/10
2b	690	Malina	01/Aug/2009	09h06	UTC-6	69°29.117	137°55.970	CTD-Rosette ↓	54	161	302	14	8.7	6.7	1010.5	99	0/10
2b	690	Malina	01/Aug/2009	09h27	UTC-6	69°28.892	137°56.013	CTD-Rosette ↑	53	127	306	11	10.7	5.7	1011.1	93	0/10
2b	690	Malina	01/Aug/2009	10h44	UTC-6	69°28.288	137°57.235	CTD-Rosette ↓	54	135	287	14	11.0	5.1	1011.4	88	0/10
2b	690	Malina	01/Aug/2009	11h04	UTC-6	69°27.992	137°57.264	CTD-Rosette ↑	55	121	298	13	11.0	5.1	1011.6	88	0/10
2b	690	Malina	01/Aug/2009	12h00	UTC-6	69°29.324	137°56.463	IOPs ↓	55	65	297	10	9.4	6.8	1012.2	94	0/10
2b	690	Malina	01/Aug/2009	12h14	UTC-6	69°29.274	137°56.536	IOPs ↑	55	358	312	14	8.4	6.8	1012.2	97	0/10
2b	690	Malina	01/Aug/2009	13h20	UTC-6	69°29.154	137°57.127	Barge Deployed (coastal transect)	55	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2b	690	Malina	01/Aug/2009	14h16	UTC-6	69°29.154	137°56.348	CTD-Rosette ↓	55	125	309	12	11.8	6.5	1013.2	85	0/10
2b	690	Malina	01/Aug/2009	14h38	UTC-6	69°29.048	137°56.320	CTD-Rosette ↑	55	108	304	10	9.8	6.3	1013.3	92	0/10
2b	690	Malina	01/Aug/2009	17h45	UTC-6	69°21.653	137°42.184	Barge Recovered (coastal transect)	55	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2b	690	Malina	01/Aug/2009	20h49	UTC-6	69°29.057	137°56.158	Box Core ↓	54	115	295	25	9.6	8.3	1016.4	93	0/10
2b	690	Malina	01/Aug/2009	20h51	UTC-6	69°29.034	137°56.172	Box Core ↑	54	118	300	28	9.0	7.8	1016.2	94	0/10
2b	680	Malina	02/Aug/2009	04h13	UTC-6	69°36.406	138°13.804	Box Core ↓	125	236	275	14	10.2	8.6	1020.1	90	0/10

Leg	Station ID	Station Type	Local Date	Local Time	UTC to local	Latitude (N)	Longitude (W)	Activity	Depth (m)	Heading (°)	Wind Dir	Wind Speed	Air (ºC)	Water (ºC)	Pr Baro	Hum (%)	Ice
2b	680	Malina	02/Aug/2009	04h17	UTC-6	69°36.421	138°13.796	Box Core ↑	125	195	273	13	10.2	8.6	1020.1	90	0/10
2b	680	Malina	02/Aug/2009	07h04	UTC-6	69°36.946	138°13.010	Casq Core Deployed	125	317	290	9	9.6	5.9	1021.5	93	0/10
2b	680	Malina	02/Aug/2009	08h35	UTC-6	69°37.996	138°13.001	Casq Core Recovered	130	301	270	5/10	9	6.7	1021.8	96	0/10
2b	680	Malina	02/Aug/2009	10h40	UTC-6	69°36.457	138°12.526	Barge Deployed (optics)	122	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2b	680	Malina	02/Aug/2009	10h45	UTC-6	69°36.456	138°12.479	CTD-Rosette ↓	122	137	270	5	9.7	7.6	1023.1	94	0/10
2b	680	Malina	02/Aug/2009	11h10	UTC-6	69°36.321	138°11.906	CTD-Rosette ↑	121	174	301	8	10.0	7.5	1023.1	93	0/10
2b	680	Malina	02/Aug/2009	11h35	UTC-6	69°36.061	138°11.404	IOPs ↓	120	115	327	7	9.5	7.3	1023.3	94	0/10
2b	680	Malina	02/Aug/2009	11h50	UTC-6	69°35.954	138°11.313	IOPs ↑	119	130	320	5	9.1	6.7	1021.1	95	0/10
2b	680	Malina	02/Aug/2009	13h10	UTC-6	69°36.465	138°13.288	CTD-Rosette ↓	124	213	29	4	9.8	6.9	1023.9	94	0/10
2b	680	Malina	02/Aug/2009	13h39	UTC-6	69°36.213	138°13.392	CTD-Rosette ↑	124	243	35	6	10.2	5.6	1024.0	89	0/10
2b	680	Malina	02/Aug/2009	13h50	UTC-6	69°36.086	138°13.505	Barge Recovered (optics)	124	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2b	680	Malina	02/Aug/2009	14h44	UTC-6	69°36.601	138°13.229	CTD-Rosette ↓	124	295	86	4	9.3	6.3	1024.5	96	0/10
2b	680	Malina	02/Aug/2009	15h17	UTC-6	69°36.427	138°13.690	CTD-Rosette ↑	125	336	87	8	10.6	6.6	1024.4	89	0/10
2b	680	Malina	02/Aug/2009	16h46	UTC-6	69°36.581	138°14.200	CTD-Rosette ↓	126	299	85	5	9.3	7.3	1024.7	93	0/10
2b	680	Malina	02/Aug/2009	16h58	UTC-6	69°36.566	138°14.397	CTD-Rosette ↑	126	288	115	5	10.4	7.4	1024.8	89	0/10
2b	680	Malina	02/Aug/2009	18h16	UTC-6	69°36.778	138°14.409	SCAMP ↓	128	228	110	4	9.2	7.2	1025.3	94	0/10
2b	680	Malina	02/Aug/2009	20h00	UTC-6	69°37.406	138°15.450	SCAMP ↑	131	356	92	6	10.7	7.0	1025.2	88	0/10
2b	690	Malina	02/Aug/2009	23h55	UTC-6	69°25.885	137°59.375	Casq Core Deployed	53	68	81	12	9.8	7.5	1024.7	96	0/10
2b	690	Malina	02/Aug/2009	23h58	UTC-6	69°25.871	137°59.366	Casq Core (bottom)	53	50	81	12	9.8	7.5	1024.7	96	0/10
2b	690	Malina	03/Aug/2009	00h00	UTC-6	69°25.867	137°59.352	Casq Core Recovered	53	49	81	12	9.8	7.5	1024.7	96	0/10
2b	690	Malina	03/Aug/2009	09h53	UTC-6	70°05.401	133°32.010	Barge Deployed (coastal transect)	36	35	100	6	6.5	6.3	1028.1	93	0/10
2b	690	Malina	03/Aug/2009	10h08	UTC-6	70°05.346	133°32.039	Zodiac Deployed (coastal transect)	36	35	100	6	6.5	6.3	1028.1	93	0/10
2b	690	Malina	03/Aug/2009	12h50	UTC-6	64°44.023	133°20.961	Zodiac Recovered (coastal transect)	18	68	79	8	8.0	7.1	1028.1	96	0/10
2b	394	Malina	03/Aug/2009	14h28	UTC-6	69°50.831	133°29.570	CTD-Rosette ↓	14	281	75	12	8.2	6.62	1027.9	96	0/10
2b	394	Malina	03/Aug/2009	14h40	UTC-6	69°50.816	133°29.667	CTD-Rosette ↑	14	304	76	11	9.8	7.12	1027.9	90	0/10
2b	394	Malina	03/Aug/2009	15h05	UTC-6	69°50.750	133°29.433	IOPs ↓	16	174	80	12	8.8	6.50	1027.7	94	0/10
2b	394	Malina	03/Aug/2009	15h15	UTC-6	69°50.720	133°29.684	IOPs ↑	20	175	87	13	8.1	6.20	1027.6	96	0/10
2b	394	Malina	03/Aug/2009	15h55	UTC-6	69°51.064	133°30.253	Barge Recovered (coastal transect)	18	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2b	394	Malina	03/Aug/2009	16h46	UTC-6	69°50.946	133°29.844	CTD-Rosette ↓	13	001	90	10	9.6	6.82	1027.7	95	0/10
2b	394	Malina	03/Aug/2009	16h55	UTC-6	69°51.022	133°29.936	CTD-Rosette ↑	13	021	80	10	9.6	6.82	1027.7	95	0/10
2b	290	Malina	04/Aug/2009	06h15	UTC-6	70°40.386	130°26.049	CTD ↓	33	259	40	15	6.9	5.52	1026.3	89	0/10
2b	290	Malina	04/Aug/2009	06h29	UTC-6	70°40.265	130°26.191	CTD ↑	32	293	30	11	6.2	5.52	1026.4	93	0/10
2b	280	Malina	04/Aug/2009	08h50	UTC-6	70°52.163	130°30.428	Barge Deployed (optics)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2b	280	Malina	04/Aug/2009	08h53	UTC-6	70°52.168	130°30.394	CTD-Rosette ↓	42	236	38	5	6.3	5.46	1026.7	91	0/10
2b	280	Malina	04/Aug/2009	09h10	UTC-6	70°52.154	130°30.730	CTD-Rosette ↑	41	216	77	7	5.5	5.43	1026.6	94	0/10
2b	280	Malina	04/Aug/2009	09h30	UTC-6	70°52.213	130°29.463	IOPs ↓	41	125	67	11	5.3	5.40	1026.6	95	0/10
2b	280	Malina	04/Aug/2009	09h40	UTC-6	70°52.195	130°29.648	IOPs ↑	41	194	94	10	5.2	5.38	1026.3	94	0/10
2b	280	Malina	04/Aug/2009	10h28	UTC-6	70°52.264	130°30.407	CTD-Rosette ↓	42	330	60	8	5.5	5.32	1026.0	95	0/10
2b	280	Malina	04/Aug/2009	10h45	UTC-6	70°52.347	130°30.781	CTD-Rosette ↑	42	342	55	7	6.0	5.30	1026.1	93	0/10
2b	280	Malina	04/Aug/2009	11h10	UTC-6	70°52.521	130°31.309	Barge Recovered (optics)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2b	280	Malina	04/Aug/2009	12h07	UTC-6	70°52.827	130°31.692	CTD-Rosette ↓	42	354	110	2	5.7	5.31	1027.0	92	0/10
2b	280	Malina	04/Aug/2009	12h10	UTC-6	70°52.858	130°31.728	Above Water Radiometry	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2b	280	Malina	04/Aug/2009	12h26	UTC-6	70°52.902	130°31.756	CTD-Rosette ↑	42	316	55	4	6.3	5.31	1025.9	90	0/10
2b	270	Malina	04/Aug/2009	13h50	UTC-6	71°04.416	130°32.871	CTD-Rosette ↓	56	312	63	6	5.5	5.10	1025.2	93	0/10
2b	270	Malina	04/Aug/2009	14h03	UTC-6	71°04.459	130°32.858	CTD-Rosette ↑	51	336	28	2	6.7	5.00	1025.1	86	0/10

Appendix 2 - Scientific log of activities conducted during the 2009 ArcticNet Expedition

Leg	Station ID	Station Type	Local Date	Local Time	UTC to local	Latitude (N)	Longitude (W)	Activity	Depth (m)	Heading (°)	Wind		Air (ºC)	Water (ºC)	Pr Baro	Hum (%)	Ice
											Dir	Speed					
2b	260	Malina	04/Aug/2009	15h21	UTC-6	71°16.142	130°36.642	Barge Deployed (optics)	59	262	336	6	5.5	4.99	1025.1	95	0/10
2b	260	Malina	04/Aug/2009	16h01	UTC-6	71°16.015	130°36.528	CTD-Rosette ↓	58	172	0	3	6.2	5.15	1024.9	90	0/10
2b	260	Malina	04/Aug/2009	16h19	UTC-6	71°15.924	130°36.303	CTD-Rosette ↑	57	112	10	3	6.1	5.2	1024.9	90	0/10
2b	260	Malina	04/Aug/2009	16h43	UTC-6	71°15.854	130°36.163	IOPs ↓	58	137	30	5	5.4	5.2	1024.7	94	0/10
2b	260	Malina	04/Aug/2009	16h50	UTC-6	71°15.812	130°36.080	IOPs ↑	58	123	30	2	5.8	5.2	1024.8	92	0/10
2b	260	Malina	04/Aug/2009	16h56	UTC-6	71°15.777	130°36.013	UV Profile ↓	58	132	30	3	5.7	5.2	1024.5	92	0/10
2b	260	Malina	04/Aug/2009	17h21	UTC-6	71°15.886	130°35.551	UV Profile ↑	58	220	20	3	7.2	5.2	1024.4	84	0/10
2b	260	Malina	04/Aug/2009	17h49	UTC-6	71°15.886	130°36.800	CTD-Rosette ↓	59	285	30	4	6.4	5.2	1024.3	91	0/10
2b	260	Malina	04/Aug/2009	18h22	UTC-6	71°16.005	130°36.984	CTD-Rosette ↑	59	316	70	5	8.6	5.2	1023.8	80	0/10
2b	260	Malina	04/Aug/2009	18h39	UTC-6	71°15.936	130°37.278	Above Water Radiometry	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2b	260	Malina	04/Aug/2009	18h40	UTC-6	71°15.934	130°37.292	Barge Recovered (optics)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2b	260	Malina	04/Aug/2009	19h08	UTC-6	71°15.999	130°36.700	Horizontal Net Tow ↓	59	61	30	7	5.6	5.4	1023.5	92	0/10
2b	260	Malina	04/Aug/2009	19h26	UTC-6	71°16.104	130°37.318	Horizontal Net Tow ↑	59	220	80	1	5.7	5.4	1023.3	93	0/10
2b	260	Malina	04/Aug/2009	19h51	UTC-6	71°15.852	130°37.920	Vertical Net Tow ↓	59	197	40	3	7.3	5.4	1023.0	87	0/10
2b	260	Malina	04/Aug/2009	20h00	UTC-6	71°15.858	130°37.946	Vertical Net Tow ↑	60	225	30	6	6.0	5.4	1022.8	91	0/10
2b	260	Malina	04/Aug/2009	20h33	UTC-6	71°16.164	130°36.760	Box Core ↓	60	63	50	6	5.9	5.3	1022.4	92	0/10
2b	260	Malina	04/Aug/2009	20h36	UTC-6	71°16.155	130°36.777	Box Core ↑	60	73	44	7	5.9	5.3	1022.4	92	0/10
2b	250	Malina	04/Aug/2009	22h20	UTC-6	71°28.315	130°41.721	CTD ↓	219	10	93	10	6.4	5.6	1021.0	92	0/10
2b	250	Malina	04/Aug/2009	22h43	UTC-6	71°28.515	130°42.480	CTD ↑	219	8	101	9	5.6	5.6	1020.7	94	0/10
2b	240	Malina	04/Aug/2009	00h15	UTC-6	71°40.354	130°44.418	CTD ↓	462	277	88	7	3.5	4.3	1019.9	97	0/10
2b	240	Malina	04/Aug/2009	00h42	UTC-6	71°40.475	130°44.619	CTD ↑	468	339	93	8	4.7	4.0	1014.7	93	0/10
2b	230	Malina	05/Aug/2009	02h00	UTC-6	71°51.979	130°50.142	CTD ↓	704	324	93	8	5.0	3.8	1019.0	93	0/10
2b	230	Malina	05/Aug/2009	02h34	UTC-6	71°51.934	130°51.290	CTD ↑	712	12	109	10	5.0	3.9	1018.6	92	0/10
2b	220	Malina	05/Aug/2009	04h10	UTC-6	72°03.495	130°53.527	CTD ↓	899	19	125	14	2.3	2.6	1017.7	99	7/10
2b	220	Malina	05/Aug/2009	04h33	UTC-6	72°03.512	130°54.269	CTD ↑	905	40	130	11	2.4	1.9	1017.5	99	7/10
2b	220	Malina	05/Aug/2009	08h11	UTC-6	72°03.737	130°49.471	CTD-Rosette ↓	834	53	130	13	2.7	1.9	1015.0	99	0/10
2b	220	Malina	05/Aug/2009	08h42	UTC-6	72°03.024	130°50.456	CTD-Rosette ↑	852	39	123	14	3.0	2.1	1014.6	99	0/10
2b	220	Malina	05/Aug/2009	08h55	UTC-6	72°03.143	130°51.014	IOPs ↓	860	42	129	14	3.0	2.0	1014.4	99	0/10
2b	220	Malina	05/Aug/2009	09h25	UTC-6	72°03.198	130°51.978	IOPs ↑	876	202	121	12	3.1	1.6	1014.3	99	0/10
2b	220	Malina	05/Aug/2009	09h25	UTC-6	72°03.170	130°52.157	Above Water Radiometry	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2b	220	Malina	05/Aug/2009	09h44	UTC-6	72°03.225	130°52.565	CTD-Rosette ↓	880	33	135	11	3.6	1.6	1014.2	99	0/10
2b	220	Malina	05/Aug/2009	10h20	UTC-6	72°03.448	130°53.643	CTD-Rosette ↑	892	26	108	12	3.2	1.5	1013.8	99	0/10
2b	220	Malina	05/Aug/2009	10h55	UTC-6	72°03.567	130°55.061	Barge Deployed (optics)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0/10
2b	220	Malina	05/Aug/2009	11h28	UTC-6	72°02.991	130°56.621	CTD-Rosette ↓	919	352	108	12	2.5	1.7	1012.9	99	0/10
2b	220	Malina	05/Aug/2009	12h04	UTC-6	72°03.033	130°57.968	CTD-Rosette ↑	940	14	115	14	3.2	1.4	1012.5	99	0/10
2b	220	Malina	05/Aug/2009	12h40	UTC-6	72°02.602	130°54.663	UV Profile ↓	892	163	111	16	3.4	1.1	1011.9	99	2/10
2b	220	Malina	05/Aug/2009	12h51	UTC-6	72°02.745	130°55.297	UV Profile ↑	899	70	109	14	3.7	1.2	1011.8	99	2/10
2b	220	Malina	05/Aug/2009	13h00	UTC-6	72°02.843	130°55.577	Barge Recovered (optics)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2b	240	Malina	05/Aug/2009	15h42	UTC-6	72°40.507	130°44.632	Barge Deployed (optics)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2b	240	Malina	05/Aug/2009	16h07	UTC-6	71°40.270	130°43.596	CTD-Rosette ↓	459	340	110	14	4.9	3.4	1009.7	96	0/10
2b	240	Malina	05/Aug/2009	16h46	UTC-6	71°40.513	130°44.160	CTD-Rosette ↑	458	30	130	14	5.6	3.6	1009.3	92	0/10
2b	240	Malina	05/Aug/2009	17h00	UTC-6	71°40.523	130°44.523	IOPs ↓	463	237	125	15	4.9	3.7	1009.2	94	0/10
2b	240	Malina	05/Aug/2009	17h29	UTC-6	71°40.826	130°44.375	IOPs ↑	466	263	115	11	4.3	3.7	1009.2	97	0/10
2b	240	Malina	05/Aug/2009	17h55	UTC-6	71°40.655	130°44.180	Barge Recovered (optics)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2b	240	Malina	05/Aug/2009	18h23	UTC-6	71°40.297	130°44.086	CTD-Rosette ↓	457	0	120	16	4.9	4.0	1008.5	95	0/10

Appendix 2 - Scientific log of activities conducted during the 2009 ArcticNet Expedition

Leg	Station ID	Station Type	Local Date	Local Time	UTC to local	Latitude (N)	Longitude (W)	Activity	Depth (m)	Heading (°)	Wind		Air (ºC)	Water (ºC)	Pr Baro	Hum (%)	Ice
											Dir	Speed					
2b	240	Malina	05/Aug/2009	19h16	UTC-6	71°40.732	130°40.839	CTD-Rosette ↑	475	33	110	9	4.7	4.2	1008.2	96	0/10
2b	240	Malina	05/Aug/2009	19h36	UTC-6	71°40.330	130°44.707	Horizontal Net Tow ↓	465	241	110	8	4.7	4.2	1008.2	96	0/10
2b	240	Malina	05/Aug/2009	19h51	UTC-6	71°40.127	130°45.080	Horizontal Net Tow ↑	476	72	120	7	4.9	4.1	1008.2	95	0/10
2b	240	Malina	05/Aug/2009	19h54	UTC-6	71°40.127	130°45.007	Above Water Radiometry	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2b	240	Malina	05/Aug/2009	20h11	UTC-6	71°40.126	130°45.071	Vertical Net Tow ↓	477	231	130	10	4.9	4.2	1008.2	95	0/10
2b	240	Malina	05/Aug/2009	20h46	UTC-6	71°40.228	130°45.235	Vertical Net Tow ↑	478	237	125	7	5.0	4.2	1008.0	94	0/10
2b	240	Malina	05/Aug/2009	21h35	UTC-6	71°40.239	130°44.320	Thorium Pumping ↓	468	178	230	4	5.6	4.3	1007.8	94	0/10
2b	240	Malina	05/Aug/2009	22h57	UTC-6	71°39.800	130°43.864	Thorium Pumping ↑	449	47	320	15	3.9	4.2	1007.9	96	0/10
2b	110	Malina	05/Aug/2009	05h04	UTC-6	71°42.067	126°28.953	CTD ↓	401	261	350	7	4.5	5.5	1008.5	99	0/10
2b	110	Malina	05/Aug/2009	05h37	UTC-6	71°41.930	126°28.638	CTD ↑	398	224	350	11	5.1	5.5	1008.8	99	0/10
2b	110	Malina	06/Aug/2009	06h40	UTC-6	71°41.816	126°28.669	Box Core ↓	400	164	5	14	3.8	5.4	1009.1	98	0/10
2b	110	Malina	06/Aug/2009	06h59	UTC-6	71°41.751	126°28.620	Box Core ↑	400	113	35	16	3.6	5.4	1009.2	99	0/10
2b	110	Malina	06/Aug/2009	07h32	UTC-6	71°41.938	126°28.820	CTD-Rosette ↓	399	233	350	17	4.1	5.4	1009.6	99	0/10
2b	110	Malina	06/Aug/2009	08h07	UTC-6	71°41.186	126°28.274	CTD-Rosette ↑	422	275	340	17	4.3	5.3	1009.9	99	0/10
2b	110	Malina	06/Aug/2009	08h34	UTC-6	71°41.992	126°29.005	IOPs ↓	401	83	340	24	3.2	5.4	1009.9	99	0/10
2b	110	Malina	06/Aug/2009	09h04	UTC-6	71°41.539	126°29.006	Above Water Radiometry	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2b	110	Malina	06/Aug/2009	09h05	UTC-6	71°41.435	126°28.939	IOPs ↑	416	327	335	17	3.9	5.3	1010.3	99	0/10
2b	110	Malina	06/Aug/2009	09h23	UTC-6	71°42.055	126°28.788	CTD-Rosette ↓	397	160	339	17	3.1	5.5	1010.4	99	0/10
2b	110	Malina	06/Aug/2009	10h01	UTC-6	71°42.760	126°28.658	CTD-Rosette ↑	397	131	347	23	3.1	5.4	1011.0	98	0/10
2b	110	Malina	06/Aug/2009	10h28	UTC-6	71°41.037	126°28.126	Barge Deployed (optics)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2b	110	Malina	06/Aug/2009	11h30	UTC-6	N/A	N/A	Above Water Radiometry	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2b	110	Malina	06/Aug/2009	11h40	UTC-6	N/A	N/A	Barge Recovered (optics)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2b	110	Malina	06/Aug/2009	12h00	UTC-6	71°41.833	126°28.661	CTD-Rosette ↓	401	177	345	22	3.2	5.2	1012.1	93	0/10
2b	110	Malina	06/Aug/2009	12h38	UTC-6	71°41.665	126°28.806	CTD-Rosette ↑	407	166	346	21	5.1	5.2	1012.9	87	0/10
2b	110	Malina	06/Aug/2009	12h55	UTC-6	71°41.821	126°29.744	Above Water Radiometry	414	297	347	25	4.2	5.2	1012.4	89	0/10
2b	110	Malina	06/Aug/2009	13h30	UTC-6	71°41.428	126°31.454	UV Profile ↓	442	171	336	25	2.6	5.3	1013.3	95	0/10
2b	110	Malina	06/Aug/2009	13h42	UTC-6	71°41.588	126°31.639	UV Profile ↑	442	162	338	18	4.5	5.4	1013.6	87	0/10
2b	110	Malina	06/Aug/2009	14h22	UTC-6	71°42.158	126°29.712	Barge Deployed (optics)	405	243	347	26	2.4	5.4	1013.9	96	0/10
2b	110	Malina	06/Aug/2009	15h29	UTC-6	71°40.965	126°30.521	Barge Recovered (optics)	453	265	331	24	3.2	4.9	1014.8	90	0/10
2b	120	Malina	06/Aug/2009	16h51	UTC-6	71°33.875	126°54.581	CTD ↓	419	167	340	18	1.4	5.5	1015.7	91	0/10
2b	120	Malina	06/Aug/2009	17h16	UTC-6	71°33.861	126°54.268	CTD ↑	421	162	350	17	4.5	5.5	1015.9	78	0/10
2b	130	Malina	06/Aug/2009	18h46	UTC-6	71°25.628	127°21.980	CTD-Rosette ↓	311	169	330	22	0.9	5.7	1016.4	91	0/10
2b	130	Malina	06/Aug/2009	19h35	UTC-6	71°25.565	127°21.276	CTD-Rosette ↑	310	136	350	16	0.4	5.6	1016.7	92	0/10
2b	130	Malina	06/Aug/2009	19h41	UTC-6	71°25.487	127°20.030	Above Water Radiometry	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2b	130	Malina	06/Aug/2009	19h57	UTC-6	71°25.521	127°20.091	AOP ↓	318	68	350	22	0.4	5.7	1016.8	93	0/10
2b	130	Malina	06/Aug/2009	20h25	UTC-6	71°25.200	127°18.932	AOP ↑	320	66	340	19	0.2	5.8	1016.9	93	0/10
2b	130	Malina	06/Aug/2009	20h43	UTC-6	71°25.390	127°21.625	IOPs ↓	309	171	350	15	0.5	5.8	1016.7	93	0/10
2b	130	Malina	06/Aug/2009	21h10	UTC-6	71°25.295	127°21.202	IOPs ↑	311	140	350	20	0.5	5.6	1017.1	92	0/10
2b	130	Malina	06/Aug/2009	21h27	UTC-6	71°25.437	127°21.423	CTD-Rosette ↓	310	175	330	16	0.3	5.6	1017.1	93	0/10
2b	130	Malina	06/Aug/2009	21h59	UTC-6	71°25.109	127°20.847	CTD-Rosette ↑	310	167	325	13	3.4	5.5	1017.2	79	0/10
2b	130	Malina	06/Aug/2009	22h14	UTC-6	71°24.776	127°20.418	Horizontal Net Tow ↓	311	82	335	14	3.0	5.5	1017.2	84	0/10
2b	130	Malina	06/Aug/2009	22h26	UTC-6	71°24.776	127°19.200	Horizontal Net Tow ↑	317	57	350	18	1.1	5.6	1017.2	90	0/10
2b	130	Malina	06/Aug/2009	22h58	UTC-6	71°25.346	127°21.606	Vertical Net Tow ↓	310	162	340	11	0.3	5.8	1017.2	94	0/10
2b	130	Malina	06/Aug/2009	23h21	UTC-6	71°25.310	127°21.768	Vertical Net Tow ↑	308	164	345	11	0.0	5.4	1017.4	94	0/10
2b	130	Malina	06/Aug/2009	00h15	UTC-6	71°25.289	127°22.414	Thorium Pumping ↓	307	353	332	10	1.0	5.3	1017.3	90	0/10

Appendix 2 - Scientific log of activities conducted during the 2009 ArcticNet Expedition

Leg	Station ID	Station Type	Local Date	Local Time	UTC to local	Latitude (N)	Longitude (W)	Activity	Depth (m)	Heading (°)	Wind		Air (ºC)	Water (ºC)	Pr Baro	Hum (%)	Ice
											Dir	Speed					
2b	130	Malina	06/Aug/2009	01h23	UTC-6	71°25.082	127°22.320	Thorium Pumping ↑	302	78	334	10	-0.2	5.3	1017.3	92	0/10
2b	130	Malina	07/Aug/2009	01h50	UTC-6	71°25.127	127°22.441	Provbio Float Deployed	304	264	329	11	-0.1	5.3	1017.4	93	0/10
2b	140	Malina	07/Aug/2009	03h00	UTC-6	71°17.033	127°47.357	CTD-Rosette ↓	151	154	336	6	1.3	5.2	1017.6	91	0/10
2b	140	Malina	07/Aug/2009	03h23	UTC-6	71°17.030	127°47.531	CTD-Rosette ↑	149	186	335	8	1.3	5.2	1017.4	89	0/10
2b	140	Malina	07/Aug/2009	03h47	UTC-6	71°17.082	127°46.980	Box Core ↓	151	54	314	8	1.1	5.3	1017.3	90	0/10
2b	140	Malina	07/Aug/2009	03h53	UTC-6	71°17.083	127°46.992	Box Core ↑	154	60	323	9	0.4	5.3	1017.3	92	0/10
2b	140	Malina	07/Aug/2009	04h00	UTC-6	71°17.085	127°46.942	Box Core ↓	151	49	325	7	0.4	5.3	1017.9	92	0/10
2b	140	Malina	07/Aug/2009	04h10	UTC-6	71°17.090	127°46.923	Box Core ↑	154	45	325	7	0.4	5.3	1017.3	93	0/10
2b	150	Malina	07/Aug/2009	05h11	UTC-6	71°09.668	128°09.650	CTD ↓	66	189	305	5	1.3	4.9	1017.0	90	0/10
2b	150	Malina	07/Aug/2009	05h30	UTC-6	71°09.541	128°09.601	CTD ↑	66	181	280	4	2.6	4.6	1016.9	84	0/10
2b	160	Malina	07/Aug/2009	06h35	UTC-6	71°03.044	128°29.812	CTD-Rosette ↓	43	166	225	4	1.0	4.4	1016.7	93	0/10
2b	160	Malina	07/Aug/2009	06h54	UTC-6	71°02.939	128°29.791	CTD-Rosette ↑	44	166	280	6	2.0	4.3	1016.3	88	0/10
2b	170	Malina	07/Aug/2009	08h35	UTC-6	70°54.845	128°55.101	CTD-Rosette ↓	35	317	233	4	0.7	4.4	1016.0	94	0/10
2b	170	Malina	07/Aug/2009	08h51	UTC-6	70°54.729	128°55.261	CTD-Rosette ↑	36	9	244	4	0.7	4.4	1015.8	95	0/10
2b	170	Malina	07/Aug/2009	09h09	UTC-6	70°54.999	128°54.974	IOPs ↓	38	68	235	5	0.7	4.5	1013.4	94	0/10
2b	170	Malina	07/Aug/2009	09h24	UTC-6	70°54.899	128°54.944	IOPs ↑	36	161	243	7	1.9	4.5	1015.5	89	0/10
2b	170	Malina	07/Aug/2009	10h08	UTC-6	70°54.916	128°55.405	CTD-Rosette ↓	35	153	269	7	2.2	4.6	1015.3	89	0/10
2b	170	Malina	07/Aug/2009	10h23	UTC-6	70°54.861	128°55.557	CTD-Rosette ↑	35	161	241	6	1.9	4.5	1015.0	92	0/10
2b	170	Malina	07/Aug/2009	10h28	UTC-6	70°54.783	128°55.819	Above Water Radiometry	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2b	170	Malina	07/Aug/2009	11h15	UTC-6	70°55.045	128°55.060	Barge Deployed (optics)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2b	170	Malina	07/Aug/2009	11h38	UTC-6	70°55.044	128°55.122	CTD-Rosette ↓	35	24	255	7	1.6	4.8	1015.1	90	0/10
2b	170	Malina	07/Aug/2009	11h53	UTC-6	70°55.097	128°55.342	CTD-Rosette ↑	37	342	253	7	1.6	4.8	1014.8	90	0/10
2b	170	Malina	07/Aug/2009	12h34	UTC-6	70°55.030	128°54.955	Above Water Radiometry	36	3	275	8	2.2	4.9	1014.6	88	0/10
2b	170	Malina	07/Aug/2009	12h54	UTC-6	70°55.045	128°55.290	UV Profile ↓ (canceled)	36	35	295	10	1.9	4.8	1014.5	88	0/10
2b	170	Malina	07/Aug/2009	12h59	UTC-6	70°55.057	128°55.495	UV Profile ↓	37	77	280	10	1.9	4.7	1014.4	88	0/10
2b	170	Malina	07/Aug/2009	13h11	UTC-6	70°55.071	128°56.633	UV Profile ↑	36	131	285	10	2.6	4.7	1014.4	85	0/10
2b	170	Malina	07/Aug/2009	13h25	UTC-6	70°55.085	128°56.724	Barge Recovered (optics)	36	203	302	9	3.2	4.5	1014.4	84	0/10
2b	150	Malina	07/Aug/2009	16h10	UTC-6	71°09.716	128°08.727	Barge Deployed (optics)	68	165	285	17	2.0	4.6	1012.7	95	0/10
2b	150	Malina	07/Aug/2009	16h20	UTC-6	71°09.644	128°08.040	IOPs ↓	68	128	280	17	2.6	4.7	1012.6	90	0/10
2b	150	Malina	07/Aug/2009	16h32	UTC-6	71°09.624	128°07.764	IOPs ↑	68	39	270	14	2.5	4.7	1012.6	88	0/10
2b	150	Malina	07/Aug/2009	16h52	UTC-6	71°09.745	128°09.691	CTD-Rosette ↓	66	124	275	12	1.9	4.9	1012.3	89	0/10
2b	150	Malina	07/Aug/2009	17h16	UTC-6	71°09.713	128°09.035	CTD-Rosette ↑	67	168	300	13	3.9	4.7	1012.3	82	0/10
2b	150	Malina	07/Aug/2009	18h31	UTC-6	71°09°100	128°08.448	Barge Recovered (optics)	64	234	315	15	3.3	4.6	1012.0	84	0/10
2b	150	Malina	07/Aug/2009	19h02	UTC-6	71°09.801	128°09.788	CTD-Rosette ↓	66	210	345	20	2.3	4.8	1012.6	88	0/10
2b	150	Malina	07/Aug/2009	19h20	UTC-6	N/A	N/A	Above Water Radiometry	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2b	150	Malina	07/Aug/2009	19h26	UTC-6	71°09.121	128°09.635	CTD-Rosette ↑	65	260	340	19	2.2	4.6	1011.9	90	0/10
2b	150	Malina	07/Aug/2009	19h39	UTC-6	71°08.951	128°09.505	UV Profile ↓	65	110	340	N/A	1.8	4.5	1012.0	92	0/10
2b	150	Malina	07/Aug/2009	19h55	UTC-6	71°08.576	128°08.967	UV Profile ↑	64	68	345	20	1.3	4.6	1012.7	94	0/10
2b	390	Malina	08/Aug/2009	05h31	UTC-6	70°10.643	133°33.635	CTD ↓	47	240	115	4	0.6	6.3	1018.0	89	0/10
2b	390	Malina	08/Aug/2009	05h46	UTC-6	70°10.638	133°33.622	CTD ↑	47	271	155	Calm	0.6	6.2	1017.9	90	0/10
2b	380	Malina	08/Aug/2009	07h07	UTC-6	70°23.782	133°36.552	CTD-Rosette ↓	63	14	140	Calm	0.2	5.5	1017.7	90	1/10
2b	380	Malina	08/Aug/2009	07h32	UTC-6	70°23.815	133°36.450	CTD-Rosette ↑	63	73	165	Calm	0.2	5.4	1017.6	86	0/10
2b	380	Malina	08/Aug/2009	08h12	UTC-6	70°23.810	133°36.184	IOPs ↓	63	110	180	4	0.2	5.4	1017.3	89	1/10
2b	380	Malina	08/Aug/2009	08h24	UTC-6	70°23.790	133°36.103	IOPs ↑	62	113	167	3	0.7	5.4	1017.3	89	1/10
2b	380	Malina	08/Aug/2009	08h45	UTC-6	70°23.720	133°35.885	Above Water Radiometry	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Appendix 2 - Scientific log of activities conducted during the 2009 ArcticNet Expedition

Leg	Station ID	Station Type	Local Date	Local Time	UTC to local	Latitude (N)	Longitude (W)	Activity	Depth (m)	Heading (°)	Wind		Air (ºC)	Water (ºC)	Pr Baro	Hum (%)	Ice
											Dir	Speed					
2b	380	Malina	08/Aug/2009	08h48	UTC-6	70°23.769	133°35.964	CTD-Rosette ↓	62	113	179	5	0.9	5.4	1017.2	90	1/10
2b	380	Malina	08/Aug/2009	09h07	UTC-6	70°23.722	133°35.892	CTD-Rosette ↑	62	120	190	5	1.1	5.4	1017.1	90	1/10
2b	380	Malina	08/Aug/2009	09h42	UTC-6	70°23.570	133°35.681	Barge Deployed (optics)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2b	380	Malina	08/Aug/2009	10h01	UTC-6	70°23.534	133°35.637	Above Water Radiometry	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2b	380	Malina	08/Aug/2009	10h08	UTC-6	70°23.557	133°35.686	CTD-Rosette ↓	63	95	171	5	1.6	5.6	1017.0	90	1/10
2b	380	Malina	08/Aug/2009	10h27	UTC-6	70°23.518	133°35.649	CTD-Rosette ↑	62	108	188	5	1.9	5.5	1016.8	87	1/10
2b	380	Malina	08/Aug/2009	10h40	UTC-6	70°23.500	133°35.739	UV Profile ↓	62	95	187	6	2.0	5.5	1016.5	89	1/10
2b	380	Malina	08/Aug/2009	11h05	UTC-6	70°23.184	133°37.785	UV Profile ↑	63	23	162	5	3.3	5.3	1016.4	82	1/10
2b	380	Malina	08/Aug/2009	11h39	UTC-6	70°25.003	133°37.250	Barge Recovered (optics)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2b	370	Malina	08/Aug/2009	13h03	UTC-6	70°35.950	133°38.967	CTD ↓	75	297	87	6	1.5	4.6	1015.8	92	1/10
2b	370	Malina	08/Aug/2009	13h21	UTC-6	70°35.898	133°39.112	CTD ↑	71	278	117	7	1.2	4.2	1015.7	92	1/10
2b	360	Malina	08/Aug/2009	15h02	UTC-6	70°48.093	133°42.964	Barge Deployed (optics)	78	29	150	8	1.7	2.8	1014.6	93	1/10
2b	360	Malina	08/Aug/2009	15h18	UTC-6	70°48.165	133°43.089	IOPs ↓	79	19	145	8	2.4	2.7	1014.4	89	2/10
2b	360	Malina	08/Aug/2009	15h32	UTC-6	70°48.228	133°43.249	IOPs ↑	79	56	151	8	3.5	2.7	1014.1	84	2/10
2b	360	Malina	08/Aug/2009	15h51	UTC-6	70°48.018	133°43.695	CTD-Rosette ↓	78	322	138	7	2.0	2.5	1014.0	91	2/10
2b	360	Malina	08/Aug/2009	16h15	UTC-6	70°48.052	133°44.339	CTD-Rosette ↑	77	233	145	7	1.8	2.2	1013.9	93	2/10
2b	360	Malina	08/Aug/2009	16h35	UTC-6	70°48.053	133°44.725	UV Profile ↓	77	275	141	10	1.8	2.0	1013.9	93	2/10
2b	360	Malina	08/Aug/2009	16h37	UTC-6	70°48.053	133°44.725	Above Water Radiometry	77	275	141	10	1.8	2.0	1013.9	93	2/10
2b	360	Malina	08/Aug/2009	16h50	UTC-6	70°47.846	133°44.293	Above Water Radiometry	76	355	132	9	2.4	2.0	1013.5	92	2/10
2b	360	Malina	08/Aug/2009	16h53	UTC-6	70°47.846	133°44.293	UV Profile ↑	76	355	132	9	2.4	2.0	1013.5	92	2/10
2b	360	Malina	08/Aug/2009	17h30	UTC-6	70°48.130	133°43.892	CTD-Rosette ↓	76	23	141	8	3.2	1.8	1013.1	90	2/10
2b	360	Malina	08/Aug/2009	17h53	UTC-6	70°48.200	133°44.029	CTD-Rosette ↑	76	51	144	8	3.3	1.7	1011.0	90	2/10
2b	360	Malina	08/Aug/2009	18h10	UTC-6	70°48.254	133°43.980	Barge Recovered (optics)	76	60	143	8	2.4	1.6	1010.9	94	2/10
2b	350	Malina	08/Aug/2009	22h18	UTC-6	70°58.291	133°44.036	CTD ↓	91	4	138	10	1.9	1.5	1010.4	97	6/10
2b	350	Malina	08/Aug/2009	22h36	UTC-6	70°58.291	133°44.016	CTD ↑	91	46	142	10	2.4	1.2	1010.3	95	6/10
2b	340	Malina	09/Aug/2009	00h16	UTC-6	71°10.368	133°49.865	CTD ↓	575	291	124	12	1.7	1.7	1009.0	98	1/10
2b	340	Malina	09/Aug/2009	00h45	UTC-6	71°10.439	133°50.626	CTD ↑	571	343	122	13	1.9	1.4	1008.8	97	1/10
2b	330	Malina	09/Aug/2009	02h00	UTC-6	71°22.377	133°53.373	CTD ↓	1086	347	140	12	2.8	1.8	1008.0	92	1/10
2b	330	Malina	09/Aug/2009	02h43	UTC-6	71°22.456	133°54.647	CTD ↑	1094	342	130	16	2.0	1.8	1007.5	94	1/10
2b	320	Malina	09/Aug/2009	04h07	UTC-6	71°34.322	133°56.131	CTD ↓	1156	301	120	13	1.8	1.93	1007.5	96	5/10
2b	320	Malina	09/Aug/2009	04h51	UTC-6	71°34.183	133°56.846	CTD ↑	1154	359	120	13	1.9	1.25	1006.9	95	5/10
2b	310	Malina	09/Aug/2009	06h31	UTC-6	71°44.551	133°57.056	CTD ↓	1614	349	115	14	1.8	1.15	1006.4	97	6/10
2b	310	Malina	09/Aug/2009	07h12	UTC-6	71°44.632	133°56.481	CTD ↑	1615	358	125	15	1.7	0.65	1006.2	97	6/10
2b	320	Malina	09/Aug/2009	09h00	UTC-6	71°34.330	133°56.944	CTD-Rosette ↓	1159	295	130	13	2.4	0.74	1005.7	98	5/10
2b	320	Malina	09/Aug/2009	09h28	UTC-6	71°34.177	133°57.603	CTD-Rosette ↑	1157	323	155	11	1.6	0.62	1005.6	98	5/10
2b	320	Malina	09/Aug/2009	09h52	UTC-6	71°34.224	133°56.277	IOPs ↓	1156	282	165	11	1.7	0.65	1005.6	99	5/10
2b	320	Malina	09/Aug/2009	10h20	UTC-6	71°34.050	133°56.666	IOPs ↑	1146	283	195	7	1.0	0.61	1005.7	99	5/10
2b	320	Malina	09/Aug/2009	10h56	UTC-6	71°33.827	133°57.223	CTD-Rosette ↓	1141	194	245	6	0.5	0.95	1005.8	99	5/10
2b	320	Malina	09/Aug/2009	10h43	UTC-6	71°33.798	133°57.257	Barge Deployed (optics)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2b	320	Malina	09/Aug/2009	11h40	UTC-6	71°33.508	133°57.690	CTD-Rosette ↑	1134	154	265	10	1.1	0.65	1005.9	99	5/10
2b	320	Malina	09/Aug/2009	12h51	UTC-6	71°33.841	133°57.038	CTD-Rosette ↓	1143	102	262	9	1.0	0.80	1006.1	99	4/10
2b	320	Malina	09/Aug/2009	13h30	UTC-6	71°33.530	133°57.558	CTD-Rosette ↑	1134	186	277	11	1.2	0.63	1006.2	98	4/10
2b	320	Malina	09/Aug/2009	13h42	UTC-6	71°33.373	133°57.665	Barge Recovered (optics)	1129	187	279	11	1.0	0.61	1006.3	98	4/10
2b	330	Malina	09/Aug/2009	15h25	UTC-6	71°22.219	133°53.081	CTD-Rosette ↓	1082	134	283	16	-0.1	1.58	1007.1	99	2/10
2b	330	Malina	09/Aug/2009	16h03	UTC-6	71°22.043	133°53.070	CTD-Rosette ↑	1074	145	280	14	2.1	1.51	1007.3	90	2/10

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Leg	Station ID	Station Type	Local Date	Local Time	UTC to local	Latitude (N)	Longitude (W)	Activity	Depth (m)	Heading (°)	Wind		Air (ºC)	Water (ºC)	Pr Baro	Hum (%)	Ice
											Dir	Speed					
2b	340	Malina	09/Aug/2009	17h44	UTC-6	71°10.341	133°49.554	CTD-Rosette ↓	578	255	295	7	0.0	1.65	1007.6	98	6/10
2b	340	Malina	09/Aug/2009	18h43	UTC-6	71°10.114	133°49.821	CTD-Rosette ↑	562	183	210	6	0.9	1.35	1007.9	96	6/10
2b	340	Malina	09/Aug/2009	18h58	UTC-6	71°10.070	133°49.922	Barge Deployed (optics)	560	179	280	6	0.9	1.36	1008.0	96	6/10
2b	340	Malina	09/Aug/2009	19h12	UTC-6	71°10.041	133°50.039	IOPs ↓	553	175	280	6	0.9	1.58	N/A	96	5/10
2b	340	Malina	09/Aug/2009	19h47	UTC-6	71°10.034	133°50.177	IOPs ↑	554	177	270	7	0.9	1.50	1008.2	96	5/10
2b	340	Malina	09/Aug/2009	20h03	UTC-6	71°10.045	133°50.184	CTD-Rosette ↓	553	180	280	7	0.8	1.57	1008.3	96	5/10
2b	340	Malina	09/Aug/2009	20h51	UTC-6	71°10.124	133°50.187	CTD-Rosette ↑	559	176	255	5	0.6	1.51	1008.5	97	5/10
2b	340	Malina	09/Aug/2009	21h00	UTC-6	71°09.424	133°50.140	Barge Recovered (optics)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2b	680	Malina	10/Aug/2009	10h40	UTC-6	69°36.351	138°14.094	CTD-Rosette ↓	125	132	305	13	3.8	5.76	1013.1	88	0/10
2b	680	Malina	10/Aug/2009	10h58	UTC-6	69°36.261	138°13.613	CTD-Rosette ↑	124	122	296	9	2.9	5.81	1013.1	91	0/10
2b	680	Malina	10/Aug/2009	11h30	UTC-6	69°36.647	138°14.174	Box Core ↓	125	113	303	10	2.5	5.94	1013.4	94	0/10
2b	680	Malina	10/Aug/2009	11h33	UTC-6	69°36.637	138°14.110	Box Core (bottom)	125	108	297	9	2.5	5.94	1013.4	94	0/10
2b	680	Malina	10/Aug/2009	11h37	UTC-6	69°36.632	138°14.009	Box Core ↑	126	72	310	13	2.5	5.94	1013.4	94	0/10
2b	670	Malina	10/Aug/2009	12h55	UTC-6	69°47.924	138°26.046	Barge Deployed (optics)	174	225	295	13	2.9	5.43	1013.6	92	0/10
2b	670	Malina	10/Aug/2009	13h16	UTC-6	69°47.835	138°26.173	CTD-Rosette ↓	174	125	290	13	3.4	5.16	1013.7	90	0/10
2b	670	Malina	10/Aug/2009	13h47	UTC-6	69°47.902	138°26.551	CTD-Rosette ↑	173	142	287	13	4.3	5.0	1014.1	86	0/10
2b	670	Malina	10/Aug/2009	14h04	UTC-6	69°47.978	138°26.732	IOPs ↓	175	50	283	12	5.3	4.92	1014.0	79	0/10
2b	670	Malina	10/Aug/2009	14h26	UTC-6	69°47.914	138°26.588	IOPs ↑	173	55	296	13	2.7	4.87	1014.2	93	0/10
2b	670	Malina	10/Aug/2009	14h29	UTC-6	69°47.925	138°26.229	Above Water Radiometry	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2b	670	Malina	10/Aug/2009	14h54	UTC-6	69°47.941	138°26.142	CTD-Rosette ↓	176	153	294	12	6.8	4.85	1014.6	76	0/10
2b	670	Malina	10/Aug/2009	15h30	UTC-6	69°48.073	138°25.722	CTD-Rosette ↑	175	102	308	16	5.7	4.77	1014.8	81	0/10
2b	670	Malina	10/Aug/2009	15h40	UTC-6	69°47.951	138°25.316	Barge Recovered (optics)	175	234	294	13	4.2	4.76	1014.8	83	0/10
2b	670	Malina	10/Aug/2009	16h00	UTC-6	69°47.802	138°24.987	UV Profile ↓	173	260	313	13	4.1	4.74	1014.9	85	0/10
2b	670	Malina	10/Aug/2009	16h15	UTC-6	69°47.785	138°24.092	UV Profile ↑	174	260	312	12	3.7	4.71	1014.9	87	0/10
2b	670	Malina	10/Aug/2009	16h46	UTC-6	69°47.829	138°25.660	CTD-Rosette ↓	173	89	305	10	4.5	4.62	1015.2	85	0/10
2b	670	Malina	10/Aug/2009	17h15	UTC-6	69°47.703	138°24.852	CTD-Rosette ↑	173	149	310	7	6.1	4.66	1015.4	78	0/10
2b	660	Malina	10/Aug/2009	18h42	UTC-6	69°59.127	138°39.368	Barge Deployed (optics)	268	254	340	11	3.6	4.92	1016.0	86	0/10
2b	660	Malina	10/Aug/2009	18h52	UTC-6	69°59.085	138°39.368	CTD-Rosette ↓	268	293	350	8	3.7	4.92	1016.0	86	0/10
2b	660	Malina	10/Aug/2009	19h41	UTC-6	69°58.669	138°37.239	CTD-Rosette ↑	264	208	330	10	4.4	4.91	1016.2	81	0/10
2b	660	Malina	10/Aug/2009	20h00	UTC-6	69°59.134	138°39.589	IOPs ↓	269	93	336	10	4.1	4.93	1016.0	83	0/10
2b	660	Malina	10/Aug/2009	20h27	UTC-6	69°58.838	138°39.199	IOPs ↑	266	116	324	8	3.2	4.90	1016.4	84	0/10
2b	660	Malina	10/Aug/2009	20h30	UTC-6	69°58.531	138°38.728	Barge Recovered (optics)	266	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2b	660	Malina	10/Aug/2009	21h09	UTC-6	69°58.241	138°38.289	CTD-Rosette ↓	261	242	342	6	4.3	4.82	1016.6	84	0/10
2b	660	Malina	10/Aug/2009	21h41	UTC-6	69°57.777	138°37.700	CTD-Rosette ↑	259	179	335	6	4.8	4.88	1016.7	81	0/10
2b	660	Malina	10/Aug/2009	21h50	UTC-6	69°57.634	138°37.560	UV Profile ↓	254	202	339	9	4.5	4.91	1016.8	83	0/10
2b	660	Malina	10/Aug/2009	22h06	UTC-6	69°57.992	138°37.661	UV Profile ↑	258	139	337	6	4.6	4.91	1016.8	83	0/10
2b	650	Malina	10/Aug/2009	23h32	UTC-6	70°10.115	138°54.506	CTD-Rosette ↓	375	203	319	10	2.3	3.30	1017.3	92	0/10
2b	650	Malina	10/Aug/2009	00h15	UTC-6	70°09.820	138°55.999	CTD-Rosette ↑	374	135	307	6	2.1	2.7	1017.7	97	0/10
2b	640	Malina	10/Aug/2009	01h30	UTC-6	70°20.394	139°08.624	CTD ↓	564	138	285	10	2.0	3.11	1018.1	96	0/10
2b	640	Malina	11/Aug/2009	01h56	UTC-6	70°20.450	139°09.119	CTD ↑	577	88	305	6	2.6	3.3	1018.3	93	0/10
2b	630	Malina	11/Aug/2009	03h06	UTC-6	71°31.962	139°22.725	CTD ↓	839	52	294	7	1.3	4.3	1018.4	98	0/10
2b	630	Malina	11/Aug/2009	03h43	UTC-6	70°32.327	139°23.148	CTD ↑	848	100	313	6	0.8	5.0	1018.7	97	0/10
2b	620	Malina	11/Aug/2009	05h04	UTC-6	70°42.197	139°36.514	CTD-Rosette ↓	1708	120	325	5	0.3	4.7	1019.3	99	8/10
2b	620	Malina	11/Aug/2009	06h14	UTC-6	70°42.305	139°36.512	CTD-Rosette ↑	1711	99	310	4	-1.5	3.4	1019.6	99	8/10
2b	610	Malina	11/Aug/2009	08h23	UTC-6	70°47.690	139°36.212	CTD-Rosette ↓	1823	225	342	5	0.0	1.3	1020.1	98	8/10

Appendix 2 - Scientific log of activities conducted during the 2009 ArcticNet Expedition

Leg	Station ID	Station Type	Local Date	Local Time	UTC to local	Latitude (N)	Longitude (W)	Activity	Depth (m)	Heading (°)	Wind Dir	Wind Speed	Air (ºC)	Water (ºC)	Pr Baro	Hum (%)	Ice
2b	610	Malina	11/Aug/2009	09h44	UTC-6	70°47.113	139°35.696	CTD-Rosette ↑	1819	251	4	4	-0.8	1.1	1020.4	98	8/10
2b	620	Malina	11/Aug/2009	11h05	UTC-6	70°41.250	139°36.057	Barge Deployed (optics)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2b	620	Malina	11/Aug/2009	11h14	UTC-6	70°41.491	139°36.303	UV Profile ↓	1672	315	2	6	0.0	0.6	1020.6	98	7/10
2b	620	Malina	11/Aug/2009	11h30	UTC-6	70°41.177	139°36.089	UV Profile ↑	1656	350	0	5	-1.0	0.7	1020.6	99	7/10
2b	620	Malina	11/Aug/2009	11h35	UTC-6	70°41.258	139°36.500	Above Water Radiometry	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2b	620	Malina	11/Aug/2009	12h38	UTC-6	70°40.908	139°37.299	CTD-Rosette ↓	1590	236	6	5	-0.1	1.2	1020.8	99	6/10
2b	620	Malina	11/Aug/2009	13h22	UTC-6	70°40.657	139°38.244	CTD-Rosette ↑	1544	297	2	6	-0.2	1.5	1021.0	98	6/10
2b	620	Malina	11/Aug/2009	13h44	UTC-6	70°40.463	139°38.238	Barge Recovered (optics)	1525	216	358	6	-0.1	1.6	1021.1	98	6/10
2b	620	Malina	11/Aug/2009	14h07	UTC-6	70°40.367	139°39.041	IOPs ↓	1516	4	3	6	0.6	1.9	1021.2	96	6/10
2b	620	Malina	11/Aug/2009	14h35	UTC-6	70°40.281	139°39.574	IOPs ↑	1504	132	02	4	-0.6	2.1	1021.3	98	6/10
2b	620	Malina	11/Aug/2009	14h50	UTC-6	70°40.077	139°39.382	CTD-Rosette ↓	1472	207	355	8	0.1	2.3	1021.2	97	5/10
2b	620	Malina	11/Aug/2009	15h32	UTC-6	70°40.049	139°39.999	CTD-Rosette ↑	1482	261	0	7	0.3	3.0	1021.3	96	5/10
2b	620	Malina	11/Aug/2009	16h44	UTC-6	70°40.419	139°37.982	CTD-Rosette ↓	1534	250	350	8	1.1	3.8	1021.1	93	3/10
2b	620	Malina	11/Aug/2009	17h20	UTC-6	70°40.457	139°38.457	CTD-Rosette ↑	1541	239	0	8	0.7	3.8	1021.1	96	2/10
2b	630	Malina	11/Aug/2009	18h47	UTC-6	70°31.880	139°22.486	CTD ↓	838	242	10	9	1.3	4.7	1020.6	96	0/10
2b	630	Malina	11/Aug/2009	19h26	UTC-6	70°32.168	139°23.032	CTD ↑	844	297	8	10	1.8	4.6	1020.3	96	0/10
2b	640	Malina	11/Aug/2009	20h45	UTC-6	70°20.362	139°08.302	CTD-Rosette ↓	573	264	4	10	1.7	3.7	1020.3	97	0/10
2b	640	Malina	11/Aug/2009	21h23	UTC-6	70°20.098	139°07.642	Above Water Radiometry	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2b	640	Malina	11/Aug/2009	21h27	UTC-6	70°20.196	139°07.875	CTD-Rosette ↑	568	266	351	12	2.3	3.4	1020.2	96	0/10
2b	640	Malina	11/Aug/2009	21h36	UTC-6	70°20.135	139°07.769	AOP Profile ↓	565	250	355	12	2.3	3.4	1020.1	96	0/10
2b	640	Malina	11/Aug/2009	22h18	UTC-6	70°20.163	139°06.484	AOP Profile ↑	563	230	359	11	2.5	3.4	1020.1	97	0/10
2b	640	Malina	11/Aug/2009	22h23	UTC-6	70°20.124	139°06.401	IOPs ↓	562	200	349	8	2.6	3.5	1020.1	97	0/10
2b	640	Malina	11/Aug/2009	22h53	UTC-6	70°20.068	139°06.132	IOPs ↑	557	105	357	13	1.6	3.5	1020.0	98	0/10
2b	640	Malina	11/Aug/2009	23h06	UTC-6	70°20.017	139°05.916	CTD-Rosette ↓	550	55	352	12	1.7	3.5	1019.9	99	0/10
2b	640	Malina	11/Aug/2009	23h10	UTC-6	70°20.000	139°05.850	CTD-Rosette ↑	551	66	357	13	1.7	3.5	1019.8	99	0/10
2b	640	Malina	11/Aug/2009	23h28	UTC-6	70°20.261	139°08.737	Horizontal Net Tow ↓	569	153	10	11	1.8	3.6	1019.5	99	0/10
2b	640	Malina	11/Aug/2009	23h37	UTC-6	70°20.002	139°08.215	Horizontal Net Tow ↑	565	117	359	11	1.9	3.5	1019.5	99	0/10
2b	640	Malina	11/Aug/2009	23h58	UTC-6	70°19.831	139°07.882	Vertical Net Tow ↓	560	48	349	12	1.8	3.6	1019.6	99	0/10
2b	640	Malina	11/Aug/2009	00h36	UTC-6	70°19.555	139°07.883	Vertical Net Tow ↑	555	42	4	13	1.9	3.7	1019.4	99	0/10
2b	640	Malina	11/Aug/2009	01h00	UTC-6	70°19.618	139°08.467	Thorium Pumping ↓	555	62	5	14	2.0	3.8	1019.2	99	0/10
2b	640	Malina	12/Aug/2009	02h12	UTC-6	70°19.180	139°09.877	Thorium Pumping ↑	536	130	18	14	1.6	3.7	1018.8	99	0/10
2b	760	Malina	12/Aug/2009	07h44	UTC-6	70°33.231	140°47.828	CTD ↓	578	110	58	6	0.6	1.7	1018.9	99	8/10
2b	760	Malina	12/Aug/2009	08h11	UTC-6	70°33.275	140°47.938	CTD ↑	578	176	46	5	0.4	1.6	1017.9	99	8/10
2b	760	Malina	12/Aug/2009	08h39	UTC-6	70°33.234	140°47.780	Above Water Radiometry	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2b	760	Malina	12/Aug/2009	08h50	UTC-6	70°33.234	140°47.784	Barge Deployed (optics)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2b	760	Malina	12/Aug/2009	09h18	UTC-6	70°33.239	140°47.785	CTD-Rosette ↓	577	175	58	6	0.4	1.6	1018.1	99	8/10
2b	760	Malina	12/Aug/2009	09h53	UTC-6	70°33.137	140°47.758	CTD-Rosette ↑	574	153	50	7	0.5	1.8	1017.7	99	8/10
2b	760	Malina	12/Aug/2009	10h07	UTC-6	70°33.057	140°47.710	IOPs ↓	574	139	50	6	0.5	1.8	1017.6	99	8/10
2b	760	Malina	12/Aug/2009	10h33	UTC-6	70°32.888	140°47.619	IOPs ↑	569	149	37	5	0.4	1.8	1017.6	99	8/10
2b	760	Malina	12/Aug/2009	10h46	UTC-6	70°32.822	140°47.618	CTD-Rosette ↓	566	173	38	4	0.4	1.8	1017.5	99	8/10
2b	760	Malina	12/Aug/2009	11h01	UTC-6	70°32.615	140°47.648	Above Water Radiometry	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2b	760	Malina	12/Aug/2009	11h27	UTC-6	70°32.574	140°47.671	CTD-Rosette ↑	559	141	38	6	0.5	1.9	1017.5	99	8/10
2b	760	Malina	12/Aug/2009	11h45	UTC-6	70°32.336	140°47.910	Barge Recovered (optics)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2b	760	Malina	12/Aug/2009	12h35	UTC-6	70°32.020	140°49.186	UV Profile ↓	555	45	55	5	1.0	1.9	1017.4	99	8/10
2b	760	Malina	12/Aug/2009	12h44	UTC-6	70°31.970	140°49.327	UV Profile ↑	558	63	51	5	1.0	1.9	1017.4	99	8/10

Appendix 2 - Scientific log of activities conducted during the 2009 ArcticNet Expedition

Leg	Station ID	Station Type	Local Date	Local Time	UTC to local	Latitude (N)	Longitude (W)	Activity	Depth (m)	Heading (°)	Wind		Air (ºC)	Water (ºC)	Pr Baro	Hum (%)	Ice
											Dir	Speed					
2b	760	Malina	12/Aug/2009	13h05	UTC-6	70°32.407	140°47.060	CTD-Rosette ↓	552	240	59	5	0.9	1.7	1017.3	99	6/10
2b	760	Malina	12/Aug/2009	13h47	UTC-6	70°32.126	140°47.719	CTD-Rosette ↑	543	259	50	5	2.3	1.8	1017.3	98	6/10
2b	760	Malina	12/Aug/2009	14h03	UTC-6	70°32.105	140°47.885	Thorium Pumping ↓	545	94	52	8	1.4	1.7	1017.2	98	6/10
2b	760	Malina	12/Aug/2009	15h24	UTC-6	70°31.822	140°49.192	Thorium Pumping ↑	558	69	34	6	1.2	1.8	1017.1	99	6/10
2b	770	Malina	12/Aug/2009	16h57	UTC-6	70°20.946	140°48.415	CTD ↓	223	339	45	6	3.4	2.3	1016.5	98	4/10
2b	770	Malina	12/Aug/2009	17h13	UTC-6	70°19.915	140°49.711	Above Water Radiometry	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2b	770	Malina	12/Aug/2009	17h22	UTC-6	70°20.842	140°48.890	CTD ↑	219	281	54	6	2.3	2.3	1016.2	96	4/10
2b	780	Malina	12/Aug/2009	19h10	UTC-6	70°09.074	140°48.162	Barge Deployed (optics)	50	354	75	6	3.5	4.0	1016.1	98	0/10
2b	780	Malina	12/Aug/2009	19h21	UTC-6	70°09.087	140°48.171	IOPs ↓	50	181	90	6	3.5	4.0	1016.1	98	0/10
2b	780	Malina	12/Aug/2009	19h35	UTC-6	70°09.164	140°48.157	IOPs ↑	50	131	77	6	2.7	4.1	1016.2	99	0/10
2b	780	Malina	12/Aug/2009	19h53	UTC-6	70°09.198	140°48.370	CTD-Rosette ↓	49	326	88	6	2.3	4.3	1016.3	99	0/10
2b	780	Malina	12/Aug/2009	20h16	UTC-6	70°09.418	140°48.466	CTD-Rosette ↑	49	310	67	6	3.0	4.3	1016.1	99	0/10
2b	780	Malina	12/Aug/2009	21h00	UTC-6	70°09.916	140°49.285	Barge Recovered (optics)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2b	780	Malina	12/Aug/2009	21h34	UTC-6	70°09.222	140°48.052	CTD-Rosette ↓	50	354	70	6	2.5	4.6	1016.0	99	0/10
2b	780	Malina	12/Aug/2009	21h51	UTC-6	70°09.344	140°47.877	CTD-Rosette ↑	49	273	47	6	3.0	4.7	1016.0	99	0/10
2b	780	Malina	12/Aug/2009	22h09	UTC-6	70°09.517	140°47.812	UV Profile ↓	51	356	69	5	3.5	4.6	1016.0	99	0/10
2b	780	Malina	12/Aug/2009	22h21	UTC-6	70°09.401	140°47.559	UV Profile ↑	50	326	59	6	2.9	4.6	1016.0	99	0/10
2b	N/A	N/A	13/Aug/2009	08h57	UTC-6	70°16.613	140°19.781	Barge Deployed (coastal transect)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2b	N/A	N/A	13/Aug/2009	09h21	UTC-6	70°16.612	140°19.772	Zodiac Deployed (coastal transect)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2b	N/A	N/A	13/Aug/2009	13h24	UTC-6	70°16.621	140°19.798	Above Water Radiometry	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2b	N/A	N/A	13/Aug/2009	15h35	UTC-6	70°16.606	140°19.778	Above Water Radiometry	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2b	N/A	N/A	13/Aug/2009	15h35	UTC-6	70°16.606	140°19.778	Zodiac Recovered (coastal transect)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2b	N/A	N/A	13/Aug/2009	16h40	UTC-6	70°16.612	140°19.787	Barge Recovered (coastal transect)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2b	N/A	N/A	13/Aug/2009	16h40	UTC-6	70°16.612	140°19.787	Barge Deployed (coastal transect)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2b	N/A	N/A	13/Aug/2009	20h00	UTC-6	70°18.421	140°18.556	Barge Recovered (coastal transect)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2b	N/A	N/A	14/Aug/2009	09h29	UTC-6	71°20.177	132°33.804	Sediment Traps Deployed	493	184	10	8	1.5	2.1	1010.6	99	0/10
2b	345	Malina	14/Aug/2009	10h22	UTC-6	71°19.801	132°33.560	CTD-Rosette ↓	479	278	20	7	2.6	2.5	1010.5	99	0/10
2b	345	Malina	14/Aug/2009	10h52	UTC-6	71°19.838	132°34.151	CTD-Rosette ↑	482	292	15	7	2.2	2.7	1010.4	99	0/10
2b	345	Malina	14/Aug/2009	11h16	UTC-6	N/A	N/A	Barge Deployed (optics)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2b	345	Malina	14/Aug/2009	11h52	UTC-6	71°20.174	132°35.281	Primary Production Line Deployed	488	138	10	4	1.7	2.8	1010.2	99	0/10
2b	345	Malina	14/Aug/2009	12h00	UTC-6	71°20.288	132°35.458	Primary Production Line Deployed (end)	496	181	8	5	1.8	2.8	1010.3	99	0/10
2b	345	Malina	14/Aug/2009	12h15	UTC-6	71°20.461	132°35.519	CTD-Rosette ↓	501	195	349	6	2.5	2.8	1010.2	97	0/10
2b	345	Malina	14/Aug/2009	12h44	UTC-6	71°20.640	132°35.589	CTD-Rosette ↑	507	179	336	6	3.2	2.9	1010.1	94	0/10
2b	345	Malina	14/Aug/2009	13h18	UTC-6	71°20.794	132°35.739	Barge Recovered (optics)	516	246	346	8	3.2	2.9	1010.0	92	0/10
2b	345	Malina	14/Aug/2009	14h24	UTC-6	71°20.939	132°36.408	CTD-Rosette ↓	517	195	345	5	2.9	3.0	1009.8	95	0/10
2b	345	Malina	14/Aug/2009	14h52	UTC-6	71°21.019	132°36.394	CTD-Rosette ↑	522	237	340	5	3.6	3.0	1009.8	87	0/10
2b	345	Malina	14/Aug/2009	16h00	UTC-6	71°21.014	132°36.751	UV Profile ↓	519	232	345	5	3.5	3.0	1009.8	89	0/10
2b	345	Malina	14/Aug/2009	16h11	UTC-6	71°21.245	132°36.283	UV Profile ↑	528	194	335	7	3.8	3.1	1009.8	87	0/10
2b	345	Malina	14/Aug/2009	16h20	UTC-6	71°21.266	132°36.541	CTD-Rosette ↓	530	301	335	7	3.5	3.0	1009.7	89	0/10
2b	345	Malina	14/Aug/2009	16h50	UTC-6	71°21.241	132°36.547	CTD-Rosette ↑	530	240	345	5	4.3	3.0	1009.7	85	0/10
2b	345	Malina	14/Aug/2009	16h50	UTC-6	71°21.241	132°36.547	SCAMP ↓	530	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0/10
2b	345	Malina	14/Aug/2009	17h07	UTC-6	71°21.219	132°36.665	SCAMP ↑	529	242	331	7	4.1	3.0	1009.7	88	0/10
2b	345	Malina	14/Aug/2009	17h14	UTC-6	71°21.180	132°36.900	Barge Deployed (optics)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2b	345	Malina	14/Aug/2009	18h17	UTC-6	71°21.127	132°37.221	CTD-Rosette ↓	519	154	310	4	1.9	3.1	1009.1	96	0/10
2b	345	Malina	14/Aug/2009	18h50	UTC-6	71°21.226	132°37.380	CTD-Rosette ↑	525	155	Calm	Calm	3.6	3.1	1009.0	85	0/10

Appendix 2 - Scientific log of activities conducted during the 2009 ArcticNet Expedition

Leg	Station ID	Station Type	Local Date	Local Time	UTC to local	Latitude (N)	Longitude (W)	Activity	Depth (m)	Heading (°)	Wind		Air (ºC)	Water (ºC)	Pr Baro	Hum (%)	Ice
											Dir	Speed					
2b	345	Malina	14/Aug/2009	19h40	UTC-6	71°21.240	132°36.900	Barge Recovered (optics)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2b	345	Malina	14/Aug/2009	20h14	UTC-6	71°21.274	132°36.993	CTD-Rosette ↓	529	13	276	1	3.1	3.3	1008.6	87	0/10
2b	345	Malina	14/Aug/2009	20h44	UTC-6	71°21.329	132°37.159	CTD-Rosette ↑	529	29	281	4	2.7	3.3	1008.5	90	0/10
2b	345	Malina	14/Aug/2009	21h40	UTC-6	71°21.098	132°36.337	Primary Production Line Recovered	525	19	285	1	2.2	3.2	1008.2	91	0/10
2b	345	Malina	14/Aug/2009	22h15	UTC-6	71°21.144	132°36.555	CTD-Rosette ↓	526	42	258	2	2.6	3.2	1008.0	90	0/10
2b	345	Malina	14/Aug/2009	22h44	UTC-6	71°21.231	132°36.711	CTD-Rosette ↑	529	85	194	3	4.3	3.3	1007.8	83	0/10
2b	345	Malina	14/Aug/2009	22h55	UTC-6	71°21.271	132°36.762	Thorium Pumping ↓	532	125	195	3	4.0	3.3	1007.7	87	0/10
2b	345	Malina	15/Aug/2009	00h06	UTC-6	71°21.571	132°36.621	Thorium Pumping ↑	538	125	193	5	1.6	3.4	1007.3	98	0/10
2b	345	Malina	15/Aug/2009	00h16	UTC-6	71°21.615	132°36.591	CTD-Rosette ↓	540	107	192	5	1.5	3.3	1007.2	98	0/10
2b	345	Malina	15/Aug/2009	00h57	UTC-6	71°21.655	132°37.128	CTD-Rosette ↑	544	28	172	6	2.0	3.3	1006.8	97	0/10
2b	345	Malina	15/Aug/2009	01h34	UTC-6	71°21.879	132°36.829	Primary Production Line Deployed	547	262	150	9	0.8	3.2	1006.1	99	0/10
2b	345	Malina	15/Aug/2009	02h12	UTC-6	71°21.827	132°36.436	CTD-Rosette ↓	548	11	148	9	2.0	3.2	1005.6	96	0/10
2b	345	Malina	15/Aug/2009	02h42	UTC-6	71°21.802	132°36.459	CTD-Rosette ↑	548	350	143	9	3.4	3.1	1005.2	91	0/10
2b	345	Malina	15/Aug/2009	03h00	UTC-6	71°21.773	132°35.989	Horizontal Net Tow ↓	544	184	145	10	2.9	3.1	1005.0	94	0/10
2b	345	Malina	15/Aug/2009	03h10	UTC-6	71°21.510	132°35.554	Horizontal Net Tow ↑	531	153	155	13	2.2	3.1	1004.9	97	0/10
2b	345	Malina	15/Aug/2009	04h18	UTC-6	71°21.109	132°35.093	CTD-Rosette ↓	519	70	180	10	2.8	3.0	1004.6	97	0/10
2b	345	Malina	15/Aug/2009	04h50	UTC-6	71°21.317	132°35.217	CTD-Rosette ↑	524	46	155	12	2.1	3.0	1004.0	97	0/10
2b	345	Malina	15/Aug/2009	05h02	UTC-6	71°21.402	132°35.102	Vertical Net Tow ↓	526	290	146	11	2.0	3.0	1003.9	98	0/10
2b	345	Malina	15/Aug/2009	05h40	UTC-6	71°21.651	132°34.941	Vertical Net Tow ↑	530	298	133	12	1.5	3.0	1002.7	99	0/10
2b	345	Malina	15/Aug/2009	06h15	UTC-6	71°21.422	132°34.967	CTD-Rosette ↓	525	17	141	16	3.6	3.1	1002.7	94	0/10
2b	345	Malina	15/Aug/2009	06h46	UTC-6	71°21.498	132°35.906	CTD-Rosette ↑	534	9	130	18	3.4	3.0	1002.2	98	0/10
2b	345	Malina	15/Aug/2009	07h25	UTC-6	71°21.646	132°38.175	SCAMP ↓	545	229	140	16	2.7	2.8	1001.6	99	0/10
2b	345	Malina	15/Aug/2009	08h20	UTC-6	71°22.032	132°41.244	CTD-Rosette ↓	559	315	132	20	3.0	2.2	1000.2	99	0/10
2b	345	Malina	15/Aug/2009	08h49	UTC-6	71°22.167	132°41.398	CTD-Rosette ↑	570	317	129	19	3.4	2.2	999.9	99	0/10
2b	345	Malina	15/Aug/2009	09h15	UTC-6	71°22.620	132°43.266	SCAMP ↑	545	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2b	345	Malina	15/Aug/2009	09h33	UTC-6	71°22.722	132°43.440	Above Water Radiometry	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2b	345	Malina	15/Aug/2009	09h36	UTC-6	71°22.607	132°43.250	IOPs ↓	594	318	132	19	3.5	2.0	999.3	99	0/10
2b	345	Malina	15/Aug/2009	10h02	UTC-6	71°22.738	132°43.382	IOPs ↑	603	320	137	18	4.0	1.8	998.8	98	0/10
2b	345	Malina	15/Aug/2009	10h18	UTC-6	71°22.824	132°43.398	CTD-Rosette ↓	608	330	133	19	4.5	1.9	998.6	97	0/10
2b	345	Malina	15/Aug/2009	11h00	UTC-6	71°23.261	132°43.797	CTD-Rosette ↑	624	322	142	19	6.2	1.9	997.6	90	0/10
2b	345	Malina	15/Aug/2009	12h17	UTC-6	71°23.551	132°39.776	CTD-Rosette ↓	601	342	145	15	4.4	2.2	997.5	97	0/10
2b	345	Malina	15/Aug/2009	12h54	UTC-6	71°23.715	132°40.096	CTD-Rosette ↑	610	3	165	17	2.3	2.3	997.1	84	0/10
2b	345	Malina	15/Aug/2009	14h15	UTC-6	71°24.551	132°38.305	CTD-Rosette ↓	589	30	212	10	3.1	2.4	997.0	98	0/10
2b	345	Malina	15/Aug/2009	14h48	UTC-6	71°24.717	132°37.990	CTD-Rosette ↑	586	43	210	10	6.5	2.5	997.2	83	0/10
2b	345	Malina	15/Aug/2009	15h31	UTC-6	71°25.638	132°36.781	SCAMP ↓	608	246	236	13	2.2	2.6	997.5	98	0/10
2b	345	Malina	15/Aug/2009	15h50	UTC-6	71°25.143	132°36.881	UV Profile ↓	610	138	249	13	2.3	2.5	997.7	99	0/10
2b	345	Malina	15/Aug/2009	15h58	UTC-6	71°25.290	132°37.127	UV Profile ↑	615	124	250	13	2.3	2.5	997.7	99	0/10
2b	345	Malina	15/Aug/2009	16h17	UTC-6	71°25.331	132°37.098	CTD-Rosette ↓	613	93	230	9	3.0	2.4	995.7	98	0/10
2b	345	Malina	15/Aug/2009	16h27	UTC-6	71°25.302	132°36.792	Above Water Radiometry	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2b	345	Malina	15/Aug/2009	16h50	UTC-6	71°25.293	132°36.787	CTD-Rosette ↑	619	76	225	6	3.4	2.5	998.1	92	0/10
2b	345	Malina	15/Aug/2009	16h58	UTC-6	71°25.375	132°36.664	SCAMP ↑	625	306	250	6	2.7	2.5	998.1	94	0/10
2b	345	Malina	15/Aug/2009	17h14	UTC-6	71°25.355	132°36.728	Barge Deployed (optics)	624	59	235	6	2.4	2.5	998.1	96	0/10
2b	345	Malina	15/Aug/2009	18h16	UTC-6	71°25.139	132°35.520	CTD-Rosette ↓	623	180	263	13	3.4	2.5	998.0	96	0/10
2b	345	Malina	15/Aug/2009	18h49	UTC-6	71°24.929	132°35.471	CTD-Rosette ↑	609	144	260	14	3.0	2.6	998.5	99	0/10
2b	345	Malina	15/Aug/2009	19h40	UTC-6	71°24.638	132°35.035	Barge Recovered (optics)	595	77	229	12	4.3	2.7	998.4	97	0/10

Appendix 2 - Scientific log of activities conducted during the 2009 ArcticNet Expedition

Leg	Station ID	Station Type	Local Date	Local Time	UTC to local	Latitude (N)	Longitude (W)	Activity	Depth (m)	Heading (°)	Wind		Air (ºC)	Water (ºC)	Pr Baro	Hum (%)	Ice
											Dir	Speed					
2b	345	Malina	15/Aug/2009	19h40	UTC-6	71°24.638	132°35.035	Above Water Radiometry	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2b	345	Malina	15/Aug/2009	20h09	UTC-6	71°24.710	132°34.922	SCAMP ↓	598	328	235	13	2.8	2.7	998.7	97	0/10
2b	345	Malina	15/Aug/2009	20h15	UTC-6	71°24.756	132°35.002	CTD-Rosette ↓	602	335	231	13	2.3	2.7	998.7	98	0/10
2b	345	Malina	15/Aug/2009	20h54	UTC-6	71°25.058	132°35.459	CTD-Rosette ↑	618	335	242	13	1.8	2.9	998.9	99	0/10
2b	345	Malina	15/Aug/2009	21h20	UTC-6	71°25.578	132°35.922	SCAMP ↑	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2b	345	Malina	15/Aug/2009	22h21	UTC-6	71°25.084	132°36.320	CTD-Rosette ↓	654	343	251	12	2.2	2.9	999.1	99	0/10
2b	345	Malina	15/Aug/2009	23h01	UTC-6	71°26.367	132°36.407	CTD-Rosette ↑	667	38	266	14	1.3	2.2	999.2	99	0/10
2b	345	Malina	15/Aug/2009	23h48	UTC-6	71°26.193	132°44.612	Primary Production Line Recovered	643	265	258	18	1.6	2.1	999.4	99	0/10
2b	345	Malina	16/Aug/2009	00h48	UTC-6	71°23.241	132°39.032	Sediment Traps Recovered	599	300	260	16	0.9	2.4	999.8	99	0/10
2b	345	Malina	16/Aug/2009	01h45	UTC-6	71°23.678	132°38.682	Box Core ↓	577	324	283	16	1.2	2.7	1000.2	99	0/10
2b	345	Malina	16/Aug/2009	02h08	UTC-6	71°23.901	132°38.141	Box Core ↑	575	350	260	12	1.3	2.8	1000.4	99	0/10
2b	N/A	N/A	16/Aug/2009	10h45	UTC-6	71°49.128	132°20.472	Barge Deployed (coastal transect)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2b	N/A	N/A	16/Aug/2009	10h55	UTC-6	71°49.122	132°20.478	Zodiac Deployed (coastal transect)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2b	N/A	N/A	16/Aug/2009	13h56	UTC-6	71°49.128	132°20.466	Above Water Radiometry	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2b	N/A	N/A	16/Aug/2009	16h30	UTC-6	71°49.146	132°20.43	Above Water Radiometry	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2b	N/A	N/A	16/Aug/2009	17h40	UTC-6	71°49.176	132°20.358	Zodiac Recovered (coastal transect)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2b	N/A	N/A	16/Aug/2009	17h40	UTC-6	71°49.176	132°20.358	Barge Recovered (coastal transect)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2b	570	CTD	17/Aug/2009	04h38	UTC-6	70°12.301	137°15.350	CTD ↓	55	N/A	240	6	4.4	3.8	1004.3	90	0/10
2b	570	CTD	17/Aug/2009	04h45	UTC-6	70°12.335	137°15.230	CTD ↑	55	N/A	34	3	4.7	3.9	1004.7	88	0/10
2b	560	CTD	17/Aug/2009	06h07	UTC-6	70°23.326	137°28.732	CTD ↓	400	41	205	10	3.6	3.7	1004.1	88	4/10
2b	560	CTD	17/Aug/2009	06h28	UTC-6	70°23.353	137°28.176	CTD ↑	400	45	220	11	5.0	3.5	1004.1	83	4/10
2b	550	CTD	17/Aug/2009	08h04	UTC-6	70°34.306	137°42.616	CTD ↓	1076	101	210	17	3.4	2.0	1003.6	85	5/10
2b	550	CTD	17/Aug/2009	08h47	UTC-6	70°34.273	137°42.161	CTD ↑	1087	94	215	17	3.6	1.6	1003.3	85	5/10
2b	540	Malina	17/Aug/2009	11h05	UTC-6	70°45.102	137°53.544	Barge Deployed (optics)	1514	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2b	540	Malina	17/Aug/2009	11h15	UTC-6	70°45.145	137°53.633	CTD-Rosette ↓	1514	127	225	15	2.9	0.7	1003.1	92	4/10
2b	540	Malina	17/Aug/2009	12h34	UTC-6	70°45.012	137°53.307	CTD-Rosette ↑	1517	130	222	14	3.0	0.8	1003.2	93	4/10
2b	540	Malina	17/Aug/2009	12h49	UTC-6	70°45.020	137°53.305	IOPs ↓	1511	235	214	15	3.0	0.8	1003.2	93	4/10
2b	540	Malina	17/Aug/2009	13h16	UTC-6	70°45.161	137°53.296	IOPs ↑	1513	289	216	15	3.0	0.8	1003.2	91	4/10
2b	540	Malina	17/Aug/2009	13h19	UTC-6	70°45.222	137°50.460	Above Water Radiometry	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2b	540	Malina	17/Aug/2009	13h37	UTC-6	70°45.216	137°53.466	Barge Recovered (optics)	1520	84	221	16	3.2	0.8	1003.2	90	4/10
2b	540	Malina	17/Aug/2009	14h02	UTC-6	70°45.292	137°53.158	CTD-Rosette ↓	1515	156	236	14	3.9	0.9	1003.5	88	4/10
2b	540	Malina	17/Aug/2009	14h45	UTC-6	70°45.329	137°52.700	CTD-Rosette ↑	1515	148	248	12	3.0	0.9	1003.7	93	4/10
2b	540	Malina	17/Aug/2009	14h58	UTC-6	70°45.360	137°52.642	UV Profile ↓	1525	110	247	14	3.1	0.9	1003.7	92	4/10
2b	540	Malina	17/Aug/2009	15h11	UTC-6	70°45.456	137°53.709	UV Profile ↑	1528	93	248	10	4.2	0.9	1003.9	87	4/10
2b	540	Malina	17/Aug/2009	16h00	UTC-6	70°45.365	137°52.300	CTD-Rosette ↓	1522	183	273	9	3.8	1.1	1004.2	92	4/10
2b	540	Malina	17/Aug/2009	16h50	UTC-6	70°45.320	137°51.462	CTD-Rosette ↑	1511	179	277	8	2.3	1.0	1004.4	97	4/10
2b	540	Malina	17/Aug/2009	17h02	UTC-6	70°77.210	137°51.263	Horizontal Net Tow ↓	1510	91	270	4	2.7	1.0	1004.5	95	4/10
2b	540	Malina	17/Aug/2009	17h12	UTC-6	70°45.327	137°50.184	Horizontal Net Tow ↑	1531	284	235	8	2.7	1.0	1004.5	95	4/10
2b	540	Malina	17/Aug/2009	17h28	UTC-6	70°45.490	137°49.751	Vertical Net Tow ↓	1501	84	Calm	Calm	2.0	1.0	1004.3	97	4/10
2b	540	Malina	17/Aug/2009	18h33	UTC-6	70°44.899	137°48.923	Vertical Net Tow ↑	1479	356	Calm	Calm	1.2	1.0	1004.5	97	4/10
2b	540	Malina	17/Aug/2009	19h05	UTC-6	70°44.743	137°48.378	Thorium Pumping ↓	1471	332	Calm	Calm	1.4	1.0	1004.3	96	3/10
2b	540	Malina	17/Aug/2009	20h15	UTC-6	70°44.337	137°47.854	Thorium Pumping ↑	1470	237	7	5	1.5	1.1	1004.4	96	3/10
2b	530	CTD	17/Aug/2009	22h28	UTC-6	70°56.427	138°08.766	CTD-Rosette ↓	1602	335	125	6	-0.1	0.3	1003.3	99	5/10
2b	530	CTD	17/Aug/2009	23h43	UTC-6	70°56.733	138°10.045	CTD-Rosette ↑	1609	26	95	6	0.2	0.7	1003.1	99	5/10
2b	430	Malina	18/Aug/2009	08h57	UTC-6	71°13.171	136°42.772	CTD-Rosette ↓	1351	265	36	12	1.3	0.4	1000.8	97	7/10

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Leg	Station ID	Station Type	Local Date	Local Time	UTC to local	Latitude (N)	Longitude (W)	Activity	Depth (m)	Heading (°)	Wind		Air (ºC)	Water (ºC)	Pr Baro	Hum (%)	Ice
											Dir	Speed					
2b	430	Malina	18/Aug/2009	10h00	UTC-6	71°12.925	136°44.246	CTD-Rosette ↑	1346	326	78	13	1.9	0.5	1000.4	95	7/10
2b	430	Malina	18/Aug/2009	10h22	UTC-6	71°12.760	136°44.249	IOPs ↓	1342	62	315	15	2.3	0.5	1001.0	93	7/10
2b	430	Malina	18/Aug/2009	10h50	UTC-6	71°12.572	136°44.403	IOPs ↑	1340	175	321	18	2.3	0.5	1001.1	93	7/10
2b	430	Malina	18/Aug/2009	11h10	UTC-6	71°12.132	136°44.214	Barge Deployed (optics)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2b	430	Malina	18/Aug/2009	11h24	UTC-6	71°12.227	136°44.204	CTD-Rosette ↓	1334	195	333	17	1.5	0.5	1001.1	95	7/10
2b	430	Malina	18/Aug/2009	12h03	UTC-6	71°11.790	136°44.338	CTD-Rosette ↑	1317	203	0	12	1.6	0.5	1001.3	95	7/10
2b	430	Malina	18/Aug/2009	12h50	UTC-6	71°11.202	136°44.820	Above Water Radiometry	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2b	430	Malina	18/Aug/2009	13h24	UTC-6	71°11.068	136°44.880	CTD-Rosette ↓	1300	216	338	14	1.4	0.5	1001.7	99	6/10
2b	430	Malina	18/Aug/2009	14h02	UTC-6	71°10.757	136°45.114	CTD-Rosette ↑	1282	255	335	12	1.2	0.5	1002.2	97	6/10
2b	430	Malina	18/Aug/2009	14h17	UTC-6	71°10.650	136°45.184	Barge Recovered (optics)	1277	228	334	14	1.1	0.5	1002.3	98	8/10
2b	430	Malina	18/Aug/2009	14h30	UTC-6	71°10.422	136°45.030	Barge Deployed (optics)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2b	430	Malina	18/Aug/2009	15h45	UTC-6	71°04.402	136°45.246	Barge Recovered (optics)	1304	261	328	12	1.4	0.5	1003.5	97	7/10
2b	440	CTD	18/Aug/2009	18h05	UTC-6	71°02.101	136°27.614	CTD ↓	1149	110	302	17	0.6	0.3	1005.8	97	7/10
2b	440	CTD	18/Aug/2009	18h55	UTC-6	71°01.761	136°28.070	CTD ↑	1137	203	305	18	1.4	0.23	1006.8	92	7/10
2b	450	CTD	18/Aug/2009	20h25	UTC-6	70°51.346	136°14.323	CTD ↓	840	137	319	12	1.6	0.36	1008.0	93	5/10
2b	450	CTD	18/Aug/2009	21h02	UTC-6	70°51.206	136°13.518	CTD ↑	837	131	309	11	1.4	0.41	1008.4	92	5/10
2b	470	CTD	18/Aug/2009	00h00	UTC-6	70°28.311	135°54.763	CTD ↓	70	129	397	10	0.6	0.48	1009.7	98	0/10
2b	470	CTD	18/Aug/2009	00h12	UTC-6	70°28.275	135°54.718	CTD ↑	62	136	396	12	N/A	N/A	1008.0	N/A	0/10
2b	480	CTD	19/Aug/2009	01h25	UTC-6	70°16.664	135°45.084	CTD ↓	60	147	290	14	2.4	2.2	1011.8	95	0/10
2b	480	CTD	19/Aug/2009	01h35	UTC-6	70°16.694	135°45.094	CTD ↑	60	148	285	12	3.0	2.1	1011.8	93	0/10
2b	460	Malina	19/Aug/2009	04h45	UTC-6	70°40.187	136°05.581	Thorium Pumping ↓	453	323	238	9	1.4	1.3	1012.2	99	2/10
2b	460	Malina	19/Aug/2009	05h46	UTC-6	70°40.592	136°04.860	Thorium Pumping ↑	459	324	235	7	1.3	1.3	1012.7	99	2/10
2b	460	Malina	19/Aug/2009	06h08	UTC-6	70°40.840	136°04.401	Horizontal Net Tow ↓	463	32	260	6	1.4	1.3	1012.7	98	2/10
2b	460	Malina	19/Aug/2009	06h19	UTC-6	70°40.921	136°04.783	Horizontal Net Tow ↑	473	261	240	6	1.4	1.3	1012.7	98	2/10
2b	460	Malina	19/Aug/2009	06h39	UTC-6	70°40°287	136°04.813	Vertical Net Tow ↓	449	261	250	8	1.5	1.3	1012.8	98	3/10
2b	460	Malina	19/Aug/2009	07h09	UTC-6	70°40.414	136°04.190	Vertical Net Tow ↑	452	59	250	8	1.5	1.3	1012.8	98	3/10
2b	460	Malina	19/Aug/2009	07h40	UTC-6	70°40.580	136°03.449	CTD-Rosette ↓	468	170	275	13	2.5	1.3	1012.9	94	3/10
2b	460	Malina	19/Aug/2009	08h21	UTC-6	70°40.666	136°02.206	CTD-Rosette ↑	463	167	249	14	2.2	1.3	1013.0	96	3/10
2b	460	Malina	19/Aug/2009	08h28	UTC-6	70°40.740	136°01.338	Above Water Radiometry	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2b	460	Malina	19/Aug/2009	08h58	UTC-6	70°40.755	136°01.107	IOPs ↓	454	18	244	11	2.5	1.3	1013.3	95	3/10
2b	460	Malina	19/Aug/2009	09h26	UTC-6	70°40.878	136°00.143	IOPs ↑	437	9	243	11	1.9	1.3	1013.4	96	3/10
2b	460	Malina	19/Aug/2009	09h40	UTC-6	70°41.005	135°59.490	CTD-Rosette ↓	434	117	247	14	2.8	1.3	1013.6	93	3/10
2b	460	Malina	19/Aug/2009	09h51	UTC-6	70°41.019	135°58.971	CTD-Rosette ↑	423	155	261	13	3.1	1.3	1013.7	90	3/10
2b	460	Malina	19/Aug/2009	10h13	UTC-6	70°41.002	135°58.076	CTD-Rosette ↓	420	181	255	12	2.5	1.3	1013.9	94	3/10
2b	460	Malina	19/Aug/2009	10h48	UTC-6	70°40.941	135°56.774	CTD-Rosette ↑	404	198	261	11	2.3	1.2	1014.1	94	3/10
2b	460	Malina	19/Aug/2009	11h10	UTC-6	70°40.806	135°54.600	Barge Deployed (optics)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2b	460	Malina	19/Aug/2009	11h35	UTC-6	70°40.742	135°54.298	UV Profile ↓	375	137	260	10	1.7	1.2	1014.5	95	4/10
2b	460	Malina	19/Aug/2009	11h47	UTC-6	70°40.941	135°54.395	UV Profile ↑	368	106	258	10	2.5	1.2	1014.6	92	4/10
2b	460	Malina	19/Aug/2009	12h11	UTC-6	70°40.915	135°53.622	CTD-Rosette ↓	372	135	165	9	3.6	1.1	1014.9	86	4/10
2b	460	Malina	19/Aug/2009	13h56	UTC-6	70°40.822	135°52.283	CTD-Rosette ↑	357	139	160	10	3.8	1.1	1015.2	87	4/10
2b	460	Malina	19/Aug/2009	14h16	UTC-6	70°40.440	135°50.160	Barge Recovered (optics)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2b	100	Malina	20/Aug/2009	08h20	UTC-6	71°48.475	127°25.063	Provbio Float Recovered	426	322	327	18	3.8	3.3	1017.1	89	1/10
2b	N/A	N/A	20/Aug/2009	11h39	UTC-6	71°18.820	127°29.579	Sediment Traps Deployed	228	341	220	19	5.1	3.3	1018.3	90	0/10
2b	135	Malina	20/Aug/2009	12h36	UTC-6	71°18.555	127°29.025	CTD-Rosette ↓	228	152	224	18	5.4	3.4	1018.1	89	0/10
2b	135	Malina	20/Aug/2009	13h10	UTC-6	71°18.781	127°27.168	CTD-Rosette ↑	228	138	230	18	5.9	3.7	1018.4	89	0/10

Appendix 2 - Scientific log of activities conducted during the 2009 ArcticNet Expedition

Leg	Station ID	Station Type	Local Date	Local Time	UTC to local	Latitude (N)	Longitude (W)	Activity	Depth (m)	Heading (°)	Wind		Air (ºC)	Water (ºC)	Pr Baro	Hum (%)	Ice
											Dir	Speed					
2b	135	Malina	20/Aug/2009	13h27	UTC-6	71°18.889	127°26.084	Barge Deployed (optics)	228	150	234	18	6.0	3.8	1018.4	89	0/10
2b	135	Malina	20/Aug/2009	13h50	UTC-6	71°19.029	127°24.709	UV Profile ↓	228	33	240	18	5.4	4.0	1018.4	90	0/10
2b	135	Malina	20/Aug/2009	14h02	UTC-6	71°18.886	127°25.471	UV Profile ↑	228	37	237	16	6.5	4.1	1018.5	87	0/10
2b	135	Malina	20/Aug/2009	14h20	UTC-6	71°18.734	127°24.312	CTD-Rosette ↓	231	90	246	14	5.4	4.2	1018.4	92	0/10
2b	135	Malina	20/Aug/2009	14h51	UTC-6	71°18.972	127°28.847	CTD-Rosette ↑	232	73	268	15	6.6	4.1	1018.9	84	0/10
2b	135	Malina	20/Aug/2009	15h32	UTC-6	71°19.471	127°27.022	Primary Production Line Deployed	245	345	206	14	3.9	4.0	1019.3	95	0/10
2b	135	Malina	20/Aug/2009	16h00	UTC-6	71°19.644	127°26.120	Barge Recovered (optics)	247	146	250	14	4.4	4.0	1019.4	93	0/10
2b	135	Malina	20/Aug/2009	16h15	UTC-6	71°19.643	127°25.237	SCAMP ↓	253	334	252	14	4.3	4.0	1019.4	96	0/10
2b	135	Malina	20/Aug/2009	16h47	UTC-6	71°18.623	127°29.253	CTD-Rosette ↓	229	121	258	14	4.2	3.9	1019.2	91	0/10
2b	135	Malina	20/Aug/2009	16h50	UTC-6	71°18.558	127°28.272	Above Water Radiometry	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2b	135	Malina	20/Aug/2009	17h20	UTC-6	71°18.405	127°27.266	CTD-Rosette ↑	234	155	258	12	6.0	3.8	1019.8	81	0/10
2b	135	Malina	20/Aug/2009	18h10	UTC-6	71°18.492	127°29.976	SCAMP ↑	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2b	135	Malina	20/Aug/2009	18h26	UTC-6	71°18.521	127°30.051	CTD-Rosette ↓	223	135	250	12	4.1	3.8	1020.0	88	0/10
2b	135	Malina	20/Aug/2009	18h56	UTC-6	71°18.145	127°29.370	CTD-Rosette ↑	224	144	254	10	5.4	3.6	1020.1	83	0/10
2b	135	Malina	20/Aug/2009	19h07	UTC-6	71°18.003	127°29.150	SCAMP ↓	223	150	245	10	5.4	3.6	1020.7	84	0/10
2b	135	Malina	20/Aug/2009	20h25	UTC-6	71°18.685	127°29.594	CTD-Rosette ↓	231	48	229	7	3.9	3.4	1020.0	92	0/10
2b	135	Malina	20/Aug/2009	20h58	UTC-6	71°18.412	127°29.627	CTD-Rosette ↑	224	128	230	10	4.9	3.3	1020.0	89	0/10
2b	135	Malina	20/Aug/2009	21h15	UTC-6	71°18.108	127°29.940	SCAMP ↑	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2b	135	Malina	20/Aug/2009	22h13	UTC-6	71°18.780	127°29.410	CTD-Rosette ↓	231	258	223	12	5.0	3.3	1020.4	88	0/10
2b	135	Malina	20/Aug/2009	22h49	UTC-6	71°18.752	127°29.926	CTD-Rosette ↑	226	146	244	12	4.5	3.3	1020.5	91	0/10
2b	135	Malina	21/Aug/2009	00h15	UTC-6	71°18.692	127°29.795	CTD-Rosette ↓	228	154	280	11	3.5	3.4	1020.9	97	0/10
2b	135	Malina	21/Aug/2009	00h47	UTC-6	71°18.741	127°29.993	CTD-Rosette ↑	226	205	302	10	3.2	3.3	1021.0	98	0/10
2b	135	Malina	21/Aug/2009	02h14	UTC-6	71°18.620	127°29.557	CTD-Rosette ↓	227	185	308	3	2.3	3.3	1021.6	99	0/10
2b	135	Malina	21/Aug/2009	02h36	UTC-6	71°18.564	127°29.411	CTD-Rosette ↑	226	215	336	3	2.3	3.3	1021.7	99	0/10
2b	135	Malina	21/Aug/2009	03h06	UTC-6	71°17.216	127°24.821	Primary Production Line Recovered	230	142	200	2	1.7	3.3	1021.8	99	0/10
2b	135	Malina	21/Aug/2009	04h13	UTC-6	71°18.656	127°29.474	CTD-Rosette ↓	231	83	Calm	Calm	1.2	3.6	1022.2	99	0/10
2b	135	Malina	21/Aug/2009	04h45	UTC-6	71°18.508	127°28.610	CTD-Rosette ↑	230	264	200	3	1.2	3.4	1022.3	99	1/10
2b	135	Malina	21/Aug/2009	05h04	UTC-6	71°18.417	127°28.197	Thorium Pumping ↓	228	264	Calm	Calm	1.3	3.4	1022.2	99	2/10
2b	135	Malina	21/Aug/2009	06h11	UTC-6	71°17.879	127°26.874	Thorium Pumping ↑	229	236	Calm	Calm	0.2	3.3	1022.2	99	2/10
2b	135	Malina	21/Aug/2009	06h46	UTC-6	71°18.458	127°29.388	CTD-Rosette ↓	227	348	Calm	Calm	0.7	3.0	1022.2	99	2/10
2b	135	Malina	21/Aug/2009	07h13	UTC-6	71°18.197	127°29.246	CTD-Rosette ↑	225	52	125	5	1.2	2.5	1022.1	99	2/10
2b	135	Malina	21/Aug/2009	07h30	UTC-6	71°17.876	127°27.183	Horizontal Net Tow ↓	225	70	115	6	0.9	2.5	1022.0	99	0/10
2b	135	Malina	21/Aug/2009	07h40	UTC-6	71°17.953	127°28.365	Horizontal Net Tow ↑	224	348	126	7	1.1	2.4	1022.1	99	9/10
2b	135	Malina	21/Aug/2009	08h19	UTC-6	71°18.460	127°29.724	CTD-Rosette ↓	224	227	122	8	0.8	1.8	1022.2	99	9/10
2b	135	Malina	21/Aug/2009	08h51	UTC-6	71°18.186	127°30.124	CTD-Rosette ↑	223	217	107	9	1.2	1.7	1022.0	99	9/10
2b	135	Malina	21/Aug/2009	10h16	UTC-6	71°18.589	127°30.179	CTD-Rosette ↓	222	264	132	11	2.3	0.9	1022.0	99	9/10
2b	135	Malina	21/Aug/2009	10h48	UTC-6	71°18.745	127°31.324	CTD-Rosette ↑	221	40	137	11	3.1	1.1	1022.0	99	9/10
2b	135	Malina	21/Aug/2009	12h18	UTC-6	71°18.677	127°29.628	CTD-Rosette ↓	227	343	140	11	3.8	1.7	1021.6	99	0/10
2b	135	Malina	21/Aug/2009	12h47	UTC-6	71°18.724	127°29.973	CTD-Rosette ↑	228	350	134	12	6.9	2.2	1021.7	95	0/10
2b	135	Malina	21/Aug/2009	13h10	UTC-6	71°19.064	127°30.418	Barge Deployed (optics)	228	58	155	13	5.1	2.5	1021.7	96	0/10
2b	135	Malina	21/Aug/2009	13h45	UTC-6	71°18.594	127°29.394	IOPs ↓	233	227	131	13	4.0	2.7	1021.4	98	0/10
2b	135	Malina	21/Aug/2009	14h10	UTC-6	71°18.713	127°28.961	IOPs ↑	230	321	143	11	5.4	2.8	1021.6	96	0/10
2b	135	Malina	21/Aug/2009	14h26	UTC-6	71°18.759	127°29.934	CTD-Rosette ↓	226	321	140	10	5.8	2.9	1021.5	94	0/10
2b	135	Malina	21/Aug/2009	14h58	UTC-6	71°19.022	127°29.402	CTD-Rosette ↑	233	41	154	13	7.4	3.0	1021.3	84	0/10
2b	135	Malina	21/Aug/2009	15h15	UTC-6	71°19.352	127°29.128	UV Profile ↓	240	217	144	11	7.0	3.0	1021.4	85	0/10

Appendix 2 - Scientific log of activities conducted during the 2009 ArcticNet Expedition

Leg	Station ID	Station Type	Local Date	Local Time	UTC to local	Latitude (N)	Longitude (W)	Activity	Depth (m)	Heading (°)	Wind Dir	Wind Speed	Air (ºC)	Water (ºC)	Pr Baro	Hum (%)	Ice
2b	135	Malina	21/Aug/2009	15h31	UTC-6	71°19.676	127°27.774	UV Profile ↑	245	275	171	13	5.8	3.1	1021.2	89	0/10
2b	135	Malina	21/Aug/2009	15h50	UTC-6	71°18.776	127°29.261	Above Water Radiometry	231	288	157	10	6.1	3.2	1021.2	88	0/10
2b	135	Malina	21/Aug/2009	16h14	UTC-6	71°18.869	127°29.203	Barge Recovered (optics)	233	16	145	13	6.3	3.2	1021.2	87	0/10
2b	135	Malina	21/Aug/2009	16h46	UTC-6	71°18.549	127°29.990	CTD-Rosette ↓	226	32	145	13	6.3	3.0	1021.0	86	0/10
2b	135	Malina	21/Aug/2009	17h13	UTC-6	71°18.485	127°29.171	CTD-Rosette ↑	227	38	146	14	7.6	2.9	1020.8	81	4/10
2b	N/A	N/A	21/Aug/2009	18h17	UTC-6	71°12.841	127°20.734	Sediment Traps Recovered	216	307	136	12	7.3	3.6	1020.3	87	4/10
2b	235	Malina	22/Aug/2009	02h30	UTC-6	71°46.868	130°50.069	CTD-Rosette ↓	619	285	115	17	5.5	1.9	1015.1	82	1/10
2b	235	Malina	22/Aug/2009	03h07	UTC-6	71°45.794	130°49.636	CTD-Rosette ↑	614	342	113	17	5.8	1.9	1014.9	88	1/10
2b	235	Malina	22/Aug/2009	03h48	UTC-6	71°45.998	130°48.709	Sediment Traps Deployed	606	307	110	18	2.8	1.9	1014.6	93	1/10
2b	235	Malina	22/Aug/2009	04h15	UTC-6	71°46.538	130°43.543	Primary Production Line Deployed	561	264	120	18	3.0	1.9	1014.2	94	1/10
2b	235	Malina	22/Aug/2009	04h37	UTC-6	71°45.623	130°45.450	CTD-Rosette ↓	568	4	121	17	2.8	1.8	1014.0	95	1/10
2b	235	Malina	22/Aug/2009	05h11	UTC-6	71°45.718	130°45.784	CTD-Rosette ↑	568	21	140	17	3.5	1.8	1013.7	93	2/10
2b	235	Malina	22/Aug/2009	05h33	UTC-6	71°45.787	130°45.961	Box Core ↓	576	296	125	16	3.0	1.8	1013.6	93	2/10
2b	235	Malina	22/Aug/2009	05h52	UTC-6	71°45.848	130°45.986	Box Core ↑	576	231	126	18	2.9	1.8	1013.2	93	2/10
2b	235	Malina	22/Aug/2009	06h15	UTC-6	71°45.780	130°48.410	CTD-Rosette ↓	599	349	126	18	3.8	1.7	1013.3	90	3/10
2b	235	Malina	22/Aug/2009	06h46	UTC-6	71°45.877	130°48.529	CTD-Rosette ↑	604	44	142	19	4.3	1.6	1013.0	86	3/10
2b	235	Malina	22/Aug/2009	08h12	UTC-6	71°45.934	130°48.070	CTD-Rosette ↓	598	39	130	17	3.9	1.5	1012.5	88	2/10
2b	235	Malina	22/Aug/2009	08h45	UTC-6	71°46.108	130°48.419	CTD-Rosette ↑	605	40	127	17	4	1.4	1012.3	88	2/10
2b	235	Malina	22/Aug/2009	10h21	UTC-6	71°45.784	130°50.083	CTD-Rosette ↓	617	300	120	14	4.1	1.3	1011.8	86	4/10
2b	235	Malina	22/Aug/2009	10h58	UTC-6	71°45.779	130°51.123	CTD-Rosette ↑	629	301	116	16	3.6	1.3	1011.7	89	4/10
2b	235	Malina	22/Aug/2009	11h16	UTC-6	71°45.760	130°49.792	UV Profile ↓	611	96	121	18	4.4	1.3	1011.5	87	4/10
2b	235	Malina	22/Aug/2009	11h32	UTC-6	71°45.790	130°51.694	UV Profile ↑	641	61	126	19	3.6	1.3	1011.2	91	3/10
2b	235	Malina	22/Aug/2009	12h23	UTC-6	71°46.143	130°53.860	CTD-Rosette ↓	666	329	113	20	4.3	1.2	1011.2	88	6/10
2b	235	Malina	22/Aug/2009	13h02	UTC-6	71°46.148	130°54.744	CTD-Rosette ↑	676	288	115	19	6.2	1.1	1010.9	82	6/10
2b	235	Malina	22/Aug/2009	13h15	UTC-6	71°46.137	130°54.536	Barge Deployed (optics)	675	234	116	19	5.0	1.1	1010.9	87	6/10
2b	235	Malina	22/Aug/2009	14h20	UTC-6	71°45.999	130°56.303	CTD-Rosette ↓	690	283	111	14	3.0	1.0	1010.7	94	4/10
2b	235	Malina	22/Aug/2009	15h01	UTC-6	71°46.093	130°56.099	CTD-Rosette ↑	686	282	112	13	7.2	1.0	1010.5	76	4/10
2b	235	Malina	22/Aug/2009	15h54	UTC-6	71°46.172	130°56.841	Barge Recovered (optics)	694	194	105	13	2.5	1.0	1010.0	96	4/10
2b	235	Malina	22/Aug/2009	16h13	UTC-6	71°46.620	130°51.342	Above Water Radiometry	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2b	235	Malina	22/Aug/2009	16h26	UTC-6	71°46.556	130°51.297	CTD-Rosette ↓	636	354	105	16	2.6	1.0	1009.6	97	4/10
2b	235	Malina	22/Aug/2009	17h03	UTC-6	71°46.709	130°51.583	CTD-Rosette ↑	643	14	107	16	3.6	1.0	1009.8	92	4/10
2b	235	Malina	22/Aug/2009	17h14	UTC-6	71°46.789	130°51.618	SCAMP ↓	642	19	110	17	3.5	1.0	1009.7	93	4/10
2b	235	Malina	22/Aug/2009	18h08	UTC-6	71°46.716	130°51.198	Above Water Radiometry	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2b	235	Malina	22/Aug/2009	18h13	UTC-6	71°46.628	130°51.142	CTD-Rosette ↓	636	28	120	16	3.5	1.1	1010.0	93	4/10
2b	235	Malina	22/Aug/2009	18h54	UTC-6	71°46.877	130°51.420	CTD-Rosette ↑	643	33	120	16	3.3	1.1	1009.1	96	4/10
2b	235	Malina	22/Aug/2009	19h47	UTC-6	71°46.161	130°49.347	SCAMP ↑	624	167	120	18	2.8	1.1	1008.7	97	4/10
2b	235	Malina	22/Aug/2009	20h22	UTC-6	71°46.473	130°50.270	CTD-Rosette ↓	626	300	110	16	3.8	1.1	1008.6	95	3/10
2b	235	Malina	22/Aug/2009	20h59	UTC-6	71°46.324	130°51.128	CTD-Rosette ↑	633	321	101	19	3.1	1.2	1008.4	97	3/10
2b	235	Malina	22/Aug/2009	22h22	UTC-6	71°46.018	130°53.815	CTD-Rosette ↓	660	8	117	16	2.6	1.1	1008.0	98	3/10
2b	235	Malina	22/Aug/2009	22h59	UTC-6	71°46.096	130°54.679	CTD-Rosette ↑	675	289	115	13	2.5	1.1	1008.1	97	3/10
2b	235	Malina	23/Aug/2009	00h15	UTC-6	71°46.192	130°56.773	CTD-Rosette ↓	693	302	104	11	2.2	1.1	1007.9	98	3/10
2b	235	Malina	23/Aug/2009	00h56	UTC-6	71°46.224	130°57.288	CTD-Rosette ↑	697	325	113	13	4.8	1.1	1007.7	88	3/10
2b	235	Malina	23/Aug/2009	02h10	UTC-6	71°46.469	130°56.351	CTD-Rosette ↓	693	315	112	11	3.1	1.1	1007.4	94	3/10
2b	235	Malina	23/Aug/2009	02h53	UTC-6	71°46.466	130°56.446	CTD-Rosette ↑	691	297	115	10	3.2	1.1	1007.2	94	3/10
2b	235	Malina	23/Aug/2009	03h40	UTC-6	71°45.148	130°46.263	Primary Production Line Recovered	569	288	129	13	2.4	1.0	1007.2	98	1/10

Appendix 2 - Scientific log of activities conducted during the 2009 ArcticNet Expedition

Leg	Station ID	Station Type	Local Date	Local Time	UTC to local	Latitude (N)	Longitude (W)	Activity	Depth (m)	Heading (°)	Wind		Air (ºC)	Water (ºC)	Pr Baro	Hum (%)	Ice
											Dir	Speed					
2b	235	Malina	23/Aug/2009	03h57	UTC-6	71°45.113	130°45.988	Primary Production Line Deployed	569	359	130	14	2.5	1.0	1007.2	98	1/10
2b	235	Malina	23/Aug/2009	04h19	UTC-6	71°46.085	130°51.099	CTD-Rosette ↓	631	1	130	13	3.3	1.1	1007.2	95	3/10
2b	235	Malina	23/Aug/2009	04h57	UTC-6	71°46.141	130°50.800	CTD-Rosette ↑	630	0	125	14	2.9	1.1	1007.2	96	3/10
2b	235	Malina	23/Aug/2009	05h07	UTC-6	71°46.862	130°51.497	Horizontal Net Tow ↓	637	344	105	11	2.9	1.1	1007.2	96	2/10
2b	235	Malina	23/Aug/2009	05h19	UTC-6	71°46.724	130°51.747	Horizontal Net Tow ↑	644	154	5	15	2.9	1.1	1007.1	97	2/10
2b	235	Malina	23/Aug/2009	06h14	UTC-6	71°46.093	130°51.074	CTD-Rosette ↓	631	0	123	13	3.0	1.1	1007.1	98	2/10
2b	235	Malina	23/Aug/2009	06h51	UTC-6	71°46.108	130°50.825	CTD-Rosette ↑	629	19	150	13	3.1	1.1	1007.1	95	2/10
2b	235	Malina	23/Aug/2009	07h04	UTC-6	71°46.114	130°50.897	Vertical Net Tow ↓	629	318	135	12	3.4	1.2	1007.1	95	1/10
2b	235	Malina	23/Aug/2009	07h46	UTC-6	71°45.990	130°50.873	Vertical Net Tow ↑	624	180	116	13	2.4	1.3	1006.9	98	1/10
2b	235	Malina	23/Aug/2009	08h12	UTC-6	71°45.875	130°51.144	CTD-Rosette ↓	634	2	119	10	2.6	1.5	1007.0	99	1/10
2b	235	Malina	23/Aug/2009	08h48	UTC-6	71°45.797	130°51.427	CTD-Rosette ↑	634	33	129	12	2.4	1.5	1007.2	99	1/10
2b	235	Malina	23/Aug/2009	09h38	UTC-6	71°45.714	130°52.980	Above Water Radiometry	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2b	235	Malina	23/Aug/2009	10h20	UTC-6	71°45.622	130°53°735	CTD-Rosette ↓	657	335	124	11	2.6	1.3	1007.5	98	1/10
2b	235	Malina	23/Aug/2009	11h02	UTC-6	71°45.432	130°53.951	CTD-Rosette ↑	660	305	122	11	2.5	1.5	1007.5	96	1/10
2b	235	Malina	23/Aug/2009	11h14	UTC-6	71°45.274	130°53.653	UV Profile ↓	652	306	122	11	4.4	1.5	1007.6	91	1/10
2b	235	Malina	23/Aug/2009	11h30	UTC-6	71°44.876	130°52.774	UV Profile ↑	641	310	115	10	8.8	1.6	1007.7	74	1/10
2b	235	Malina	23/Aug/2009	12h10	UTC-6	71°45.234	130°54.096	Barge Deployed (optics)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2b	235	Malina	23/Aug/2009	12h25	UTC-6	71°45.242	130°54.003	CTD-Rosette ↓	656	327	102	12	3.6	1.6	1007.8	95	3/10
2b	235	Malina	23/Aug/2009	13h03	UTC-6	71°45.170	130°54.292	CTD-Rosette ↑	656	307	100	11	4.6	1.6	1008.0	91	3/10
2b	235	Malina	23/Aug/2009	13h29	UTC-6	71°45.312	130°55.074	Above Water Radiometry	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2b	235	Malina	23/Aug/2009	14h20	UTC-6	71°45.324	130°54.670	CTD-Rosette ↓	654	315	102	14	3.8	1.6	1008.6	95	3/10
2b	235	Malina	23/Aug/2009	14h56	UTC-6	71°45.176	130°54.601	CTD-Rosette ↑	661	290	100	13	3.4	1.6	1008.7	95	3/10
2b	235	Malina	23/Aug/2009	15h30	UTC-6	71°45.120	130°54.438	Barge Recovered (optics)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2b	235	Malina	23/Aug/2009	15h51	UTC-6	71°45.095	130°54.351	SCAMP ↓	658	294	95	10	3.3	1.6	1008.8	96	3/10
2b	235	Malina	23/Aug/2009	16h16	UTC-6	71°45.038	130°54.300	CTD-Rosette ↓	656	351	96	13	3.9	1.6	1008.9	92	3/10
2b	235	Malina	23/Aug/2009	16h53	UTC-6	71°44.903	130°54.242	CTD-Rosette ↑	649	328	95	14	3.3	1.6	1008.9	95	3/10
2b	235	Malina	23/Aug/2009	17h10	UTC-6	71°44.788	130°54.127	SCAMP ↑	644	349	110	13	3.7	1.5	1009.0	94	3/10
2b	235	Malina	23/Aug/2009	18h15	UTC-6	71°44.562	130°54.410	CTD-Rosette ↓	640	358	101	13	3.0	1.4	1009.2	98	3/10
2b	235	Malina	23/Aug/2009	18h55	UTC-6	71°44.362	130°54.234	CTD-Rosette ↑	627	22	93	13	3.0	1.3	1009.3	96	3/10
2b	235	Malina	23/Aug/2009	20h16	UTC-6	71°44.811	130°50.348	CTD-Rosette ↓	611	4	105	13	2.9	1.5	1009.8	98	3/10
2b	235	Malina	23/Aug/2009	20h55	UTC-6	71°44.823	130°50.918	CTD-Rosette ↑	611	13	89	14	2.8	1.5	1010.0	99	3/10
2b	235	Malina	23/Aug/2009	21h22	UTC-6	71°43.915	130°50.043	Thorium Pumping ↓	586	181	85	14	2.0	1.5	1010.1	99	3/10
2b	235	Malina	23/Aug/2009	22h19	UTC-6	71°43.499	130°51.511	Thorium Pumping ↑	581	181	92	13	1.9	1.5	1010.4	99	3/10
2b	235	Malina	23/Aug/2009	22h40	UTC-6	71°43.660	130°50.542	CTD-Rosette ↓	574	318	84	14	2.2	1.5	1010.5	99	3/10
2b	235	Malina	23/Aug/2009	23h28	UTC-6	71°43.786	130°51.622	CTD-Rosette ↑	592	1	85	10	1.5	1.5	1010.6	99	3/10
2b	235	Malina	23/Aug/2009	00h25	UTC-6	71°43.889	130°52.180	CTD-Rosette ↓	547	279	72	10	1.7	1.5	1011.0	99	3/10
2b	235	Malina	23/Aug/2009	01h02	UTC-6	71°43.842	130°51.964	CTD-Rosette ↑	588	280	76	11	1.8	1.5	1011.0	98	3/10
2b	235	Malina	24/Aug/2009	02h15	UTC-6	71°43.952	130°52.347	CTD-Rosette ↓	600	294	83	10	1.3	1.5	1011.2	99	3/10
2b	235	Malina	24/Aug/2009	02h52	UTC-6	71°43.871	130°52.042	CTD-Rosette ↑	595	324	77	11	1.7	1.5	1011.4	97	3/10
2b	235	Malina	24/Aug/2009	03h53	UTC-6	71°44.609	130°30.803	Primary Production Line Recovered	776	264	67	8	1.1	1.3	1011.5	99	3/10
2b	235	Malina	24/Aug/2009	04h35	UTC-6	71°44.208	130°45.088	CTD-Rosette ↓	546	212	74	10	0.9	1.3	1011.5	99	3/10
2b	235	Malina	24/Aug/2009	05h15	UTC-6	71°44.187	130°45.006	CTD-Rosette ↑	546	308	75	11	1.7	1.2	1011.4	99	3/10
2b	235	Malina	24/Aug/2009	05h28	UTC-6	71°43.744	130°49.248	IOPs ↓	575	183	80	9	1.7	1.2	1011.4	99	3/10
2b	235	Malina	24/Aug/2009	05h57	UTC-6	71°43.590	130°49.091	IOPs ↑	565	232	65	10	0.8	1.2	1011.4	99	3/10
2b	235	Malina	24/Aug/2009	06h14	UTC-6	71°43.283	130°50.102	SCAMP ↓	567	111	57	9	0.9	1.2	1011.3	99	3/10

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Leg	Station ID	Station Type	Local Date	Local Time	UTC to local	Latitude (N)	Longitude (W)	Activity	Depth (m)	Heading (°)	Wind		Air (ºC)	Water (ºC)	Pr Baro	Hum (%)	Ice
											Dir	Speed					
2b	235	Malina	24/Aug/2009	06h23	UTC-6	71°43.171	130°49.783	CTD-Rosette ↓	562	48	61	12	0.8	1.2	1011.3	99	3/10
2b	235	Malina	24/Aug/2009	07h04	UTC-6	71°42.934	130°49.855	CTD-Rosette ↑	575	302	70	13	1.1	1.2	1011.2	99	3/10
2b	235	Malina	24/Aug/2009	07h22	UTC-6	71°42.775	130°48.737	SCAMP ↑	562	114	80	15	0.7	1.2	1011.3	99	3/10
2b	235	Malina	24/Aug/2009	08h13	UTC-6	71°42.589	130°48.302	Sediment Traps Recovered	552	73	67	11	0.6	1.2	1011.2	99	3/10
2b	235	Malina	24/Aug/2009	08h32	UTC-6	71°42.749	130°47.785	CTD-Rosette ↓	543	345	79	12	0.6	1.2	1011.2	99	3/10
2b	235	Malina	24/Aug/2009	08h58	UTC-6	71°42.694	130°48.306	CTD-Rosette ↑	555	355	95	12	1.2	1.2	1011.1	99	3/10
Leg 3a																	
3a	N/A	Weather	28/Aug/2009	21h00	UTC-6	70°41.600	126°01.800	Weather Balloon	190	315	95	25	7.2	6.2	1002.7	97	0/10
3a	S1	Short	29/Aug/2009	18h00	UTC-6	69°30.050	137°59.820	CTD-Rosette ↓	60	288	342	11	1.5	3.5	1008.6	96	0/10
3a	S1	Short	29/Aug/2009	18h32	UTC-6	69°29.950	137°59.570	CTD-Rosette ↑	58	255	341	11	1.8	3.9	1008.6	96	0/10
3a	S1	Short	29/Aug/2009	19h00	UTC-6	69°29.900	137°59.060	MOB ↓	56	241	340	10	2.1	3.9	1008.5	94	0/10
3a	S1	Short	29/Aug/2009	19h48	UTC-6	69°30.000	137°58.900	Water Pumping ↓	55	321	340	9	1.9	4.0	1010.9	90	0/10
3a	S1	Short	29/Aug/2009	19h55	UTC-6	69°30.000	137°58.800	Water Pumping ↓	55	311	355	10	1.9	4.0	1010.8	90	0/10
3a	S1	Short	29/Aug/2009	22h28	UTC-6	69°29.900	137°57.200	Water Pumping ↑	50	77	170	4	1.4	3.8	1009.2	90	0/10
3a	S1	Short	29/Aug/2009	23h10	UTC-6	69°30.000	137°58.000	MOB ↑	52	280	140	8	1.9	3.8	1008.5	91	0/10
3a	S1	Short	29/Aug/2009	23h37	UTC-6	69°29.900	137°59.600	CTD-Rosette ↓	59	135	140	11	2.2	3.7	1008.0	91	0/10
3a	S1	Short	29/Aug/2009	23h47	UTC-6	69°29.900	137°59.600	CTD-Rosette ↑	59	134	140	12	2.2	3.7	1007.8	92	0/10
3a	S1	Short	30/Aug/2009	01h07	UTC-6	69°29.900	137°59.400	CTD-Rosette ↓	58	125	140	17	3.7	3.6	1006.2	91	0/10
3a	S1	Short	30/Aug/2009	01h23	UTC-6	69°29.900	137°59.000	CTD-Rosette ↑	56	83	155	17	3.9	3.7	1006.1	91	0/10
3a	S1	Short	30/Aug/2009	03h06	UTC-6	69°29.900	137°58.900	CTD-Rosette ↓	56	82	130	19	4.8	3.6	1004.1	89	0/10
3a	S1	Short	30/Aug/2009	03h18	UTC-6	69°30.100	137°58.900	CTD-Rosette ↑	56	34	135	20	5.1	3.6	1003.7	88	0/10
3a	S1.1	Short	30/Aug/2009	04h42	UTC-6	69°40.170	138°09.130	CTD-Rosette ↓	126	101	97	16	4.4	3.9	1000.1	94	0/10
3a	S1.1	Short	30/Aug/2009	04h56	UTC-6	69°40.160	138°09.010	CTD-Rosette ↑	126	98	96	16	4.5	4.2	1001.0	93	0/10
3a	S1.1	Short	30/Aug/2009	06h00	UTC-6	69°40.450	138°09.690	CTD-Rosette ↓	128	80	80	14	4.4	4.2	1000.6	94	0/10
3a	S1.1	Short	30/Aug/2009	06h14	UTC-6	69°40.520	138°09.730	CTD-Rosette ↑	130	78	83	16	4.4	4.2	1000.4	94	0/10
3a	S1.2	Short	30/Aug/2009	07h27	UTC-6	69°49.890	138°19.570	CTD-Rosette ↓	189	68	67	12	3.1	3.6	1000.5	96	0/10
3a	S1.2	Short	30/Aug/2009	07h52	UTC-6	69°49.800	138°20.100	CTD-Rosette ↑	190	53	56	8	2.8	3.3	1003.6	97	0/10
3a	S1.2	Short	30/Aug/2009	08h37	UTC-6	69°50.000	138°20.500	CTD-Rosette ↓	191	57	50	7	2.6	3.1	1003.6	98	1/10
3a	S1.2	Short	30/Aug/2009	08h49	UTC-6	69°50.000	138°20.600	CTD-Rosette ↑	191	45	40	6	2.5	3.1	1003.6	98	1/10
3a	S1.2	Short	30/Aug/2009	09h44	UTC-6	69°50.300	138°21.100	CTD-Rosette ↓	195	36	40	10	2.4	3.0	1003.7	99	0/10
3a	S1.2	Short	30/Aug/2009	09h51	UTC-6	69°50.300	138°21.100	CTD-Rosette ↑	194	48	43	11	2.2	3.0	1003.7	99	0/10
3a	S2	Short	30/Aug/2009	11h06	UTC-6	70°00.000	138°30.200	CTD-Rosette ↓	259	50	62	12	0.8	2.2	1003.9	99	0/10
3a	S2	Short	30/Aug/2009	11h44	UTC-6	70°00.200	138°30.800	CTD-Rosette ↑	260	66	60	10	0.5	2.1	1004.2	99	1/10
3a	S2	Short	30/Aug/2009	14h22	UTC-6	70°00.520	138°30.340	CTD-Rosette ↓	260	112	0	8	0.5	1.8	1005.6	99	1/10
3a	S2	Short	30/Aug/2009	14h45	UTC-6	70°00.500	138°30.200	Weather Balloon	261	109	340	11	0.3	1.8	1005.9	99	1/10
3a	S2	Short	30/Aug/2009	14h52	UTC-6	70°00.500	138°30.200	CTD-Rosette ↑	260	94	335	11	0.3	1.8	1006.2	99	1/10
3a	S2	Short	30/Aug/2009	15h19	UTC-6	70°00.500	138°29.600	MOB ↓	260	67	335	16	0.3	1.8	1006.9	99	1/10
3a	S2	Short	30/Aug/2009	18h16	UTC-6	69°59.680	138°29.740	CTD-Rosette ↓	256	311	319	22	-0.3	1.6	1008.3	93	0/10
3a	S2	Short	30/Aug/2009	18h33	UTC-6	69°59.700	138°30.070	CTD-Rosette ↑	256	316	327	18	-0.6	1.6	1008.6	93	0/10
3a	S2	Short	30/Aug/2009	18h55	UTC-6	69°59.410	138°30.320	Water Pumping Deployment	257	344	319	23	-0.5	1.5	1009.0	93	0/10
3a	S2	Short	30/Aug/2009	19h16	UTC-6	69°59.340	138°30.360	Water Pumping ↓	257	341	318	20	-0.5	1.5	1009.0	93	0/10
3a	S2	Short	30/Aug/2009	23h08	UTC-6	69°58.600	138°32.300	Water Pumping ↑	258	355	310	22	-1.0	1.5	1014.3	94	1/10
3a	S2	Short	30/Aug/2009	23h55	UTC-6	69°54.200	138°34.710	MOB ↑	221	46	320	22	-0.6	1.4	1014.5	78	1/10
3a	S2	Short	31/Aug/2009	00h48	UTC-6	70°01.410	138°32.860	CTD-Rosette ↓	271	24	305	19	-1.4	1.2	1014.7	79	0/10
3a	S2	Short	31/Aug/2009	01h08	UTC-6	70°01.500	138°33.050	CTD-Rosette ↑	271	33	305	16	-1.6	1.2	1014.8	78	0/10

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Leg	Station ID	Station Type	Local Date	Local Time	UTC to local	Latitude (N)	Longitude (W)	Activity	Depth (m)	Heading (°)	Wind		Air (ºC)	Water (ºC)	Pr Baro	Hum (%)	Ice
											Dir	Speed					
3a	S2	Short	31/Aug/2009	01h37	UTC-6	70°01.370	138°32.310	Water Pumping (moonpool) ↓	268	32	295	15	-1.9	1.1	1014.9	86	0/10
3a	S2	Short	31/Aug/2009	03h08	UTC-6	70°01.990	138°32.270	Water Pumping (moonpool) ↑	269	350	300	16	-2.0	0.98	1014.6	81	0/10
3a	L1	Long	31/Aug/2009	14h18	UTC-6	71°05.550	139°00.590	Weather Balloon	1911	352	110	7	0.5	0.11	1009.9	78	7/10
3a	L1	Long	31/Aug/2009	14h18	UTC-6	71°05.550	139°00.590	CTD-Rosette ↓	1911	352	110	7	0.5	0.11	1009.9	78	7/10
3a	L1	Long	31/Aug/2009	14h22	UTC-6	71°05.560	139°00.650	On Ice Sampling ↓	1909	352	105	7	0.5	0.11	1009.9	78	7/10
3a	L1	Long	31/Aug/2009	15h00	UTC-6	71°05.690	139°01.160	EM Sampling (helicopter) ↓	1912	353	100	9	1.4	0.12	1009.8	74	7/10
3a	L1	Long	31/Aug/2009	15h48	UTC-6	71°05.830	139°01.410	CTD-Rosette ↑	1913	356	109	8	1.2	0.12	1006.9	75	8/10
3a	L1	Long	31/Aug/2009	16h17	UTC-6	71°05.950	139°01.490	EM sampling (helicopter) ↑	1911	357	107	13	0.7	0.13	1006.3	82	8/10
3a	L1	Long	31/Aug/2009	16h35	UTC-6	71°06.040	139°01.520	TM-Rosette ↓	1911	357	104	12	0.2	0.13	1006.0	81	8/10
3a	L1	Long	31/Aug/2009	17h47	UTC-6	71°06.320	139°01.490	TM-Rosette ↑	1912	356	104	10	0.2	0.13	1008.1	82	8/10
3a	L1	Long	31/Aug/2009	18h44	UTC-6	71°06.400	139°01.400	EM sampling ↓ (helicopter)	1912	356	113	10-15	0.2	0.13	1007.1	85	8/10
3a	L1	Long	31/Aug/2009	18h59	UTC-6	71°06.400	139°01.400	EM sampling ↑ (helicopter)	1942	355	100	17	-1.6	0.1	1006.5	88	8/10
3a	L1	Long	31/Aug/2009	20h05	UTC-6	71°06.400	139°01.400	TM-Rosette ↓	1942	355	100	17	-1.6	0.1	1006.5	88	8/10
3a	L1	Long	31/Aug/2009	20h10	UTC-6	71°06.400	139°01.400	TM-Rosette ↑	1942	355	100	16	-1.5	0.1	1006.5	89	8/10
3a	L1	Long	31/Aug/2009	20h17	UTC-6	71°06.300	139°81.500	CTD-Rosette ↓	1913	353	100	18	-1.5	0.1	1006.5	89	8/10
3a	L1	Long	31/Aug/2009	21h41	UTC-6	71°06.000	139°02.50	CTD-Rosette ↑	1918	352	93	22	-1.8	0.1	1005.6	91	8/10
3a	L1	Long	31/Aug/2009	22h25	UTC-6	71°05.900	139°03.400	Water Pumping (moonpool) ↓	1926	351	97	22	-1.6	0.1	1005.1	91	8/10
3a	L1	Long	01/Sep/2009	01h33	UTC-6	71°05.940	139°08.870	Water Pumping (moonpool) ↑	1981	354	90	21	-1.4	0.1	1004.6	95	8/10
3a	L1	Long	01/Sep/2009	03h11	UTC-6	71°06.410	139°11.370	High Volume Water Pumping (moonpool) ↓	1982	354	90	22	-1.1	0.1	1004.1	94	8/10
3a	L1	Long	01/Sep/2009	08h35	UTC-6	71°07.640	139°12.400	High Volume Water Pumping (moonpool) ↑	1982	352	101	18	-0.4	0.1	1002.2	94	7/10
3a	L1	Long	01/Sep/2009	09h05	UTC-6	71°07.400	139°11.900	Helicopter Deployed	1982	350	97	16	0.0	0.1	1004.7	93	7/10
3a	L1	Long	01/Sep/2009	09h12	UTC-6	71°07.400	139°11.900	On Ice Sampling ↓	1982	350	99	17	0.1	0.1	1004.7	93	7/10
3a	L1	Long	01/Sep/2009	09h28	UTC-6	71°07.400	139°11.900	CTD-Rosette ↓	1990	350	95	15	0.1	0.1	1004.8	93	7/10
3a	L1	Long	01/Sep/2009	11h02	UTC-6	71°06.800	139°12.500	CTD-Rosette ↑	1986	350	94	16	0.5	0.0	1008.8	97	7/10
3a	L1	Long	01/Sep/2009	10h47	UTC-6	71°06.800	139°12.500	Helicopter Recovered	1987	350	95	18	0.5	0.1	1005.1	92	7/10
3a	L1	Long	01/Sep/2009	11h57	UTC-6	71°06.540	139°13.530	EM sampling ↓	1989	350	100	16	0.7	0.1	1005.2	92	7/10
3a	L1	Long	01/Sep/2009	12h14	UTC-6	71°06.460	139°13.920	EM sampling ↑	N/A	350	100	18	0.9	0.1	1005.1	92	7/10
3a	L1	Long	01/Sep/2009	12h38	UTC-6	71°06.360	139°14.630	High Volume Water Pumping (moonpool) ↓	1997	350	100	17	0.9	0.1	1005.1	92	7/10
3a	L1	Long	01/Sep/2009	13h06	UTC-6	71°06.290	139°15.260	On Ice Sampling ↑	1999	350	105	16	1.1	0.1	1005.2	91	7/10
3a	L1	Long	01/Sep/2009	14h46	UTC-6	71°06.340	139°17.930	High Volume Water Pumping (moonpool) ↑ (canceled)	2015	353	110	13	1.3	0.1	1005.8	91	7/10
3a	L1	Long	01/Sep/2009	14h54	UTC-6	71°06.370	139°18.120	Photogrametry ↓	2015	353	110	13	1.4	0.1	1005.8	91	7/10
3a	L1	Long	01/Sep/2009	15h05	UTC-6	71°06.390	139°18.260	CTD-Rosette ↓	2016	354	110	14	1.4	0.1	1005.9	91	7/10
3a	L1	Long	01/Sep/2009	15h47	UTC-6	71°06.580	139°19.070	Photogrametry ↑	2021	357	112	16	1.7	0.1	1006.0	92	7/10
3a	L1	Long	01/Sep/2009	16h48	UTC-6	71°06.910	139°19.840	CTD-Rosette ↑	2026	0	116	16	1.4	0.1	1006.1	94	7/10
3a	L1	Long	01/Sep/2009	17h57	UTC-6	71°07.300	139°20.190	TM-Rosette ↓	2032	3	114	15	1.5	0.1	1006.0	96	7/10
3a	L1	Long	01/Sep/2009	18h19	UTC-6	71°07.040	139°20.020	TM-Rosette ↑	2030	5	115	15	1.5	0.1	1006.0	97	7/10
3a	L1	Long	01/Sep/2009	19h10	UTC-6	71°07.630	139°19.960	CTD-Rosette ↓	2028	7	113	13	1.3	0.0	1006.3	98	7/10
3a	L1	Long	01/Sep/2009	20h06	UTC-6	71°07.700	139°19.400	Scatterometer	2029	8	114	10	1.4	0.1	1006.8	98	7/10
3a	L1	Long	01/Sep/2009	20h20	UTC-6	71°07.700	139°19.200	CTD-Rosette ↑	2030	9	117	11	1.2	0.1	1006.8	99	7/10
3a	L1	Long	01/Sep/2009	23h10	UTC-6	71°07.000	139°17.700	High Volume Water Pumping ↓	2043	16	126	13	1.3	0.0	1007.2	95	7/10
3a	L1	Long	02/Sep/2009	03h00	UTC-6	71°06.280	139°20.380	High Volume Water Pumping ↑	2044	25	140	11	1.3	0.0	1008.2	96	7/10
3a	L1	Long	02/Sep/2009	03h20	UTC-6	71°06.280	139°20.640	CTD-Rosette ↓	2048	26	145	11	1.4	0.0	1008.3	96	7/10
3a	L1	Long	02/Sep/2009	04h33	UTC-6	71°06.400	139°21.330	CTD-Rosette ↑	2050	30	148	10	1.2	0.0	1008.4	97	7/10
3a	L1	Long	02/Sep/2009	05h12	UTC-6	71°06.520	139°21.490	TM-Rosette ↓	2053	31	149	11	1.3	0.0	1008.5	97	7/10

Appendix 2 - Scientific log of activities conducted during the 2009 ArcticNet Expedition

Leg	Station ID	Station Type	Local Date	Local Time	UTC to local	Latitude (N)	Longitude (W)	Activity	Depth (m)	Heading (°)	Wind		Air (ºC)	Water (ºC)	Pr Baro	Hum (%)	Ice
											Dir	Speed					
3a	L1	Long	02/Sep/2009	06h39	UTC-6	71°06.760	139°21.180	TM-Rosette ↑	2052	33	137	11	1.1	0.0	1008.9	98	7/10
3a	L1	Long	02/Sep/2009	07h07	UTC-6	71°06.810	139°20.890	CTD-Rosette ↓	2051	34	141	10	1.3	0.0	1009.1	97	7/10
3a	L1	Long	02/Sep/2009	08h10	UTC-6	71°06.800	139°20.100	Scatterometer ↓	2048	33	138	11	1.4	0.0	1009.3	96	6/10
3a	L1	Long	02/Sep/2009	08h20	UTC-6	71°06.800	139°19.800	Scatterometer ↑	2046	34	144	11	1.5	0.0	1009.3	96	6/10
3a	L1	Long	02/Sep/2009	08h40	UTC-6	71°06.800	139°19.500	CTD-Rosette ↑	2044	34	139	9	1.6	0.0	1009.6	96	6/10
3a	L1	Long	02/Sep/2009	08h47	UTC-6	71°06.800	139°19.300	On Ice Sampling ↓	2044	35	142	10	1.7	0.0	1009.6	95	6/10
3a	L1	Long	02/Sep/2009	10h12	UTC-6	71°06.500	139°18.200	EM Sampling (helicopter) ↓	2038	36	141	14	1.9	0.0	1009.5	95	6/10
3a	L1	Long	02/Sep/2009	10h30	UTC-6	71°06.500	139°18.100	TM-Rosette↓	2038	37	139	14	2.2	0.0	1009.4	94	6/10
3a	L1	Long	02/Sep/2009	10h38	UTC-6	71°06.400	139°18.000	TM-Rosette ↑	2037	37	140	13	2.3	0.0	1009.5	94	6/10
3a	L1	Long	02/Sep/2009	10h48	UTC-6	71°06.400	139°17.900	On Ice Sampling ↑	2035	37	143	11	2.3	0.0	1009.5	94	6/10
3a	L1	Long	02/Sep/2009	11h21	UTC-6	71°06.200	139°17.800	CTD-Rosette ↓	2034	37	133	10	3.2	0.0	1009.8	90	6/10
3a	L1	Long	02/Sep/2009	12h15	UTC-6	71°05.830	139°17.650	EM sampling (helicopter) ↑	2031	38	240	4	2.1	0.0	1010.5	92	6/10
3a	L1	Long	02/Sep/2009	12h42	UTC-6	71°05.640	139°17.660	CTD-Rosette ↑	2025	39	165	5	2.9	0.0	1010.6	88	6/10
3a	L1	Long	02/Sep/2009	13h04	UTC-6	71°05.490	139°17.710	On Ice Sampling (beacon replacement) ↓	2023	40	150	5	3.2	0.0	1010.6	91	7/10
3a	L1	Long	02/Sep/2009	13h14	UTC-6	71°05.430	139°17.750	On Ice Sampling (beacon replaced) ↑	2022	40	130	3	3.2	0.0	1010.6	91	7/10
3a	L1	Long	02/Sep/2009	13h58	UTC-6	71°05.140	139°18.090	TM-Rosette ↓	2021	42	130	6	2.2	0.0	1010.7	95	7/10
3a	L1	Long	02/Sep/2009	15h23	UTC-6	71°04.760	139°19.220	TM-Rosette ↑	2024	45	105	9	1.9	0.0	1010.7	95	7/10
3a	L1	Long	02/Sep/2009	15h51	UTC-6	71°06.590	139°17.990	Weather Balloon	2037	6	123	12	2.0	0.0	1010.5	95	7/10
3a	L1-5	Long	03/Sep/2009	08h50	UTC-6	73°19.000	139°23.100	TM-Rosette ↓	3251	215	310	9	0.3	-0.2	1009.6	99	7/10
3a	L1-5	Long	03/Sep/2009	09h45	UTC-6	73°18.800	139°22.800	TM-Rosette ↑	3247	195	280	10	0.4	-0.2	1009.9	99	7/10
3a	L2	Long	03/Sep/2009	18h09	UTC-6	74°39.150	137°22.920	CTD-Rosette ↓	3370	133	215	15	0.5	-0.5	1005.1	99	8/10
3a	L2	Long	03/Sep/2009	19h07	UTC-6	74°38.900	137°21.500	Cage Sampling ↓	3367	138	226	15	0.5	-0.5	1004.3	99	8/10
3a	L2	Long	03/Sep/2009	19h20	UTC-6	74°38.850	137°21.320	Cage Sampling ↑	3366	142	222	16	0.5	-0.5	1004.0	99	8/10
3a	L2	Long	03/Sep/2009	20h30	UTC-6	74°38.600	137°20.500	CTD-Rosette ↑	3365	155	221	14	0.0	-0.4	1003.0	99	8/10
3a	L2	Long	03/Sep/2009	21h05	UTC-6	74°38.600	137°20.200	TM-Rosette ↓	3366	161	223	14	0.1	-0.4	1002.9	99	8/10
3a	L2	Long	03/Sep/2009	22h16	UTC-6	74°38.500	137°19.200	Weather Balloon	3373	158	230	15	0.0	-0.4	1002.3	99	9/10
3a	L2	Long	03/Sep/2009	23h05	UTC-6	78°38.500	137°18.400	TM-Rosette ↑	3369	157	232	14	-0.2	-0.4	1001.8	99	9/10
3a	L2	Long	04/Sep/2009	00h23	UTC-6	74°38.650	137°17.000	CTD-Rosette ↓	3367	156	235	11	-0.2	-0.4	1001.1	99	9/10
3a	L2	Long	04/Sep/2009	00h27	UTC-6	74°38.650	137°16.890	Weather Balloon	3367	156	230	12	-0.2	-0.4	1000.9	99	9/10
3a	L2	Long	04/Sep/2009	01h07	UTC-6	74°38.650	137°15.990	CTD-Rosette ↑	3369	157	240	13	-0.2	-0.4	1000.7	99	9/10
3a	L2	Long	04/Sep/2009	01h46	UTC-6	74°38.620	137°14.990	Water Pumping Deployment (moonpool)	3374	158	245	13	-0.2	-0.4	1000.5	99	9/10
3a	L2	Long	04/Sep/2009	05h46	UTC-6	74°37.090	137°08.830	Water Pumping (moonpool) ↓	3339	163	285	15	-0.4	-0.3	1001.1	99	8/10
3a	L2	Long	04/Sep/2009	07h24	UTC-6	74°36.130	137°07.650	Water Pumping (moonpool) ↑	3336	156	282	15	-1.4	-0.4	1001.8	90	8/10
3a	L2	Long	04/Sep/2009	08h12	UTC-6	74°35.600	137°07.300	Weather Balloon	3334	168	275	19	-1.1	-0.4	1001.8	94	9/10
3a	L2	Long	04/Sep/2009	08h14	UTC-6	74°35.600	137°07.300	CTD-Rosette ↓	3331	168	273	18	-1.1	-0.4	1001.8	94	9/10
3a	L2	Long	04/Sep/2009	08h46	UTC-6	74°35.300	137°07.100	CTD-Rosette ↑	3338	167	267	20	-1.1	-0.4	1001.8	93	9/10
3a	L2	Long	04/Sep/2009	10h16	UTC-6	74°34.900	137°06.600	TM-Rosette ↓	3331	160	269	24	-0.6	-0.4	1001.6	93	9/10
3a	L2	Long	04/Sep/2009	11h00	UTC-6	74°34.900	137°05.800	TM-Rosette ↑	3330	158	260	24	-0.4	-0.4	999.2	94	9/10
3a	L2	Long	04/Sep/2009	11h14	UTC-6	74°34.870	137°04.880	On Ice Sampling ↓	3329	158	265	22	-0.4	-0.4	1001.5	93	9/10
3a	L2	Long	04/Sep/2009	12h35	UTC-6	74°34.850	137°03.360	CTD-Rosette ↓	3329	158	264	27	-0.3	-0.4	1001.3	93	9/10
3a	L2	Long	04/Sep/2009	12h43	UTC-6	74°34.850	137°03.360	On Ice Sampling ↑	3329	158	264	27	-0.3	-0.4	1001.3	93	9/10
3a	L2	Long	04/Sep/2009	13h21	UTC-6	74°34.800	137°01.470	CTD-Rosette ↑	3327	158	263	26	-0.3	-0.4	1001.3	94	9/10
3a	L2	Long	04/Sep/2009	15h26	UTC-6	74°34.160	136°54.800	CTD-Rosette ↓	3319	172	270	30	0.2	-0.4	1000.9	93	9/10
3a	L2	Long	04/Sep/2009	17h50	UTC-6	74°32.470	136°47.410	CTD-Rosette ↑	3303	170	284	26	-0.1	-0.4	1002.1	89	9/10
3a	L2	Long	04/Sep/2009	18h49	UTC-6	74°31.600	136°45.600	TM-Rosette ↓	3295	190	280	26	-0.1	-0.4	1002.5	91	9/10

Appendix 2 - Scientific log of activities conducted during the 2009 ArcticNet Expedition

Leg	Station ID	Station Type	Local Date	Local Time	UTC to local	Latitude (N)	Longitude (W)	Activity	Depth (m)	Heading (°)	Wind		Air (ºC)	Water (ºC)	Pr Baro	Hum (%)	Ice
											Dir	Speed					
3a	L2	Long	04/Sep/2009	18h49	UTC-6	74°31.600	136°45.500	On Ice Sampling ↓	3295	190	280	26	-0.1	-0.4	1002.5	91	9/10
3a	L2	Long	04/Sep/2009	18h40	UTC-6	74°31.600	136°45.500	Scatterometer ↓	3295	190	280	26	-0.1	-0.4	1002.5	91	9/10
3a	L2	Long	04/Sep/2009	19h05	UTC-6	74°31.240	136°44.880	On Ice Sampling ↑	3294	195	283	31	0.0	-0.4	1002.6	87	9/10
3a	L2	Long	04/Sep/2009	19h21	UTC-6	74°30.980	136°44.460	TM-Rosette ↑	3296	194	285	31	0.0	-0.4	1003.1	87	9/10
3a	L2	Long	04/Sep/2009	19h30	UTC-6	74°30.750	136°44.190	Cage Sampling ↓	3293	195	296	31	0.0	-0.4	1003.1	87	9/10
3a	L2	Long	04/Sep/2009	19h55	UTC-6	74°30.440	136°43.820	Cage Sampling ↑	3290	190	290	25	-0.3	-0.4	1003.5	89	8/10
3a	L2	Long	04/Sep/2009	21h37	UTC-6	74°26.500	136°28.000	CTD-Rosette ↓	3242	205	300	19	-0.4	-0.5	1005.1	87	8/10
3a	L2	Long	04/Sep/2009	21h52	UTC-6	74°26.300	136°28.200	CTD-Rosette ↑	3241	182	300	22	-0.8	-0.5	1005.5	96	8/10
3a	L2	Long	04/Sep/2009	22h39	UTC-6	74°25.900	136°28.800	CTD-Rosette ↓	3240	182	300	24	-0.6	-0.5	1006.1	88	8/10
3a	L2	Long	04/Sep/2009	22h49	UTC-6	74°25.800	136°28.900	CTD-Rosette ↑	3240	182	303	25	-0.6	-0.5	1006.2	88	8/10
3a	L2	Long	04/Sep/2009	23h24	UTC-6	74°25.600	136°29.300	CTD-Rosette ↓	3240	215	320	22	-0.8	-0.5	1006.7	90	8/10
3a	L2	Long	04/Sep/2009	23h29	UTC-6	74°25.500	136°29.400	CTD-Rosette ↑ (canceled)	3240	209	311	20	-0.8	-0.5	1006.7	90	8/10
3a	L2	Long	04/Sep/2009	23h39	UTC-6	74°25.400	136°29.500	CTD-Rosette ↓	3241	200	309	23	-0.7	-0.5	1006.8	88	8/10
3a	L2	Long	04/Sep/2009	23h48	UTC-6	74°25.400	136°29.600	CTD-Rosette ↑	3241	189	305	21	-0.8	-0.5	1007.0	88	8/10
3a	L2	Long	05/Sep/2009	00h30	UTC-6	74°25.150	136°30.030	TM-Rosette ↓	3241	207	306	22	-0.9	-0.5	1007.6	91	8/10
3a	L2	Long	05/Sep/2009	00h47	UTC-6	74°25.080	136°30.130	TM-Rosette ↑	3242	213	302	20	-1.1	-0.5	1007.9	86	8/10
3a	L2	Long	05/Sep/2009	01h25	UTC-6	74°25.040	136°30.010	CTD-Rosette ↓	3241	213	307	18	-1.0	-0.5	1008.1	84	8/10
3a	L2	Long	05/Sep/2009	01h36	UTC-6	74°25.040	136°29.920	CTD-Rosette ↑	3241	213	297	21	-1.0	-0.5	1008.3	86	8/10
3a	L2	Long	05/Sep/2009	02h48	UTC-6	74°25.910	136°30.060	CTD-Rosette ↓	3242	209	301	16	-1.1	-0.5	1009.2	91	7/10
3a	L2	Long	05/Sep/2009	05h18	UTC-6	74°24.800	136°24.880	CTD-Rosette ↑	3228	200	289	10	-1.3	-0.5	1010.3	86	7/10
3a	L2	Long	05/Sep/2009	06h48	UTC-6	74°25.200	136°26.430	Water Pumping (moonpool) ↓	3233	290	236	11	-1.8	-0.5	1010.4	89	7/10
3a	L2	Long	05/Sep/2009	09h44	UTC-6	74°24.200	136°26.000	On Ice Sampling ↓	3228	200	203	10	-1.3	-0.6	1009.2	95	7/10
3a	L2	Long	05/Sep/2009	09h50	UTC-6	74°24.000	136°25.000	MOB ↓	3228	198	198	10	-1.3	-0.6	1009.1	96	7/10
3a	L2	Long	05/Sep/2009	10h07	UTC-6	74°24.100	136°25.400	TM-Rosette ↓↑	3228	187	192	9	-1.4	-0.6	1008.9	96	7/10
3a	L2	Long	05/Sep/2009	11h06	UTC-6	74°24.100	136°26.100	MOB ↑	3228	144	187	14	-1.1	-0.6	1007.7	97	7/10
3a	L2	Long	05/Sep/2009	11h13	UTC-6	74°24.200	136°25.900	On Ice Sampling ↑	3228	115	185	14	-1.0	-0.6	1007.5	97	7/10
3a	L2	Long	05/Sep/2009	12h27	UTC-6	74°25.060	136°26.130	TM-Rosette ↓	3231	83	160	17	-0.5	-0.6	1005.1	95	8/10
3a	L2	Long	05/Sep/2009	13h13	UTC-6	74°25.580	136°26.690	Weather Balloon	3236	89	155	21	-0.5	-0.6	1003.9	93	8/10
3a	L2	Long	05/Sep/2009	14h40	UTC-6	74°25.830	136°25.060	TM-Rosette ↑	3236	80	180	23	0.1	-0.6	1001.7	94	8/10
3a	L2	Long	05/Sep/2009	18h20	UTC-6	74°27.260	136°19.710	TM-Rosette ↓	3240	245	262	23	0.8	-0.7	1000.0	99	8/10
3a	L2	Long	05/Sep/2009	18h24	UTC-6	74°27.240	136°19.470	Weather Balloon	3240	245	260	22	0.8	-0.7	1000.0	99	8/10
3a	L2	Long	05/Sep/2009	18h28	UTC-6	74°27.230	136°19.080	TM-Rosette ↑	3240	220	260	22	0.8	-0.7	1000.0	99	8/10
3a	L2	Long	05/Sep/2009	19h04	UTC-6	74°26.810	136°14.320	Water Pumping (deployment)	3234	280	285	27	0.7	-0.7	1000.6	99	8/10
3a	L2	Long	05/Sep/2009	19h40	UTC-6	74°26.670	136°14.180	Water Pumping ↓	3234	280	285	25	0.7	-0.7	1000.9	98	8/10
3a	L2	Long	05/Sep/2009	23h30	UTC-6	74°23.300	136°09.300	Water Pumping ↑	3213	176	288	23	0.3	-0.7	1004.8	84	8/10
3a	L2	Long	06/Sep/2009	00h22	UTC-6	74°22.920	136°09.510	TM-Rosette ↓	3212	197	280	18	0.3	-0.7	1005.1	84	8/10
3a	L2	Long	06/Sep/2009	01h08	UTC-6	74°22.710	136°10.050	TM-Rosette ↑	3212	166	265	16	0.6	-0.7	1005.6	83	8/10
3a	L2	Long	06/Sep/2009	09h42	UTC-6	74°25.300	133°54.300	On Ice Sampling ↓	3236	27	215	10	-0.9	-0.8	1006.3	95	9+/10
3a	L2	Long	06/Sep/2009	10h02	UTC-6	74°25.200	133°53.600	Helicopter Deployed	3109	27	212	10	-0.6	-0.8	1006.1	94	9+/10
3a	L2	Long	06/Sep/2009	10h10	UTC-6	74°25.100	133°53.400	On Ice Sampling ↑	3113	27	212	12	-0.8	-0.8	1006.3	95	9+/10
3a	L2	Long	06/Sep/2009	11h30	UTC-6	74°26.400	133°21.000	Helicopter Recovered	3045	300	204	14	-0.8	-0.9	1005.6	96	9/10
3a	L2	Long	06/Sep/2009	14h32	UTC-6	74°26.250	133°22.940	On Ice Sampling ↓	3051	77	210	15	0.2	-0.85	1005.4	94	9/10
3a	L2	Long	06/Sep/2009	14h35	UTC-6	74°26.250	133°22.990	On Ice Sampling ↑	3051	78	200	14	0.2	-0.85	1005.4	94	9/10
3a	L2	Long	06/Sep/2009	14h35	UTC-6	74°26.250	133°23.000	EM Sampling ↓	3051	78	200	14	0.2	-0.85	1005.4	94	9/10
3a	L2	Long	06/Sep/2009	14h44	UTC-6	74°26.260	133°23.130	On Ice Sampling (beacon) ↓	3052	77	210	13	0.2	-0.85	1005.2	94	9/10

Appendix 2 - Scientific log of activities conducted during the 2009 ArcticNet Expedition

Leg	Station ID	Station Type	Local Date	Local Time	UTC to local	Latitude (N)	Longitude (W)	Activity	Depth (m)	Heading (°)	Wind		Air (ºC)	Water (ºC)	Pr Baro	Hum (%)	Ice
											Dir	Speed					
3a	L2	Long	06/Sep/2009	14h50	UTC-6	74°26.270	133°23.180	On Ice Sampling (beacon installed)	3051	77	205	14	0.2	-0.85	1005.1	94	9/10
3a	L2	Long	07/Sep/2009	00h15	UTC-6	74°33.830	134°53.900	Weather Balloon	2464	315	253	29	-0.5	-1.0	1001.8	82	9/10
3a	L3	Long	07/Sep/2009	08h04	UTC-6	75°19.500	137°39.600	CTD-Rosette ↓	3490	280	284	21	-0.9	-0.9	1006.3	83	7/10
3a	L3	Long	07/Sep/2009	10h40	UTC-6	75°16.900	137°35.000	CTD-Rosette ↑	3490	280	278	19	-1.0	-0.9	1008.9	87	7/10
3a	L3	Long	07/Sep/2009	11h15	UTC-6	75°16.900	137°35.200	Water Pumping ↓	3482	300	282	20	-1.0	-0.9	1008.9	87	7/10
3a	L3	Long	07/Sep/2009	12h54	UTC-6	75°16.990	137°35.590	EM Sampling ↓	3483	313	270	18	-0.9	-0.9	1009.4	86	7/10
3a	L3	Long	07/Sep/2009	13h22	UTC-6	75°16.980	137°35.690	EM Sampling ↑	3483	340	290	17	-1.2	-0.9	1009.8	93	7/10
3a	L3	Long	07/Sep/2009	14h37	UTC-6	75°17.380	137°35.920	Weather Balloon	3484	350	280	16	-1.2	-0.9	1010.9	90	7/10
3a	L3	Long	07/Sep/2009	15h02	UTC-6	75°17.390	137°35.870	Water Pumping ↑	3483	10	275	13	-1.2	-0.9	1010.9	90	7/10
3a	L3	Long	07/Sep/2009	15h25	UTC-6	75°16.790	137°33.880	CTD-Rosette ↓	3482	321	285	15	-1.0	-0.9	1011.1	91	7/10
3a	L3	Long	07/Sep/2009	15h48	UTC-6	75°16.750	137°33.900	CTD-Rosette ↑	3482	208	290	14	-0.9	-0.9	1011.1	90	7/10
3a	L3	Long	07/Sep/2009	16h19	UTC-6	75°16.630	137°33.440	TM-Rosette ↓	3481	296	294	17	-1.0	-0.8	1011.5	87	7/10
3a	L3	Long	07/Sep/2009	17h07	UTC-6	75°16.640	137°33.290	TM-Rosette ↑	3481	269	280	15	-1.0	-0.8	1011.9	88	7/10
3a	L3	Long	07/Sep/2009	18h19	UTC-6	75°16.890	137°28.750	CTD-Rosette ↓	3474	278	287	12	-1.1	-0.8	1012.5	92	7/10
3a	L3	Long	07/Sep/2009	20h49	UTC-6	75°16.400	137°26.700	CTD-Rosette ↑	3470	276	276	15	-2.1	-0.8	1013.4	94	7/10
3a	L3	Long	08/Sep/2009	09h29	UTC-6	73°16.600	135°34.800	EM Sampling ↓	3527	105	0	6	-2.1	-0.9	1018.5	87	9/10
3a	N/A	N/A	08/Sep/2009	15h05	UTC-6	72°40.400	136°02.600	Helicopter Deployed	2458	225	221	9	-1.1	-0.9	1018.8	84	9/10
3a	N/A	N/A	08/Sep/2009	17h06	UTC-6	72°30.520	136°34.820	Helicopter Recovered	2530	Var	33	6	-1.6	-0.9	1016.1	87	9/10
3a	L1-1	Long	08/Sep/2009	17h10	UTC-6	72°30.580	136°35.130	Scatterometer ↓	2527	304	65	7	-0.2	-0.9	1018.6	80	8/10
3a	L1-1	Long	08/Sep/2009	17h25	UTC-6	72°30.580	136°35.130	Scatterometer ↑	2527	304	65	7	-0.2	-0.9	1018.6	80	8/10
3a	L1-1	Long	08/Sep/2009	17h49	UTC-6	72°30.630	136°35.490	On Ice Sampling ↓	2530	329	37	6	-1.7	-0.9	1018.6	86	8/10
3a	L1-1	Long	08/Sep/2009	18h10	UTC-6	72°30.700	136°35.680	On Ice Sampling ↑	2532	303	37	7	-1.2	-0.8	1018.5	83	8/10
3a	L1-1	Long	08/Sep/2009	18h18	UTC-6	72°30.730	136°35.750	TM-Rosette ↓	2533	318	27	9	-1.2	-0.8	1018.5	83	8/10
3a	L1-1	Long	08/Sep/2009	18h28	UTC-6	72°30.760	136°35.860	TM-Rosette ↑	2531	305	30	7	-2.0	-0.8	1018.5	87	8/10
3a	L1-1	Long	08/Sep/2009	19h02	UTC-6	72°30.820	136°35.950	CTD-Rosette ↓	2531	258	18	8	-1.7	-0.8	1018.5	88	8/10
3a	L1-1	Long	08/Sep/2009	20h59	UTC-6	72°30.600	136°35.500	CTD-Rosette ↑	2528	306	58	9	-2.2	-0.8	1018.5	90	8/10
3a	L1-1	Long	08/Sep/2009	21h32	UTC-6	72°30.300	136°35.200	TM-Rosette ↓	2525	297	51	11	-2.3	-0.8	1018.5	90	8/10
3a	L1-1	Long	08/Sep/2009	21h55	UTC-6	72°30.100	136°35.100	TM-Rosette ↑	2525	297	61	9	-2.3	-0.8	1018.5	90	8/10
3a	L1-1	Long	08/Sep/2009	23h35	UTC-6	72°29.500	136°35.000	Water Pumping ↓	2516	20	93	10	-4.1	-0.7	1018.7	97	8/10
3a	L1-1	Long	09/Sep/2009	03h16	UTC-6	72°29.160	136°40.550	Water Pumping ↑	2517	72	60	7	-5.4	-0.7	1018.4	96	8/10
3a	L1-1	Long	09/Sep/2009	04h14	UTC-6	72°29.500	136°43.340	CTD-Rosette ↓	2525	58	63	8	-5.3	-0.7	1018.2	96	8/10
3a	L1-1	Long	09/Sep/2009	05h21	UTC-6	72°29.890	136°44.830	CTD-Rosette ↑	2529	84	58	8	-5.3	-0.7	1018.3	96	8/10
3a	L1-1	Long	09/Sep/2009	06h11	UTC-6	72°30.060	136°45.880	TM-Rosette ↓	2528	74	61	9	-5.3	-0.7	1018.4	96	8/10
3a	L1-1	Long	09/Sep/2009	06h40	UTC-6	72°30.250	136°46.450	TM-Rosette ↑	2547	31	83	8	-5.3	-0.7	1018.5	96	8/10
3a	L1-1	Long	09/Sep/2009	08h32	UTC-6	72°30.900	136°47.400	CTD-Rosette ↓	2543	295	63	8	-4.6	-0.7	1018.3	96	9/10
3a	L1-1	Long	09/Sep/2009	08h53	UTC-6	72°30.900	136°47.500	CTD-Rosette ↑	2542	351	65	7	-4.7	-0.7	1018.4	96	9/10
3a	L1-1	Long	09/Sep/2009	09h30	UTC-6	72°31.100	136°47.900	EM Sampling ↓	2554	340	64	7	-4.7	-0.7	1018.3	95	9/10
3a	L1-1	Long	09/Sep/2009	09h35	UTC-6	72°31.000	136°47.700	Zodiac Deployed	2533	272	62	10	-4.0	-0.7	1018.4	96	9/10
3a	L1-1	Long	09/Sep/2009	10h24	UTC-6	72°30.700	136°47.000	Zodiac Recovered	2535	146	58	13	-4.2	-0.7	1018.3	95	9/10
3a	L1-1	Long	09/Sep/2009	10h50	UTC-6	72°30.800	136°44.300	MOB ↓ On Ice Sampling ↓	2536	65	71	17	-4.8	-0.7	1018.3	95	9/10
3a	L1-1	Long	09/Sep/2009	11h30	UTC-6	72°30.700	136°45.000	EM Sampling ↑	2534	350	73	15	-3.9	-0.7	1018.2	96	9/10
3a	L1-1	Long	09/Sep/2009	12h25	UTC-6	72°30.700	136°46.400	TM-Rosette ↓	2534	353	80	15	-4.2	-0.7	1018.1	96	9/10
3a	L1-1	Long	09/Sep/2009	14h20	UTC-6	72°30.700	136°50.400	Weather Balloon	2540	2	80	17	-3.2	-0.7	1019.9	90	9/10
3a	L1-1	Long	09/Sep/2009	14h26	UTC-6	72°30.700	136°50.400	TM-Rosette ↑	2540	2	80	17	-3.2	-0.7	1017.9	90	9/10
3a	L1-1	Long	09/Sep/2009	15h13	UTC-6	72°30.100	136°50.000	On Ice Sampling ↑	2533	59	80	15	-2.8	-0.7	1018.0	88	9/10

Appendix 2 - Scientific log of activities conducted during the 2009 ArcticNet Expedition

Leg	Station ID	Station Type	Local Date	Local Time	UTC to local	Latitude (N)	Longitude (W)	Activity	Depth (m)	Heading (°)	Wind		Air (ºC)	Water (ºC)	Pr Baro	Hum (%)	Ice
											Dir	Speed					
3a	L1-1	Long	09/Sep/2009	15h30	UTC-6	72°29.600	136°55.500	Water Pumping (moonpool deployment)	2554	47	85	17	-2.9	-0.7	1018.0	88	9/10
3a	L1-1	Long	09/Sep/2009	16h05	UTC-6	71°29.860	136°56.290	Water Pumping ↓	2535	67	85	15	-2.5	-0.7	1017.9	87	9/10
3a	L1-1	Long	09/Sep/2009	16h39	UTC-6	72°30.000	136°56.000	MOB ↑	2537	77	85	15	-2.4	-0.7	1017.9	88	9/10
3a	L1-1	Long	09/Sep/2009	18h29	UTC-6	72°30.910	136°59.030	Helicopter Recovered	2543	80	88	17	-2.9	-0.6	1017.9	93	9/10
3a	L1-1	Long	09/Sep/2009	19h42	UTC-6	72°31.510	136°59.650	Water Pumping (moonpool recovery)	2547	72	84	18	-3.3	-0.6	1017.7	97	9/10
3a	L1-1	Long	09/Sep/2009	20h12	UTC-6	72°31.600	136°59.600	Water Pumping ↑	2549	85	76	20	-3.3	-0.6	1017.7	97	9/10
3a	L1-1	Long	09/Sep/2009	20h51	UTC-6	72°32.200	136°55.800	CTD-Rosette ↓	2552	83	80	16	-3.4	-0.6	1017.6	97	9/10
3a	L1-1	Long	09/Sep/2009	22h38	UTC-6	72°32.400	136°55.500	CTD-Rosette ↑	2553	80	80	17	-3.7	-0.6	1017.7	97	9/10
3a	L1-1	Long	09/Sep/2009	23h00	UTC-6	72°32.400	136°55.400	TM-Rosette ↓	2551	80	80	18	-3.7	-0.6	1017.7	97	9/10
3a	L1-1	Long	10/Sep/2009	00h31	UTC-6	72°32.400	136°55.300	TM-Rosette ↑	2563	82	75	16	-3.4	-0.6	1017.5	98	9/10
3a	L1-1	Long	10/Sep/2009	02h00	UTC-6	72°32.600	136°59.200	CTD-Rosette ↓	2555	68	80	18	-3.2	-0.5	1017.4	98	9/10
3a	L1-1	Long	10/Sep/2009	02h26	UTC-6	72°32.700	136°59.100	CTD-Rosette ↑	2557	69	85	15	-3.2	-0.5	1017.4	98	9/10
3a	L1-1	Long	10/Sep/2009	03h16	UTC-6	72°32.500	137°03.200	CTD-Rosette ↓	2558	79	85	22	-3.0	-0.5	1016.9	98	9/10
3a	L1-1	Long	10/Sep/2009	03h39	UTC-6	72°32.700	137°03.400	CTD-Rosette ↑	2559	76	85	18	-2.8	-0.5	1016.8	98	9/10
3a	L1-1	Long	10/Sep/2009	04h11	UTC-6	72°32.910	137°04.070	CTD-Rosette ↓	2560	88	85	20	-2.8	-0.5	1016.8	98	9/10
3a	L1-1	Long	10/Sep/2009	04h19	UTC-6	72°32.970	137°04.420	CTD-Rosette ↑	2562	79	84	18	-2.8	-0.5	1016.8	98	9/10
3a	L1-1	Long	10/Sep/2009	04h56	UTC-6	72°33.260	137°05.530	CTD-Rosette ↓	2567	76	86	21	-2.7	-0.5	1016.5	97	9/10
3a	L1-1	Long	10/Sep/2009	05h04	UTC-6	72°33.340	137°05.630	CTD-Rosette ↑	2566	81	78	21	-2.6	-0.5	1016.4	97	9/10
3a	L1-1	Long	10/Sep/2009	05h35	UTC-6	72°33.550	137°07.090	Water Pumping (moonpool deployment)	2570	80	83	22	-2.5	-0.5	1016.1	96	9/10
3a	L1-1	Long	10/Sep/2009	06h08	UTC-6	72°33.730	137°06.990	Water Pumping ↓	2573	93	80	22	-2.5	-0.5	1016.1	95	9/10
3a	L1-1	Long	10/Sep/2009	09h14	UTC-6	72°34.900	137°09.000	Water Pumping ↑	2587	80	83	21	-2.0	-0.4	1015.2	92	9/10
3a	L1-1	Long	10/Sep/2009	10h13	UTC-6	72°35.200	137°08.600	CTD-Rosette ↓	2590	86	87	20	-1.7	-0.4	1014.9	91	9/10
3a	L1-1	Long	10/Sep/2009	12h00	UTC-6	72°35.600	137°09.600	CTD-Rosette ↑	2594	87	95	23	-1.9	-0.4	1014.5	97	9/10
3a	L1-1	Long	10/Sep/2009	12h40	UTC-6	72°35.900	137°10.600	Water Pumping (moonpool deployment)	2600	87	95	24	-1.7	-0.4	1014.3	99	9/10
3a	L1-1	Long	10/Sep/2009	14h50	UTC-6	72°36.300	137°13.100	Weather Balloon	2606	99	95	20	-0.1	-0.4	1013.5	99	9/10
3a	L1-1	Long	10/Sep/2009	16h00	UTC-6	72°36.700	137°14.500	Water Pumping (moonpool recovery)	2612	104	101	22	0.1	-0.3	1012.9	99	9/10
3a	L1-1	Long	10/Sep/2009	16h57	UTC-6	72°37.100	137°15.600	Water Pumping ↑	2615	100	100	25	0.2	-0.3	1012.2	99	9/10
3a	L1-1	Long	10/Sep/2009	17h17	UTC-6	72°37.300	137°19.600	CTD-Rosette ↓	2626	115	105	24	0.2	-0.3	1012.2	99	9/10
3a	L1-1	Long	10/Sep/2009	17h30	UTC-6	72°37.400	137°19.700	CTD-Rosette ↑	2628	106	104	23	0.3	-0.3	1012.5	99	9/10
3a	L1-1	Long	10/Sep/2009	17h53	UTC-6	72°37.600	137°19.900	CTD-Rosette ↓	2631	103	106	19	0.2	-0.3	1011.9	99	9/10
3a	L1-1	Long	10/Sep/2009	18h03	UTC-6	72°37.700	137°19.800	CTD-Rosette ↑	2632	95	109	22	0.2	-0.3	1011.8	99	9/10
3a	L1-1	Long	10/Sep/2009	18h23	UTC-6	72°38.120	137°20.040	EM Sampling ↓	2634	30	107	22	0.2	-0.3	1011.6	99	9/10
3a	L1-1	Long	10/Sep/2009	18h33	UTC-6	72°38.400	137°20.350	EM Sampling ↑	2642	31	106	22	0.3	-0.3	1011.4	99	9/10
3a	L1-1	Long	10/Sep/2009	18h42	UTC-6	72°38.800	137°21.200	EM Sampling ↓	2636	268	103	20	0.3	-0.3	1011.4	99	9/10
3a	S-4	Long	11/Sep/2009	11h44	UTC-6	71°11.100	132°56.500	TM-Rosette ↓	317	115	93	18	3.4	0.2	999.3	99	0/10
3a	S-4	Long	11/Sep/2009	12h01	UTC-6	71°11.100	132°56.600	TM-Rosette ↑	317	104	100	16	3.4	0.2	999.2	99	0/10
Leg 3b																	
3b	Area-1	Mapping	14/Sep/2009	03h46	UTC-6	70°49.000	136°16.500	CTD ↓	745	320	330	18	0.0	1.9	1008.7	99	0/10
3b	Area-1	Mapping	14/Sep/2009	04h10	UTC-6	70°48.900	136°16.900	CTD ↑	735	310	330	16	0.0	1.9	1009.0	99	0/10
3b	Area-1	Mapping	14/Sep/2009	04h50	UTC-6	70°48.730	136°03.050	Bottom Mapping ↓	767	236	330	16	0.0	1.9	1009.0	99	0/10
3b	Area-1	Mapping	14/Sep/2009	07h05	UTC-6	70°41.440	136°38.850	Bottom Mapping ↑	971	236	320	20	0.0	1.4	1010.4	96	0/10
3b	Area-1	Mapping	14/Sep/2009	07h40	UTC-6	70°41.250	136°20.260	Bottom Mapping ↓	652	34	313	22	-0.3	1.3	1010.8	96	0/10
3b	Area-1	Mapping	14/Sep/2009	09h40	UTC-6	70°50.100	136°02.700	Bottom Mapping ↑	794	36	315	17	-0.3	2.0	1011.4	97	0/10
3b	Area-2	Mapping	14/Sep/2009	09h49	UTC-6	70°50.100	136°02.800	CTD ↓	794	333	316	17	-0.3	2.0	1011.4	97	0/10
3b	Area-2	Mapping	14/Sep/2009	10h15	UTC-6	70°50.100	136°03.000	CTD ↑	794	350	317	20	-0.3	1.9	1011.7	96	0/10

Appendix 2 - Scientific log of activities conducted during the 2009 ArcticNet Expedition

Leg	Station ID	Station Type	Local Date	Local Time	UTC to local	Latitude (N)	Longitude (W)	Activity	Depth (m)	Heading (°)	Wind Dir	Wind Speed	Air (ºC)	Water (ºC)	Pr Baro	Hum (%)	Ice
3b	Area-2	Mapping	14/Sep/2009	10h34	UTC-6	70°49.400	136°05.160	Bottom Mapping ↓	797	191	326	16	0.4	1.8	1012.2	96	0/10
3b	Area-2	Mapping	14/Sep/2009	12h40	UTC-6	70°38.500	136°09.400	Bottom Mapping ↑	481	192	300	15	0.6	2.2	1013.7	95	0/10
3b	Area-2	Mapping	14/Sep/2009	12h55	UTC-6	70°49.300	136°06.000	Bottom Mapping ↓	451	358	300	18	-0.2	2.2	1013.7	97	0/10
3b	Area-2	Mapping	14/Sep/2009	14h39	UTC-6	70°49.200	136°06.000	Bottom Mapping ↑	797	358	310	19	0.3	2.1	1014.5	96	0/10
3b	Area-2	Mapping	14/Sep/2009	15h08	UTC-6	70°47.500	136°14.300	Bottom Mapping ↓	761	148	310	15	0.5	2.1	1014.5	96	0/10
3b	Area-2	Mapping	14/Sep/2009	15h45	UTC-6	70°44.900	136°09.800	Bottom Mapping ↑	616	148	315	14	2.0	2.1	1015.8	92	0/10
3b	Area-2	Mapping	14/Sep/2009	15h45	UTC-6	70°44.900	136°09.800	Bottom Mapping ↓	616	135	315	14	2.0	2.1	1015.8	92	0/10
3b	Area-2	Mapping	14/Sep/2009	17h03	UTC-6	70°39.000	135°52.400	Bottom Mapping ↑	242	133	315	11	1.3	1.9	1016.5	91	0/10
3b	Area-2	Mapping	14/Sep/2009	17h03	UTC-6	70°39.000	135°52.400	Bottom Mapping ↓	242	121	315	11	1.3	1.9	1016.5	91	0/10
3b	Area-2	Mapping	14/Sep/2009	17h31	UTC-6	70°37.200	135°44.500	Bottom Mapping ↑	102	121	310	12	0.9	2.3	1016.7	93	0/10
3b	Area-2	Mapping	14/Sep/2009	17h31	UTC-6	70°37.200	135°44.500	Bottom Mapping ↓	102	137	310	12	0.9	2.3	1016.7	93	0/10
3b	Area-2	Mapping	14/Sep/2009	17h38	UTC-6	70°35.400	135°41.500	Bottom Mapping ↑	67	154	312	14	1.6	2.3	1016.8	92	0/10
3b	Area-2	Mapping	14/Sep/2009	17h48	UTC-6	70°35.400	135°41.000	Bottom Mapping ↓	65	135	308	11	1.6	2.3	1016.8	92	0/10
3b	Area-2	Mapping	14/Sep/2009	17h54	UTC-6	70°34.900	135°39.400	Bottom Mapping ↑	65	137	307	11	1.8	2.4	1016.8	91	0/10
3b	Area-3	Mapping	14/Sep/2009	18h07	UTC-6	70°34.900	135°38.700	CTD ↓	66	298	310	13	1.8	2.5	1016.9	91	0/10
3b	Area-3	Mapping	14/Sep/2009	18h13	UTC-6	70°35.900	135°38.800	CTD ↑	66	310	304	13	1.0	2.5	1017.0	94	0/10
3b	Area-3	Mapping	14/Sep/2009	18h47	UTC-6	70°36.700	135°40.000	Bottom Mapping ↓	70	313	306	13	0.7	2.7	1017.2	95	0/10
3b	Area-3	Mapping	14/Sep/2009	22h15	UTC-6	70°48.700	136°32.500	Bottom Mapping ↑	1000	307	354	5	0.6	2.3	1019.4	96	0/10
3b	Area-4	Mapping	14/Sep/2009	22h30	UTC-6	70°48.800	136°32.700	CTD ↓	993	49	350	5	0.4	2.2	1019.9	96	0/10
3b	Area-4	Mapping	14/Sep/2009	22h58	UTC-6	70°48.900	136°32.700	CTD ↑	1019	64	355	6	0.4	2.2	1019.9	96	0/10
3b	Area-4	Mapping	14/Sep/2009	23h20	UTC-6	70°46.700	136°34.800	Bottom Mapping ↓	1015	92	0	5	0.5	2.1	1020.1	97	0/10
3b	Area-4	Mapping	15/Sep/2009	02h18	UTC-6	70°47.100	135°45.300	Bottom Mapping ↑	568	88	20	3	0.1	1.1	1021.6	96	0/10
3b	Area-4	Mapping	15/Sep/2009	02h18	UTC-6	70°47.100	135°45.300	Bottom Mapping ↓	568	83	20	3	0.1	1.1	1021.6	96	0/10
3b	Area-4	Mapping	15/Sep/2009	03h15	UTC-6	70°47.900	135°27.800	Bottom Mapping ↑	431	81	60	3	0.2	1.1	1021.9	97	0/10
3b	Area-4	Mapping	15/Sep/2009	03h41	UTC-6	70°46.200	135°41.100	Bottom Mapping ↓	517	269	75	3	0.2	1.2	1022.1	97	0/10
3b	Area-4	Mapping	15/Sep/2009	06h10	UTC-6	70°45.980	136°26.520	Bottom Mapping ↑	809	270	85	6	0.8	1.8	1022.7	90	0/10
3b	Area-5	Mapping	15/Sep/2009	09h48	UTC-6	70°44.300	135°26.700	CTD ↓	262	60	122	9	1.3	1.6	1023.3	93	0/10
3b	Area-5	Mapping	15/Sep/2009	10h00	UTC-6	70°44.400	135°26.800	CTD ↑	266	74	110	9	1.6	1.9	1023.3	92	0/10
3b	Area-5	Mooring	15/Sep/2009	13h44	UTC-6	70°43.900	136°00.900	Met/Ocean Buoy Deployed	546	139	120	16	1.9	1.5	1022.7	98	0/10
3b	Area-5	Mapping	15/Sep/2009	14h39	UTC-6	70°44.500	136°22.700	CTD ↓	811	106	110	18	1.7	1.6	1022.2	99	0/10
3b	Area-5	Mapping	15/Sep/2009	15h09	UTC-6	70°44.700	136°22.500	CTD ↑	787	112	105	14	2.1	1.6	1022.2	99	0/10
3b	Area-5	Mapping	16/Sep/2009	02h03	UTC-6	70°41.800	136°43.800	Bottom Mapping ↑	1080	237	115	17	2.9	1.2	1019.6	97	0/10
3b	Area-5	Mapping	16/Sep/2009	02h53	UTC-6	70°44.200	136°26.400	Bottom Mapping ↓	918	62	120	16	3.2	1.1	1019.3	97	0/10
3b	Area-5	Mapping	16/Sep/2009	04h00	UTC-6	70°47.530	136°11.430	Bottom Mapping ↑	734	61	110	15/20	3.1	1.3	1019.4	97	0/10
3b	Area-5	Mapping	16/Sep/2009	04h07	UTC-6	70°46.810	136°09.960	Bottom Mapping ↓	693	221	110	15/20	3.1	1.3	1019.4	97	0/10
3b	Area-5	Mapping	16/Sep/2009	05h30	UTC-6	70°41.280	136°27.640	Bottom Mapping ↑	795	221	110	15/20	3.1	1.0	1018.8	97	0/10
3b	Area-5	Mapping	16/Sep/2009	06h15	UTC-6	70°42.000	136°10.500	Bottom Mapping ↓	555	25	108	15	3.1	1.0	1018.8	97	0/10
3b	Area-5	Mapping	16/Sep/2009	07h15	UTC-6	70°45.560	136°07.640	Bottom Mapping ↑	724	25	105	16	3.3	1.3	1018.3	98	0/10
3b	Area-6	Mapping	16/Sep/2009	07h21	UTC-6	70°46.540	136°06.790	CTD ↓	727	109	100	16	3.0	1.3	1018.3	98	0/10
3b	Area-6	Mapping	16/Sep/2009	07h49	UTC-6	70°46.530	136°06.820	CTD ↑	727	107	100	16	3.1	1.1	1018.3	98	0/10
3b	A	Mooring	16/Sep/2009	09h41	UTC-6	70°43.700	136°01.600	Mixed Layer Buoy A Deployed	560	105	115	14	5.2	2.6	1017.2	94	0/10
3b	B	Mooring	16/Sep/2009	11h10	UTC-6	70°39.500	135°36.400	Mixed Layer Buoy B Deployed	132	105	115	12	5.2	2.6	1017.2	94	0/10
3b	B-09	Mooring	16/Sep/2009	11h30	UTC-6	70°39.300	135°36.500	CTD ↓	117	90	116	13	5.2	2.7	1017.1	94	0/10
3b	B-09	Mooring	16/Sep/2009	11h40	UTC-6	70°39.300	135°36.500	CTD ↑	117	76	117	14	5.2	2.7	1017.1	94	0/10
3b	B-09	Mooring	16/Sep/2009	13h11	UTC-6	70°39.900	135°36.400	Mooring B-09 Recovered	160	94	120	13	5.2	2.9	1016.8	94	0/10

Appendix 2 - Scientific log of activities conducted during the 2009 ArcticNet Expedition

Leg	Station ID	Station Type	Local Date	Local Time	UTC to local	Latitude (N)	Longitude (W)	Activity	Depth (m)	Heading (°)	Wind		Air (ºC)	Water (ºC)	Pr Baro	Hum (%)	Ice
											Dir	Speed					
3b	Area-6	Mapping	16/Sep/2009	13h35	UTC-6	70°38.800	135°36.200	Bottom Mapping ↓	93	330	110	13	5.3	2.9	1016.5	94	0/10
3b	Area-6	Mapping	16/Sep/2009	14h29	UTC-6	70°44.800	135°42.900	Bottom Mapping ↑	469	343	105	14	5.1	2.9	1016.3	94	0/10
3b	Area-6	Mapping	16/Sep/2009	14h45	UTC-6	70°44.000	135°44.300	Bottom Mapping ↓	509	317	110	13	4.9	2.2	1016.3	94	0/10
3b	Area-6	Mapping	16/Sep/2009	15h53	UTC-6	70°48.800	136°00.800	Bottom Mapping ↑	772	313	95	15	5.4	1.6	1015.6	84	0/10
3b	Area-7	Mooring	16/Sep/2009	16h09	UTC-6	70°44.690	136°22.530	Calibration Mooring (start)	764	127	83	15	3.2	1.7	1013.3	96	0/10
3b	Area-7	Mooring	16/Sep/2009	22h15	UTC-6	70°44.500	136°21.700	Calibration Mooring (end)	763	58	82	19	3.5	1.7	1010.8	93	0/10
3b	Area-7	Mapping	16/Sep/2009	22h30	UTC-6	70°44.500	136°21.700	CTD-Rosette ↓	764	68	78	19	3.6	1.7	1010.8	93	0/10
3b	Area-7	Mapping	16/Sep/2009	22h35	UTC-6	70°48.800	136°07.300	Bottom Mapping ↓	788	116	69	20	2.8	1.4	1010.2	96	0/10
3b	Area-7	Mapping	16/Sep/2009	22h56	UTC-6	70°44.500	136°21.800	CTD-Rosette ↑	751	64	78	18	3.6	1.6	1010.6	94	0/10
3b	Area-7	Mapping	17/Sep/2009	00h19	UTC-6	70°47.100	135°58.900	Bottom Mapping ↑	708	115	75	22	3.2	1.1	1009.7	96	0/10
3b	Area-7	Mapping	17/Sep/2009	00h19	UTC-6	70°47.100	135°58.900	Bottom Mapping ↓	708	135	75	22	3.2	1.1	1009.7	96	0/10
3b	Area-7	Mapping	17/Sep/2009	00h47	UTC-6	70°44.400	135°52.800	Bottom Mapping ↑	593	136	75	21	3.4	1.1	1009.4	95	0/10
3b	Area-7	Mapping	17/Sep/2009	00h47	UTC-6	70°44.400	135°52.800	Bottom Mapping ↓	593	153	75	21	3.4	1.1	1009.4	95	0/10
3b	Area-7	Mapping	17/Sep/2009	00h55	UTC-6	70°43.800	135°52.200	Bottom Mapping ↑	550	155	75	21	3.4	1.1	1009.3	96	0/10
3b	Area-7	Mapping	17/Sep/2009	00h55	UTC-6	70°43.800	135°52.200	Bottom Mapping ↓	550	172	75	21	3.4	1.1	1009.3	96	0/10
3b	Area-7	Mapping	17/Sep/2009	01h54	UTC-6	70°36.800	135°50.800	Bottom Mapping ↑	138	166	80	22	4.9	1.8	1008.2	94	0/10
3b	Area-7	Mapping	17/Sep/2009	02h48	UTC-6	70°37.200	136°16.900	Bottom Mapping ↓	564	60	75	18	4.1	2.2	1007.2	95	0/10
3b	Area-7	Mapping	17/Sep/2009	04h38	UTC-6	70°43.110	135°48.190	Bottom Mapping ↑	450	57	70	20	4.0	1.5	1006.4	96	0/10
3b	Area-7	Mapping	17/Sep/2009	05h25	UTC-6	70°49.820	135°29.420	Bottom Mapping ↓	469	239	70	20	3.6	2.8	1005.6	96	0/10
3b	Area-7	Mapping	17/Sep/2009	06h53	UTC-6	70°44.200	135°52.860	Bottom Mapping (interrupted)	572	239	70	20	3.0	1.8	1005.0	96	0/10
3b	B-09	Mooring	17/Sep/2009	09h20	UTC-6	70°39.961	135°35.947	Mooring B-09 Deployed	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
3b	Area-7	Mapping	17/Sep/2009	11h40	UTC-6	70°44.300	136°41.500	Bottom Mapping ↓	1054	57	43	19	2.5	1.9	1001.1	96	0/10
3b	Area-7	Mapping	17/Sep/2009	12h13	UTC-6	70°43.800	136°25.300	Bottom Mapping (interrupted) Calibration (start)	900	54	45	21	2.1	1.7	1000.6	98	0/10
3b	Area-7	Mapping	17/Sep/2009	13h05	UTC-6	70°44.000	136°23.700	Calibration (end)	794	225	55	24	3.4	1.9	1000.7	94	0/10
3b	Area-7	Mapping	17/Sep/2009	13h55	UTC-6	70°40.300	136°14.600	Bottom Mapping ↓	555	63	50	20	2.3	1.9	999.8	98	0/10
3b	Area-7	Mapping	17/Sep/2009	15h19	UTC-6	70°44.300	135°51.800	Bottom Mapping ↑	552	64	50	21	3.3	1.4	999.0	97	0/10
3b	Area-8	Mapping	17/Sep/2009	15h45	UTC-6	70°44.600	135°52.000	CTD ↓	558	62	56	21	3.3	1.8	998.9	97	0/10
3b	Area-8	Mapping	17/Sep/2009	16h08	UTC-6	70°74.500	135°87.300	CTD ↑	569	75	58	22	3.4	1.6	998.6	97	0/10
3b	Area-8	Mapping	17/Sep/2009	16h44	UTC-6	70°42.800	135°49.310	Bottom Mapping ↓	449	324	70	21	3.5	2.2	998.3	98	0/10
3b	Area-8	Mapping	17/Sep/2009	18h05	UTC-6	70°49.210	136°10.060	Bottom Mapping ↑	800	324	55	18	2.1	1.7	997.9	99	0/10
3b	Area-8	Piston Core	17/Sep/2009	18h52	UTC-6	70°44.820	136°10.320	Piston Core ↓	613	Var	38	20	2.1	1.5	996.8	99	0/10
3b	Area-8	Piston Core	17/Sep/2009	20h28	UTC-6	70°45.000	136°17.700	Piston Core ↑	613	Var	40	20	2.1	1.5	996.2	99	0/10
3b	Area-8	Mapping	17/Sep/2009	21h50	UTC-6	70°43.600	136°29.400	Bottom Mapping ↓	427	84	35	27	2.7	3.0	992.9	98	0/10
3b	Area-8	Mapping	18/Sep/2009	00h41	UTC-6	70°43.100	136°17.800	Bottom Mapping ↑	170	83	35	27	2.9	3.4	992.5	98	0/10
3b	Area-8	Mapping	18/Sep/2009	01h48	UTC-6	70°48.100	135°56.200	Bottom Mapping ↓	709	271	35	27	2.8	3.7	992.6	99	0/10
3b	Area-8	Mapping	18/Sep/2009	04h15	UTC-6	70°47.750	136°41.040	Bottom Mapping ↑	1152	271	30	25/30	2.8	3.4	992.8	98	0/10
3b	Area-8	Mapping	18/Sep/2009	04h35	UTC-6	70°44.220	136°43.250	Bottom Mapping ↓	1288	105	30	25/30	2.8	3.4	992.8	98	0/10
3b	Area-8	Mapping	18/Sep/2009	13h00	UTC-6	70°46.700	135°38.400	Bottom Mapping ↑	456	55	20	30/35	2.4	3.4	994.9	90	0/10
3b	Area-8	Mapping	18/Sep/2009	13h20	UTC-6	70°46.200	135°37.500	Bottom Mapping ↓	460	235	20	30/35	2.4	3.4	994.9	90	0/10
3b	Area-8	Mapping	18/Sep/2009	14h32	UTC-6	70°39.000	136°11.500	Bottom Mapping ↑	515	235	15	32	1.7	3.5	996.3	94	0/10
3b	Area-8	Mapping	18/Sep/2009	14h49	UTC-6	70°38.600	136°10.300	Bottom Mapping ↓	497	54	15	30	0.9	3.2	996.2	95	0/10
3b	Area-8	Mapping	18/Sep/2009	17h07	UTC-6	70°46.100	135°35.000	Bottom Mapping ↑	126	57	20	35	1.0	3.4	997.1	96	0/10
3b	Area-8	Mapping	18/Sep/2009	17h21	UTC-6	70°45.200	135°36.000	Bottom Mapping ↓	415	232	20	32	1.3	3.3	997.7	95	0/10
3b	Area-8	Mapping	18/Sep/2009	22h00	UTC-6	70°44.400	135°33.900	Bottom Mapping ↓	366	237	20	31	1.8	3.2	1000.9	88	0/10

Appendix 2 - Scientific log of activities conducted during the 2009 ArcticNet Expedition

Leg	Station ID	Station Type	Local Date	Local Time	UTC to local	Latitude (N)	Longitude (W)	Activity	Depth (m)	Heading (°)	Wind		Air (ºC)	Water (ºC)	Pr Baro	Hum (%)	Ice
											Dir	Speed					
3b	Area-8	Mapping	18/Sep/2009	23h18	UTC-6	70°37.800	136°05.300	Bottom Mapping ↑	347	237	18	29	1.8	3.5	1002.5	90	0/10
3b	Area-8	Mapping	18/Sep/2009	23h40	UTC-6	70°36.900	136°06.500	Bottom Mapping ↓	313	57	19	31	1.0	3.5	1002.1	91	0/10
3b	Area-8	Mapping	19/Sep/2009	02h22	UTC-6	70°44.200	135°31.600	Bottom Mapping ↑	339	53	20	31	0.2	3.2	1003.8	93	0/10
3b	Area-8	Mapping	19/Sep/2009	02h40	UTC-6	70°43.700	135°31.400	Bottom Mapping ↓	306	236	10	33	0.7	3.2	1004.5	94	0/10
3b	Area-8	Mapping	19/Sep/2009	03h56	UTC-6	70°36.200	136°06.800	Bottom Mapping ↑	275	235	15	26	0.5	3.4	1005.7	91	0/10
3b	Area-8	Mapping	19/Sep/2009	04h10	UTC-6	70°35.880	136°05.360	Bottom Mapping ↓	244	55	15	25/30	0.5	3.4	1005.7	93	0/10
3b	Area-8	Mapping	19/Sep/2009	06h30	UTC-6	70°43.000	135°28.580	Bottom Mapping ↑	214	55	15	25/30	0.0	3.2	1006.5	91	0/10
3b	Area-8	Mapping	19/Sep/2009	06h34	UTC-6	70°42.820	135°29.420	Bottom Mapping ↓	215	238	15	25/30	0.0	3.2	1006.5	91	0/10
3b	Area-8	Mapping	19/Sep/2009	07h55	UTC-6	70°34.720	136°05.040	Bottom Mapping ↑	113	238	15	20	0.0	3.1	1006.5	91	0/10
3b	Area-8	Mapping	19/Sep/2009	08h00	UTC-6	70°34.740	136°04.860	Bottom Mapping ↓	73	58	15	25/30	0.0	3.1	1006.5	91	0/10
3b	Area-8	Mapping	19/Sep/2009	10h38	UTC-6	70°42.500	135°27.500	Bottom Mapping ↑	155	58	20	20/25	-0.5	3.8	1008.7	93	0/10
3b	Area-8	Mapping	19/Sep/2009	11h00	UTC-6	70°41.900	135°27.700	Bottom Mapping ↓	133	238	31	20/25	0.6	3.6	1009.3	89	0/10
3b	Area-8	Mapping	19/Sep/2009	12h30	UTC-6	70°34.500	136°02.800	Bottom Mapping ↑	118	239	20	20/25	0.9	3.9	1010.5	89	0/10
3b	Area-8	Mapping	19/Sep/2009	12h30	UTC-6	70°34.500	136°02.800	Bottom Mapping ↓	117	239	20	20/25	0.9	3.9	1010.5	89	0/10
3b	Area-8	Mapping	19/Sep/2009	12h55	UTC-6	70°33.060	136°09.700	Bottom Mapping (interrupted)	120	241	20	21	0.2	3.8	1010.5	90	0/10
3b	Area-8	Mapping	19/Sep/2009	13h13	UTC-6	70°33.000	136°09.800	Bottom Mapping ↓	120	241	20	21	0.2	3.8	1010.5	90	0/10
3b	Area-8	Mapping	19/Sep/2009	15h00	UTC-6	70°26.700	136°41.600	Bottom Mapping ↑	305	238	25	18	0.6	3.8	1011.8	87	0/10
3b	Area-8	Box Core	19/Sep/2009	18h54	UTC-6	70°48.070	136°05.920	Box Core (bottom)	742	60	25	18	-1.2	2.7	1014.0	80	0/10
3b	Area-8	Box Core	19/Sep/2009	19h15	UTC-6	70°48.060	136°05.920	Box Core ↑	743	60	40	12	-1.2	2.6	1015.2	79	0/10
3b	Area-8	Piston Core	19/Sep/2009	20h00	UTC-6	70°48.060	136°05.900	Piston Core ↓	743	60	40	12	-1.2	2.6	1015.2	79	0/10
3b	Area-8	Piston Core	19/Sep/2009	20h34	UTC-6	70°48.000	136°05.900	Piston Core ↑	743	60	40	12	-1.2	2.6	1015.2	79	0/10
3b	Area-9	Mapping	19/Sep/2009	21h08	UTC-6	70°47.900	136°06.000	CTD ↓	744	73	24	12	-1.2	2.6	1015.3	81	0/10
3b	Area-9	Mapping	19/Sep/2009	21h39	UTC-6	70°47.800	136°06.000	CTD ↑	756	84	25	16	-1.4	2.6	1015.6	80	0/10
3b	Area-9	Mapping	19/Sep/2009	22h35	UTC-6	70°54.400	136°04.000	Bottom Mapping ↓	839	237	37	15	-1.6	2.4	1015.9	87	0/10
3b	Area-9	Mapping	19/Sep/2009	23h15	UTC-6	70°54.000	136°07.300	Bottom Mapping (interrupted)	866	237	8	14	-0.9	2.2	1016.2	83	0/10
3b	Area-9	Mapping	20/Sep/2009	00h06	UTC-6	70°57.000	136°07.100	Bottom Mapping ↓	906	237	35	16	-2.2	2.2	1016.5	89	0/10
3b	Area-9	Mapping	20/Sep/2009	01h32	UTC-6	70°46.200	136°57.800	Bottom Mapping ↑	1393	237	20	15	-2.2	2.3	1016.8	86	0/10
3b	Area-9	Mapping	20/Sep/2009	01h58	UTC-6	70°44.600	136°54.100	Bottom Mapping ↓	1230	55	25	16	-2.2	2.4	1016.8	86	0/10
3b	Area-9	Mapping	20/Sep/2009	04h17	UTC-6	70°56.020	136°00.650	Bottom Mapping ↑	884	55	25	10/15	-2.8	2.6	1017.2	97	0/10
3b	Area-9	Mapping	20/Sep/2009	04h30	UTC-6	70°54.800	136°00.100	Bottom Mapping ↓	824	237	35	10/15	-2.7	2.5	1017.2	97	0/10
3b	Area-9	Mapping	20/Sep/2009	06h30	UTC-6	70°44.380	136°51.560	Bottom Mapping ↑	1145	237	15	15/20	-2.4	2.3	1017.7	89	0/10
3b	Area-9	Mapping	20/Sep/2009	06h38	UTC-6	70°42.800	136°50.800	Bottom Mapping ↓	1158	59	15	15/20	-2.4	2.3	1017.7	89	0/10
3b	Area-9	Mapping	20/Sep/2009	07h43	UTC-6	70°48.420	136°24.200	Bottom Mapping ↑	800	59	35	15/20	-3.0	2.7	1017.5	89	0/10
3b	Area-9	Piston Core	20/Sep/2009	08h35	UTC-6	70°48.000	136°06.100	Piston Core ↓	745	65	34	12	-3.2	2.2	1018.1	89	0/10
3b	Area-9	Piston Core	20/Sep/2009	09h25	UTC-6	70°48.000	136°05.900	Piston Core ↑	745	68	34	12	-3.5	2.2	1018.3	89	0/10
3b	Area-9	Piston Core	20/Sep/2009	11h28	UTC-6	70°48.000	136°05.900	Piston Core ↓	745	50	30	12	-3.4	2.2	1018.6	92	0/10
3b	Area-9	Piston Core	20/Sep/2009	12h13	UTC-6	70°48.000	136°06.100	Piston Core ↑	745	33	30	10	-3.1	2.2	1018.6	86	0/10
3b	Area-9	Mapping	20/Sep/2009	12h34	UTC-6	70°46.700	136°10.100	Bottom Mapping ↓	706	238	40	12	-2.9	2.2	1018.6	86	0/10
3b	Area-9	Mapping	20/Sep/2009	13h18	UTC-6	70°44.800	136°19.400	Bottom Mapping ↑	628	240	50	10	-1.6	2.3	1018.6	83	0/10
3b	Area-9	Piston Core	20/Sep/2009	14h16	UTC-6	70°45.800	136°10.800	Piston Core ↓	655	35	45	10	-2.7	2.4	1018.5	85	0/10
3b	Area-9	Piston Core	20/Sep/2009	14h54	UTC-6	70°45.700	136°10.800	Piston Core ↑	650	54	35	11	-2.6	2.3	1018.5	85	0/10
3b	Area-9	Mapping	20/Sep/2009	15h12	UTC-6	70°46.200	136°09.100	Weather Balloon	690	55	40	13	-2.3	2.3	1018.3	83	0/10
3b	Area-9	Mapping	20/Sep/2009	15h23	UTC-6	70°45.800	136°08.400	Bottom Mapping ↓	686	244	40	14	-2.6	2.3	1018.3	91	0/10
3b	Area-9	Mapping	20/Sep/2009	15h55	UTC-6	70°44.200	136°15.200	Bottom Mapping ↑	594	237	30	12	-1.2	2.8	1018.4	85	0/10
3b	Area-9	Piston Core	20/Sep/2009	16h22	UTC-6	70°44.600	136°13.100	Piston Core ↓	620	43	71	10	-2.3	2.4	1018.3	86	0/10

Appendix 2 - Scientific log of activities conducted during the 2009 ArcticNet Expedition

Leg	Station ID	Station Type	Local Date	Local Time	UTC to local	Latitude (N)	Longitude (W)	Activity	Depth (m)	Heading (°)	Wind Dir	Wind Speed	Air (ºC)	Water (ºC)	Pr Baro	Hum (%)	Ice
3b	Area-9	Piston Core	20/Sep/2009	16h48	UTC-6	70°44.600	136°13.500	Piston Core ↑	40	43	60	12	-1.9	2.3	1018.2	83	0/10
3b	Area-9	Mapping	20/Sep/2009	18h15	UTC-6	70°48.500	136°07.500	Bottom Mapping ↓	749	154	33	8	-2.3	2.1	1018.2	84	0/10
3b	Area-9	Mapping	20/Sep/2009	19h46	UTC-6	70°39.430	135°58.210	Bottom Mapping ↑	310	156	35	10/15	-1.2	2.4	1017.3	87	0/10
3b	Area-9	Mapping	20/Sep/2009	20h23	UTC-6	70°33.400	135°57.100	Bottom Mapping ↓	65	319	27	15	0.0	3.1	1016.4	85	0/10
3b	Area-9	Mapping	20/Sep/2009	21h26	UTC-6	70°38.650	136°09.800	Bottom Mapping ↑	65	319	27	15	0.0	3.1	1016.4	85	0/10
3b	Area-9	Mapping	20/Sep/2009	21h55	UTC-6	70°41.200	136°10.200	Bottom Mapping ↓	N/A	302	30	15	0.0	3.1	1016.3	84	0/10
3b	Area-9	Mapping	20/Sep/2009	22h37	UTC-6	70°42.900	136°19.100	Bottom Mapping ↑	N/A	302	35	15	0.0	3.1	1016.2	84	0/10
3b	Area-9	Mapping	20/Sep/2009	22h40	UTC-6	70°42.800	136°19.800	Bottom Mapping ↓	791	270	52	15	0.0	3.1	1016.1	83	0/10
3b	Area-9	Mapping	20/Sep/2009	23h24	UTC-6	70°42.900	136°33.300	Bottom Mapping ↑	1123	270	54	16	0.1	3.1	1016.0	82	0/10
3b	Area-9	Mapping	20/Sep/2009	23h25	UTC-6	70°43.200	136°33.700	Bottom Mapping ↓	1163	304	54	16	0.1	3.1	1016.0	82	0/10
3b	Area-9	Mapping	20/Sep/2009	23h36	UTC-6	70°43.800	136°38.400	Bottom Mapping ↑	1247	304	59	18	0.1	3.1	1016.0	82	0/10
3b	Area-9	Mapping	20/Sep/2009	23h37	UTC-6	70°43.800	136°38.400	Bottom Mapping ↓	1247	281	59	18	0.1	3.1	1016.0	82	0/10
3b	Area-9	Mapping	20/Sep/2009	23h57	UTC-6	70°44.200	136°43.400	Bottom Mapping ↑	1291	281	45	18	0.5	2.7	1015.8	78	0/10
3b	Area-9	Mapping	20/Sep/2009	23h57	UTC-6	70°44.200	136°43.400	Bottom Mapping ↓	1291	309	45	18	0.5	2.7	1015.8	78	0/10
3b	Area-9	Mapping	21/Sep/2009	00h18	UTC-6	70°45.900	136°49.800	Bottom Mapping ↑	1361	310	50	17	-0.2	2.7	1015.6	88	0/10
3b	Area-9	Mapping	21/Sep/2009	00h38	UTC-6	70°45.400	136°55.600	Bottom Mapping ↓	1324	56	45	18	0.2	2.7	1015.9	81	0/10
3b	Area-9	Mapping	21/Sep/2009	02h11	UTC-6	70°56.600	136°03.200	Bottom Mapping ↑	880	56	40	18	-1.2	2.3	1015.1	86	0/10
3b	Area-9	Mapping	21/Sep/2009	02h30	UTC-6	70°53.800	135°58.800	Bottom Mapping ↓	799	241	50	19	-1.5	1.9	1016.1	87	0/10
3b	Area-9	Mapping	21/Sep/2009	03h15	UTC-6	70°48.200	136°25.600	Bottom Mapping ↑	821	239	45	23	-0.5	2.0	1016.2	84	0/10
3b	Area-9	Mapping	21/Sep/2009	03h33	UTC-6	70°47.000	136°23.700	Bottom Mapping ↓	713	57	35	22	-1.2	2.0	1015.5	86	0/10
3b	Area-10	Mapping	21/Sep/2009	05h38	UTC-6	70°43.800	136°17.100	CTD ↓	613	28	20	42	-0.7	2.1	1015.1	89	0/10
3b	Area-10	Mapping	21/Sep/2009	06h04	UTC-6	70°43.900	136°17.800	CTD ↑	613	37	35	23	-0.7	2.1	1015.1	91	0/10
3b	Area-10	Piston Core	21/Sep/2009	06h40	UTC-6	70°43.490	136°15.510	Piston Core ↓	599	Var	47	20	-0.2	2.2	1015.0	98	0/10
3b	Area-10	Piston Core	21/Sep/2009	07h39	UTC-6	70°43.510	136°15.600	Piston Core ↑	599	Var	47	20	-0.2	2.2	1015.0	98	0/10
3b	Area-10	Mapping	21/Sep/2009	07h53	UTC-6	70°43.210	136°14.980	Bottom Mapping ↓	604	57	45	15/20	-0.1	2.1	1014.9	98	0/10
3b	Area-10	Mapping	21/Sep/2009	08h00	UTC-6	70°43.300	136°14.230	Bottom Mapping ↓	590	57	62	19	-0.1	2.1	1010.0	95	0/10
3b	Area-10	Mapping	21/Sep/2009	08h30	UTC-6	70°45.100	136°06.110	Bottom Mapping ↑	595	57	62	18	-0.1	2.1	1015.2	95	0/10
3b	Area-10	Mapping	21/Sep/2009	08h44	UTC-6	70°45.400	136°07.500	Bottom Mapping ↓	630	237	63	17	-0.1	2.1	1016.0	90	0/10
3b	Area-10	Mapping	21/Sep/2009	09h24	UTC-6	70°43.500	136°16.400	Bottom Mapping ↑	630	237	64	18	-0.1	2.1	1016.4	90	0/10
3b	Area-10	Piston Core	21/Sep/2009	09h58	UTC-6	70°43.800	136°15.100	Piston Core ↓	585	64	64	18	-0.1	-0.1	1016.8	87	0/10
3b	Area-10	Piston Core	21/Sep/2009	10h58	UTC-6	70°44.000	136°15.400	Piston Core ↑	585	64	64	17	-0.1	-0.1	1016.8	87	0/10
3b	Area-10	Mapping	21/Sep/2009	11h50	UTC-6	70°44.250	136°16.180	Bottom Mapping ↓	647	237	64	17	-0.1	-0.1	1016.8	87	0/10
3b	Area-10	Mapping	21/Sep/2009	12h00	UTC-6	70°43.600	136°18.900	Bottom Mapping ↑	647	237	55	16	-0.1	-0.1	1016.8	87	0/10
3b	Area-10	Mapping	21/Sep/2009	12h23	UTC-6	70°42.900	136°18.000	Bottom Mapping ↓	748	55	60	21	0.0	0.0	1016.6	88	0/10
3b	Area-10	Mapping	21/Sep/2009	12h52	UTC-6	70°44.300	136°11.500	Bottom Mapping (interrupted)	598	58	50	18	-0.8	-0.8	1016.9	89	0/10
3b	Area-10	Piston Core	21/Sep/2009	13h30	UTC-6	70°42.700	136°17.300	Piston Core ↓	739	60	53	19	-0.6	-0.6	1017.3	89	0/10
3b	Area-10	Piston Core	21/Sep/2009	14h08	UTC-6	70°42.600	136°17.300	Piston Core ↑	732	60	55	19	-0.9	-0.9	1017.6	88	0/10
3b	Area-10	Box Core	21/Sep/2009	16h09	UTC-6	70°33.400	135°57.200	Box Core ↓	73	60	54	21	-0.2	-0.2	1018.2	85	0/10
3b	Area-10	Box Core	21/Sep/2009	16h21	UTC-6	70°33.400	135°57.200	Box Core ↑	73	70	54	21	-0.2	-0.2	1018.1	85	0/10
3b	Area-10	Piston Core	21/Sep/2009	18h18	UTC-6	70°33.470	135°57.190	Piston Core ↓	73	70	65	15/20	-0.7	-0.7	1018.5	86	0/10
3b	Area-10	Piston Core	21/Sep/2009	18h27	UTC-6	70°33.300	135°57.600	Piston Core ↑	73	69	45	17/20	-0.9	-0.9	1018.6	85	0/10
3b	N/A	MVP	21/Sep/2009	18h50	UTC-6	70°33.300	135°58.700	MVP ↓	73	336	60	16	-0.6	-0.6	1018.5	85	0/10
3b	N/A	MVP	21/Sep/2009	19h49	UTC-6	70°35.500	136°01.790	MVP ↑	73	336	64	15	-1.5	-1.5	1019.1	86	0/10
3b	Area-11	Mapping	21/Sep/2009	20h03	UTC-6	70°35.500	136°01.800	CTD ↓	185	70	72	15	-1.5	-1.5	1019.1	86	0/10
3b	Area-11	Mapping	21/Sep/2009	20h14	UTC-6	70°35.500	136°01.800	CTD ↑	190	70	72	15	-1.5	-1.5	1019.1	86	0/10

Appendix 2 - Scientific log of activities conducted during the 2009 ArcticNet Expedition

Leg	Station ID	Station Type	Local Date	Local Time	UTC to local	Latitude (N)	Longitude (W)	Activity	Depth (m)	Heading (°)	Wind		Air (ºC)	Water (ºC)	Pr Baro	Hum (%)	Ice
											Dir	Speed					
3b	LF07	Hydrophone	21/Sep/2009	21h30	UTC-6	70°38.900	136°07.300	MARU Buoy Recovered	460	326	77	17	-1.7	-1.7	1019.3	84	0/10
3b	Area-11	Mapping	21/Sep/2009	21h45	UTC-6	70°35.600	136°05.800	Bottom Mapping ↓	244	144	61	18	-1.4	-1.4	1019.1	84	0/10
3b	Area-11	Mapping	21/Sep/2009	22h08	UTC-6	70°34.700	136°03.200	Bottom Mapping ↑	130	144	54	14	-1.3	-1.3	1019.0	83	0/10
3b	Area-11	Mapping	21/Sep/2009	22h11	UTC-6	70°34.800	136°02.700	Bottom Mapping ↓	132	58	54	14	-1.3	-1.3	1019.0	83	0/10
3b	Area-11	Mapping	21/Sep/2009	23h14	UTC-6	70°39.900	135°37.800	Bottom Mapping ↑	176	58	67	18	-1.0	3.7	1019.0	79	0/10
3b	Area-11	Mapping	21/Sep/2009	23h17	UTC-6	70°39.900	135°37.800	Bottom Mapping ↓	176	237	67	18	-1.0	3.7	1019.0	79	0/10
3b	Area-11	Mapping	21/Sep/2009	23h25	UTC-6	70°39.500	135°39.800	Bottom Mapping ↑	172	237	67	18	-1.0	3.7	1019.0	79	0/10
3b	Area-11	Mapping	21/Sep/2009	23h30	UTC-6	70°39.300	135°39.700	Bottom Mapping ↓	160	58	79	16	-0.9	3.6	1018.9	79	0/10
3b	Area-11	Mapping	21/Sep/2009	23h40	UTC-6	70°39.700	135°37.900	Bottom Mapping ↑	165	58	79	16	-0.9	3.6	1018.9	79	0/10
3b	Area-11	Mapping	21/Sep/2009	23h45	UTC-6	70°39.700	135°37.400	Bottom Mapping ↓	159	237	79	16	-0.9	3.6	1018.9	79	0/10
3b	Area-11	Mapping	21/Sep/2009	23h53	UTC-6	70°39.200	135°39.400	Bottom Mapping ↑	146	237	72	16	-1.1	3.6	1019.2	80	0/10
3b	Area-11	Mapping	22/Sep/2009	00h02	UTC-6	70°39.800	135°39.100	Bottom Mapping ↓	188	58	72	16	-1.1	3.6	1019.2	80	0/10
3b	Area-11	Mapping	22/Sep/2009	00h28	UTC-6	70°42.200	135°27.400	Bottom Mapping ↑	142	57	60	15	-1.1	3.6	1018.6	77	0/10
3b	Area-11	Mapping	22/Sep/2009	00h36	UTC-6	70°42.500	135°29.000	Bottom Mapping ↓	183	235	75	15	-1.0	3.6	1018.6	78	0/10
3b	Area-11	Mapping	22/Sep/2009	02h02	UTC-6	70°35.200	136°03.800	Bottom Mapping ↑	200	238	80	16	-0.8	3.7	1018.8	79	0/10
3b	Area-11	Mapping	22/Sep/2009	02h11	UTC-6	70°35.700	136°04.400	Bottom Mapping ↓	231	58	60	15	-0.6	3.6	1018.6	79	0/10
3b	Area-11	Mapping	22/Sep/2009	03h42	UTC-6	70°43.100	135°29.400	Bottom Mapping ↑	253	59	80	17	-1.2	3.6	1018.7	85	0/10
3b	Area-11	Mapping	22/Sep/2009	03h49	UTC-6	70°43.400	135°30.800	Bottom Mapping ↓	304	240	70	15	-1.3	3.6	1019.0	90	0/10
3b	Area-11	Mapping	22/Sep/2009	05h20	UTC-6	70°36.220	136°05.600	Bottom Mapping ↑	284	240	90	16	-0.7	3.6	1018.8	77	0/10
3b	Area-11	Mapping	22/Sep/2009	05h26	UTC-6	70°36.930	136°04.910	Bottom Mapping ↓	278	58	90	16	-0.7	3.6	1018.8	77	0/10
3b	Area-11	Mapping	22/Sep/2009	06h25	UTC-6	70°41.180	135°43.670	Bottom Mapping (interrupted)	303	58	90	15	-0.5	3.7	1018.4	79	0/10
3b	Area-12	Mapping	22/Sep/2009	07h15	UTC-6	70°33.400	135°57.400	CTD ↓	66	76	71	19	-0.4	3.7	1018.1	78	0/10
3b	Area-12	Mapping	22/Sep/2009	07h19	UTC-6	70°33.400	135°57.500	CTD ↑	66	81	70	19	-0.4	3.7	1018.1	78	0/10
3b	Area-12	Piston Core	22/Sep/2009	08h37	UTC-6	70°33.460	135°57.200	Piston Core ↓	75	85	80	23	-0.4	3.8	1018.0	77	0/10
3b	Area-12	Piston Core	22/Sep/2009	09h05	UTC-6	70°33.500	135°57.300	Piston Core ↑	75	85	90	20	-0.5	3.8	1018.0	78	0/10
3b	LF11	Hydrophone	22/Sep/2009	09h46	UTC-6	70°32.900	135°56.480	MARU Buoy Recovered/Deployed	70	316	90	20	-0.5	3.8	1018.0	78	0/10
3b	LF12	Hydrophone	22/Sep/2009	11h14	UTC-6	70°32.800	135°35.500	MARU Buoy Recovered	60	342	80	19	-0.2	3.8	1017.9	78	0/10
3b	LF05	Hydrophone	22/Sep/2009	12h36	UTC-6	70°33.200	135°13.800	MARU Buoy Recovered	55	345	80	18	-0.7	4.1	1018.4	78	0/10
3b	LF09	Hydrophone	22/Sep/2009	13h53	UTC-6	70°38.300	135°22.400	MARU Buoy Recovered	70	303	90	24	-0.6	4.2	1018.4	79	0/10
3b	LF08	Hydrophone	22/Sep/2009	14h49	UTC-6	70°39.300	135°45.800	MARU Buoy Recovered	225	90	80	18	0.3	4.0	1018.7	77	0/10
3b	Area-12	Mapping	22/Sep/2009	14h53	UTC-6	70°37.900	135°47.100	Bottom Mapping ↓	195	237	88	18	-0.3	3.9	1018.5	80	0/10
3b	Area-12	Mapping	22/Sep/2009	15h26	UTC-6	70°35.300	136°01.600	Bottom Mapping ↑	138	237	85	21	-0.4	3.7	1018.6	77	0/10
3b	Area-12	Box Core	22/Sep/2009	15h38	UTC-6	70°35.500	136°02.600	Box Core ↓	210	80	88	19	-0.1	3.7	1018.5	76	0/10
3b	Area-12	Box Core	22/Sep/2009	15h50	UTC-6	70°35.500	136°02.600	Box Core ↑	210	95	80	19	0.0	3.8	1018.3	77	0/10
3b	Area-12	Piston Core	22/Sep/2009	16h10	UTC-6	70°35.520	136°02.540	Piston Core ↓	210	75	90	20	-0.1	3.8	1018.4	77	0/10
3b	Area-12	Piston Core	22/Sep/2009	16h54	UTC-6	70°35.530	136°82.550	Piston Core ↑	211	72	90	21	-0.1	3.7	1018.5	77	0/10
3b	LF06	Hydrophone	22/Sep/2009	18h16	UTC-6	70°39.230	136°27.850	MARU Buoy Recovered	611	90	101	23	0.0	3.6	1017.9	77	0/10
3b	LF06	Hydrophone	22/Sep/2009	18h55	UTC-6	70°38.990	136°28.370	MARU Buoy Recovered (end)	611	Var	103	20	-0.1	3.1	1017.7	77	0/10
3b	Area-13	Mapping	22/Sep/2009	21h04	UTC-6	70°45.100	136°38.900	CTD ↓	1212	90	111	20	0.2	2.2	1016.9	80	0/10
3b	Area-13	Mapping	22/Sep/2009	21h33	UTC-6	70°45.200	136°39.000	CTD ↑	1219	70	103	23	0.0	2.0	1016.9	78	0/10
3b	Area-13	Mapping	22/Sep/2009	21h50	UTC-6	70°45.500	136°41.100	Bottom Mapping ↓	1233	237	103	23	0.4	2.1	1016.9	77	0/10
3b	Area-13	Mapping	22/Sep/2009	22h12	UTC-6	70°43.200	136°51.800	Bottom Mapping ↑	1175	237	100	26	-0.1	2.0	1016.8	77	0/10
3b	Area-13	Mapping	22/Sep/2009	22h29	UTC-6	70°42.400	136°49.700	Bottom Mapping ↓	1169	57	120	24	0.3	2.1	1016.1	78	0/10
3b	Area-13	Mapping	22/Sep/2009	23h56	UTC-6	70°53.600	135°56.400	Bottom Mapping ↑	783	57	124	20	0.3	2.7	1016.0	79	0/10
3b	Area-13	Mapping	23/Sep/2009	00h02	UTC-6	70°52.900	135°57.200	Bottom Mapping ↓	756	233	120	21	0.2	2.5	1015.9	79	0/10

Leg	Station ID	Station Type	Local Date	Local Time	UTC to local	Latitude (N)	Longitude (W)	Activity	Depth (m)	Heading (°)	Wind		Air (ºC)	Water (ºC)	Pr Baro	Hum (%)	Ice
											Dir	Speed					
3b	Area-13	Mapping	23/Sep/2009	02h18	UTC-6	70°41.900	136°49.200	Bottom Mapping ↑	1139	234	110	28	0.8	2.8	1015.0	78	0/10
3b	Area-13	Mapping	23/Sep/2009	02h24	UTC-6	70°41.500	136°47.900	Bottom Mapping ↓	1155	62	120	27	0.7	2.8	1014.6	78	0/10
3b	Area-13	Mapping	23/Sep/2009	04h45	UTC-6	70°52.570	135°55.900	Bottom Mapping ↑	805	62	120	25	0.6	2.5	1014.2	79	0/10
3b	Area-13	Mapping	23/Sep/2009	04h49	UTC-6	70°52.060	135°55.320	Bottom Mapping ↓	758	238	124	26	0.6	2.5	1014.2	79	0/10
3b	Area-13	Mapping	23/Sep/2009	05h56	UTC-6	70°46.630	135°20.850	Bottom Mapping ↑	673	235	112	25	0.6	2.5	1013.3	79	0/10
3b	Area-13	Mapping	23/Sep/2009	07h30	UTC-6	70°47.270	136°12.980	Bottom Mapping ↓	718	237	115	25	0.6	2.5	1012.4	79	0/10
3b	Area-13	Mapping	23/Sep/2009	08h03	UTC-6	70°45.200	136°22.500	Bottom Mapping ↑	771	237	121	22	0.7	2.8	1011.4	89	0/10
3b	Area-13	Mapping	23/Sep/2009	08h11	UTC-6	70°44.800	136°21.200	Bottom Mapping ↓	718	57	121	22	0.7	2.8	1011.4	89	0/10
3b	Area-13	Mapping	23/Sep/2009	08h47	UTC-6	70°47.000	136°10.800	Bottom Mapping ↑	767	57	107	21	0.9	2.5	1011.3	90	0/10
3b	Area-13	Piston Core	23/Sep/2009	09h20	UTC-6	70°46.900	136°12.300	Piston Core ↓	702	105	106	21	0.9	2.4	1011.3	92	0/10
3b	Area-13	Piston Core	23/Sep/2009	10h07	UTC-6	70°46.200	136°19.000	Piston Core ↑	690	105	107	21	0.9	2.4	1011.1	92	0/10
3b	LF02	Hydrophone	23/Sep/2009	11h42	UTC-6	70°45.100	136°16.600	MARU Buoy Recovered	618	12	127	24	1.0	2.4	1009.5	92	0/10
3b	LF03	Hydrophone	23/Sep/2009	13h13	UTC-6	70°45.100	135°56.000	MARU Buoy Recovered	628	355	120	21	0.7	2.5	1009.3	96	0/10
3b	LF04	Hydrophone	23/Sep/2009	14h30	UTC-6	70°45.000	135°34.600	MARU Buoy Recovered	395	40	120	17	0.4	2.8	1008.8	98	0/10
3b	LF10	Hydrophone	23/Sep/2009	15h35	UTC-6	70°45.200	135°14.000	MARU Buoy Recovered	82	98	100	19	0.9	3.1	1008.2	99	0/10
3b	Area-13	Piston Core	23/Sep/2009	16h25	UTC-6	70°47.570	135°33.742	Piston Core ↓	412	271	104	20	1.2	3.2	1007.2	98	0/10
3b	Area-13	Piston Core	23/Sep/2009	16h56	UTC-6	70°47.680	135°33.620	Piston Core ↑	412	271	105	20	1.2	3.2	1007.2	98	0/10
3b	Area-14	Piston Core	23/Sep/2009	19h05	UTC-6	70°47.570	135°33.750	Piston Core ↓	420	64	90	21	1.5	3.2	1004.7	99	0/10
3b	Area-14	Piston Core	23/Sep/2009	19h41	UTC-6	70°47.600	135°33.000	Piston Core ↑	420	81	86	19	1.5	3.2	1004.7	99	0/10
3b	Area-14	Mapping	23/Sep/2009	19h52	UTC-6	70°47.500	135°33.900	CTD ↓	418	78	89	22	1.5	3.3	1004.0	99	0/10
3b	Area-14	Mapping	23/Sep/2009	20h10	UTC-6	70°47.600	135°34.100	CTD ↑	418	86	86	22	1.6	3.3	1003.8	99	0/10
3b	Area-14	Mapping	23/Sep/2009	20h40	UTC-6	70°47.200	135°38.600	Bottom Mapping ↓	489	237	93	20	2.1	3.3	1004.0	98	0/10
3b	Area-14	Mapping	23/Sep/2009	22h50	UTC-6	70°35.000	136°36.300	Bottom Mapping ↑	674	237	96	14	2.8	3.1	1002.2	93	0/10
3b	Area-14	Mapping	23/Sep/2009	22h59	UTC-6	70°35.500	136°36.200	Bottom Mapping ↓	731	57	96	14	2.8	3.1	1002.2	93	0/10
3b	Area-14	Mapping	24/Sep/2009	00h25	UTC-6	70°43.800	135°58.900	Bottom Mapping (interrupted)	559	60	80	16	2.7	2.8	1001.9	92	0/10
3b	Area-14	Mapping	24/Sep/2009	00h42	UTC-6	70°43.400	136°03.900	Bottom Mapping ↓	561	237	75	14	2.5	2.9	1002.1	92	0/10
3b	Area-14	Mapping	24/Sep/2009	01h17	UTC-6	70°41.100	136°14.500	Bottom Mapping ↑	579	236	70	13	2.5	2.9	1001.9	92	0/10
3b	Area-14	Mapping	24/Sep/2009	01h29	UTC-6	70°41.300	136°14.600	Bottom Mapping ↓	583	61	60	15	2.7	2.8	1001.5	93	0/10
3b	Area-14	Mapping	24/Sep/2009	02h04	UTC-6	70°43.500	136°04.200	Bottom Mapping ↑	558	59	60	17	2.5	2.8	1001.3	92	0/10
3b	Area-14	Mapping	24/Sep/2009	02h17	UTC-6	70°43.500	135°59.000	Bottom Mapping ↓	537	60	60	19	2.5	2.8	1001.1	91	0/10
3b	Area-14	Mapping	24/Sep/2009	02h50	UTC-6	70°43.800	135°43.800	Bottom Mapping ↑	558	57	60	20	2.3	2.9	1000.8	89	0/10
3b	Area-14	Mapping	24/Sep/2009	03h10	UTC-6	70°47.000	135°38.200	Bottom Mapping ↓	477	238	60	20	2.1	3.1	1001.2	90	0/10
3b	Area-14	Mapping	24/Sep/2009	04h18	UTC-6	70°40.120	136°11.190	Bottom Mapping ↑	495	238	60	20	2.5	3.1	1001.3	90	0/10
3b	Area-14	Mapping	24/Sep/2009	04h22	UTC-6	70°39.770	136°09.520	Bottom Mapping ↓	505	57	60	20	2.7	3.1	1001.3	86	0/10
3b	Area-14	Mapping	24/Sep/2009	05h30	UTC-6	70°46.840	135°35.870	Bottom Mapping ↑	465	57	50	19	1.9	3.1	1000.6	91	0/10
3b	Area-14	Mapping	24/Sep/2009	05h35	UTC-6	70°46.260	135°35.640	Bottom Mapping ↓	440	238	50	19	1.9	3.1	1000.6	91	0/10
3b	Area-14	Mapping	24/Sep/2009	06h20	UTC-6	70°39.650	136°07.250	Weather Balloon	469	238	55	17	2.8	3.2	1001.5	85	0/10
3b	Area-14	Mapping	24/Sep/2009	06h30	UTC-6	70°39.160	136°09.59	Bottom Mapping ↑	489	238	55	17	2.8	3.2	1001.5	85	0/10
3b	Area-15	Mapping	24/Sep/2009	07h25	UTC-6	70°35.680	136°02.710	CTD ↓	194	54	42	19	1.6	3.0	1001.1	89	0/10
3b	Area-15	Mapping	24/Sep/2009	07h36	UTC-6	70°35.720	136°03.000	CTD ↑	207	32	64	20	1.5	3.2	1001.3	89	0/10
3b	Area-15	Piston Core	24/Sep/2009	08h42	UTC-6	70°35.500	136°02.600	Piston Core ↓	198	60	42	19	1.3	3.5	1001.7	87	0/10
3b	Area-15	Piston Core	24/Sep/2009	09h06	UTC-6	70°35.500	136°02.500	Piston Core ↑	198	60	42	19	1.3	3.5	1001.7	87	0/10
3b	Area-15	Box Core	24/Sep/2009	09h56	UTC-6	70°37.300	135°58.500	Box Core ↓	221	55	31	16	0.9	3.4	1002.2	86	0/10
3b	Area-15	Box Core	24/Sep/2009	10h11	UTC-6	70°37.300	135°58.600	Box Core ↑	221	70	31	16	0.9	3.4	1002.2	86	0/10
3b	Area-15	Piston Core	24/Sep/2009	10h38	UTC-6	70°37.200	135°58.600	Piston Core ↓	221	65	22	20	0.3	3.4	1002.6	92	0/10

Appendix 2 - Scientific log of activities conducted during the 2009 ArcticNet Expedition

Leg	Station ID	Station Type	Local Date	Local Time	UTC to local	Latitude (N)	Longitude (W)	Activity	Depth (m)	Heading (°)	Wind		Air (ºC)	Water (ºC)	Pr Baro	Hum (%)	Ice
											Dir	Speed					
3b	Area-15	Piston Core	24/Sep/2009	10h58	UTC-6	70°37.200	135°58.700	Piston Core ↑	221	65	22	20	0.3	3.4	1002.6	92	0/10
3b	Area-15	Mapping	24/Sep/2009	11h37	UTC-6	70°35.100	136°00.500	Bottom Mapping ↓	122	58	12	19	0.4	3.5	1003.3	86	0/10
3b	Area-15	Mapping	24/Sep/2009	11h49	UTC-6	70°36.300	135°54.700	Bottom Mapping ↑	135	58	14	21	0.3	3.6	1002.5	85	0/10
3b	Area-15	Mapping	24/Sep/2009	11h54	UTC-6	70°36.000	135°54.900	Bottom Mapping ↓	112	238	30	19	0.3	3.6	1002.5	85	0/10
3b	Area-15	Mapping	24/Sep/2009	12h05	UTC-6	70°34.800	136°00.400	Bottom Mapping ↑	106	237	25	19	0.8	3.7	1003.3	86	0/10
3b	Area-15	Piston Core	24/Sep/2009	12h42	UTC-6	70°37.300	135°58.600	Piston Core ↓	225	45	20	15	0.0	3.7	1003.8	84	0/10
3b	Area-15	Piston Core	24/Sep/2009	13h10	UTC-6	70°37.100	135°58.200	Piston Core ↑	210	70	15	16	-0.2	3.6	1004.3	83	0/10
3b	Area-15	Mapping	24/Sep/2009	13h49	UTC-6	70°34.900	136°00.500	Bottom Mapping ↓	113	46	355	17	-0.2	3.7	1004.7	90	0/10
3b	Area-15	Mapping	24/Sep/2009	14h17	UTC-6	70°36.300	135°54.200	Bottom Mapping ↑	124	57	355	21	-0.5	3.8	1004.7	88	0/10
3b	Area-15	Box Core	24/Sep/2009	14h47	UTC-6	70°37.300	135°50.900	Box Core ↓↑	167	20	352	14	-0.7	3.9	1005.5	90	0/10
3b	Area-15	Piston Core	24/Sep/2009	16h00	UTC-6	70°37.260	135°50.900	Piston Core ↓	168	20	0	12	-0.9	3.9	1006.7	86	0/10
3b	Area-15	Piston Core	24/Sep/2009	16h20	UTC-6	70°37.120	135°50.900	Piston Core ↑	168	Var	0	14	-0.9	3.9	1006.7	86	0/10
3b	Area-15	Mapping	24/Sep/2009	17h03	UTC-6	70°35.900	135°54.400	Bottom Mapping ↓	108	236	25	12	-0.8	3.9	1007.4	85	0/10
3b	Area-15	Mapping	24/Sep/2009	17h15	UTC-6	70°34.700	136°00.200	Bottom Mapping ↑	97	238	20	12	-0.8	3.9	1007.5	84	0/10
3b	Area-15	Mapping	24/Sep/2009	17h25	UTC-6	70°35.100	136°01.800	Bottom Mapping ↓	134	38	0	14	-0.7	3.9	1007.6	84	0/10
3b	Area-15	Mapping	24/Sep/2009	17h51	UTC-6	70°38.650	135°56.800	Bottom Mapping ↓	262	4	8	12	-1.2	3.8	1007.6	88	0/10
3b	Area-15	Piston Core	24/Sep/2009	18h35	UTC-6	70°38.910	135°56.790	Piston Core ↓	213	40	359	10	-1.3	3.6	1008.5	89	0/10
3b	Area-15	Piston Core	24/Sep/2009	19h05	UTC-6	70°38.890	135°56.800	Piston Core ↑	213	60	359	11	-1.4	3.5	1008.5	90	0/10
3b	Area-16	Mapping	24/Sep/2009	19h18	UTC-6	70°38.970	135°56.700	CTD ↓	279	33	354	12	-1.3	3.6	1008.5	91	0/10
3b	Area-16	Mapping	24/Sep/2009	19h30	UTC-6	70°38.940	135°56.970	CTD ↑	279	31	351	13	-1.2	3.6	1008.7	90	0/10
3b	N/A	MVP	24/Sep/2009	19h45	UTC-6	70°38.810	135°57.480	MVP ↓	277	150	18	10	-1.4	3.6	1008.7	92	0/10
3b	N/A	MVP	24/Sep/2009	20h25	UTC-6	70°38.590	135°57.900	MVP ↑	277	150	345	10	-1.3	3.6	1008.8	89	0/10
3b	Area-16	Mapping	24/Sep/2009	20h55	UTC-6	70°41.400	135°43.400	Bottom Mapping ↓	321	58	357	10	-1.4	3.6	1009.1	87	0/10
3b	Area-16	Mapping	24/Sep/2009	21h52	UTC-6	70°46.100	135°21.000	Bottom Mapping ↑	234	58	8	10	-1.4	3.6	1009.1	86	0/10
3b	Area-16	Mapping	24/Sep/2009	21h58	UTC-6	70°46.600	135°21.900	Bottom Mapping ↓	272	238	8	8	-1.4	3.6	1009.2	86	0/10
3b	Area-16	Mapping	24/Sep/2009	11h14	UTC-6	70°37.000	136°07.300	Bottom Mapping ↑	338	238	10	8	-1.4	3.5	1009.4	86	0/10
3b	Area-16	Mapping	24/Sep/2009	11h20	UTC-6	70°37.500	136°08.000	Bottom Mapping ↓	395	58	10	7	-1.4	3.5	1009.5	86	0/10
3b	Area-16	Mapping	25/Sep/2009	01h05	UTC-6	70°47.100	135°22.500	Bottom Mapping ↑	305	57	340	11	-2.2	3.5	1009.7	91	0/10
3b	Area-16	Mapping	25/Sep/2009	01h16	UTC-6	70°47.400	135°24.300	Bottom Mapping ↓	335	236	20	10	-2.1	3.5	1009.7	91	0/10
3b	Area-16	Mapping	25/Sep/2009	02h33	UTC-6	70°37.900	136°09.400	Bottom Mapping ↑	436	237	15	11	-1.9	3.4	1009.9	89	0/10
3b	Area-16	Mapping	25/Sep/2009	02h43	UTC-6	70°38.400	136°09.600	Bottom Mapping ↓	487	58	10	9	-1.9	3.5	1009.9	90	0/10
3b	Area-16	Mapping	25/Sep/2009	04h30	UTC-6	70°47.880	135°24.920	Bottom Mapping ↑	370	55	10	7	-2.3	3.5	1009.8	87	0/10
3b	Area-16	Mapping	25/Sep/2009	04h36	UTC-6	70°48.170	135°25.220	Bottom Mapping ↓	386	238	7	5	-2.3	3.3	1009.8	86	0/10
3b	Area-16	Mapping	25/Sep/2009	05h52	UTC-6	70°38.490	136°12.300	Bottom Mapping ↑	517	238	34	10	-2.1	3.1	1009.6	86	0/10
3b	Area-16	Mapping	25/Sep/2009	05h58	UTC-6	70°38.340	136°14.840	Bottom Mapping ↓	548	237	35	15	-2.1	3.1	1009.6	86	0/10
3b	Area-16	Mapping	25/Sep/2009	06h55	UTC-6	70°38.740	136°10.180	Bottom Mapping ↑	496	57	10	9	-2.1	3.3	1009.2	90	0/10
3b	Area-17	Mapping	25/Sep/2009	07h07	UTC-6	70°38.820	136°10.460	CTD ↓	496	26	20	9	-2.1	3.3	1009.2	90	0/10
3b	Area-17	Mapping	25/Sep/2009	07h26	UTC-6	70°38.810	136°11.150	CTD ↑	496	12	10	10	-2.5	3.1	1009.5	91	0/10
3b	Area-17	Piston Core	25/Sep/2009	08h30	UTC-6	70°38.500	136°09.200	Piston Core ↓	475	55	23	12	-2.5	3.1	1009.4	90	0/10
3b	Area-17	Piston Core	25/Sep/2009	09h00	UTC-6	70°38.100	136°09.600	Piston Core ↑	472	55	23	12	-2.5	3.1	1009.4	90	0/10
3b	Area-17	Mapping	25/Sep/2009	09h19	UTC-6	70°39.100	136°12.500	Bottom Mapping ↓	527	238	33	11	-2.2	3.0	1009.3	93	0/10
3b	Area-17	Mapping	25/Sep/2009	09h28	UTC-6	70°38.300	136°16.400	Bottom Mapping ↑	564	238	30	12	-2.1	2.9	1009.4	93	0/10
3b	Area-17	Mapping	25/Sep/2009	09h39	UTC-6	70°38.700	136°17.630	Bottom Mapping ↓	574	58	27	12	-2.1	2.9	1009.5	93	0/10
3b	Area-17	Mapping	25/Sep/2009	09h47	UTC-6	78°39.600	136°13.400	Bottom Mapping ↑	536	58	30	13	-2.5	2.9	1009.2	92	0/10
3b	Area-17	Piston Core	25/Sep/2009	10h30	UTC-6	70°38.100	136°09.600	Piston Core ↓	475	50	24	11	-2.4	2.8	1009.3	91	0/10

Appendix 2 - Scientific log of activities conducted during the 2009 ArcticNet Expedition

Leg	Station ID	Station Type	Local Date	Local Time	UTC to local	Latitude (N)	Longitude (W)	Activity	Depth (m)	Heading (°)	Wind		Air (ºC)	Water (ºC)	Pr Baro	Hum (%)	Ice
											Dir	Speed					
3b	Area-17	Piston Core	25/Sep/2009	10h55	UTC-6	70°38.000	136°09.900	Piston Core ↑	477	60	24	12	-2.5	2.8	1009.3	90	0/10
3b	Area-17	Mapping	25/Sep/2009	11h39	UTC-6	70°42.700	136°07.800	Bottom Mapping ↓	587	237	21	11	-2.3	2.8	1009.2	88	0/10
3b	Area-17	Mapping	25/Sep/2009	12h14	UTC-6	70°41.600	136°15.400	Bottom Mapping ↑	643	235	30	11	-0.1	2.6	1009.6	81	0/10
3b	Area-17	Piston Core	25/Sep/2009	12h46	UTC-6	70°40.380	136°14.130	Piston Core ↓	554	38	4	11	-2.3	2.5	1009.6	87	0/10
3b	Area-17	Mapping	25/Sep/2009	13h04	UTC-6	70°40.300	136°14.100	Weather Balloon	554	90	10	12	-2.4	2.6	1009.7	86	0/10
3b	Area-17	Piston Core	25/Sep/2009	13h09	UTC-6	70°40.300	136°14.200	Piston Core ↑	554	122	20	10	-2.4	2.6	1009.6	86	0/10
3b	Area-17	Piston Core	25/Sep/2009	14h35	UTC-6	70°41.100	136°10.040	Piston Core ↓	530	40	20	9	-2.5	2.6	1009.9	87	0/10
3b	Area-17	Piston Core	25/Sep/2009	15h00	UTC-6	70°41.000	136°10.100	Piston Core ↑	526	103	20	9	-2.5	2.6	1009.9	87	0/10
3b	Area-17	Mapping	25/Sep/2009	15h28	UTC-6	70°41.800	136°15.200	Bottom Mapping ↓	658	55	10	13	-2.3	2.6	1009.9	88	0/10
3b	Area-17	Piston Core	25/Sep/2009	16h32	UTC-6	70°44.340	136°08.660	Piston Core ↓	613	30	15	5/10	-2.8	2.5	1009.9	90	0/10
3b	Area-17	Piston Core	25/Sep/2009	17h13	UTC-6	70°43.950	136°08.800	Piston Core ↑	613	90	340	5/10	-2.6	2.5	1010.2	89	0/10
3b	Area-17	Mapping	25/Sep/2009	18h10	UTC-6	70°44.030	136°07.110	Bottom Mapping ↓	611	238	15	5/10	-2.8	2.6	1010.2	91	0/10
3b	Area-17	Mapping	25/Sep/2009	18h48	UTC-6	70°41.890	136°17.570	Bottom Mapping ↑	595	235	10	5	-2.9	2.6	1010.5	91	0/10
3b	Area-18	Mapping	25/Sep/2009	18h58	UTC-6	70°41.330	136°16.540	CTD ↓	591	14	10	5	-3.0	2.5	1010.5	90	0/10
3b	Area-18	Mapping	25/Sep/2009	19h18	UTC-6	70°41.350	136°16.930	CTD ↑	596	47	32	8	-2.9	2.5	1010.6	90	0/10
3b	Area-18	Mapping	25/Sep/2009	20h21	UTC-6	70°36.000	136°37.400	Bottom Mapping ↓	797	57	29	6	-2.8	2.6	1010.4	92	0/10
3b	Area-18	Mapping	25/Sep/2009	22h20	UTC-6	70°47.300	135°44.300	Bottom Mapping ↑	569	57	0	7	-2.7	2.8	1010.6	85	0/10
3b	Area-18	Mapping	25/Sep/2009	22h24	UTC-6	70°47.400	135°46.900	Bottom Mapping ↓	601	237	23	6	-2.7	2.8	1010.6	85	0/10
3b	Area-18	Mapping	26/Sep/2009	00h12	UTC-6	70°36.400	136°38.800	Bottom Mapping ↑	866	237	40	9	-3.0	2.6	1011.3	88	0/10
3b	Area-18	Mapping	26/Sep/2009	00h18	UTC-6	70°37.000	136°38.900	Bottom Mapping ↓	882	59	30	6	-3.0	2.6	1011.3	88	0/10
3b	Area-18	Mapping	26/Sep/2009	02h11	UTC-6	70°48.000	135°46.600	Bottom Mapping ↑	625	58	10	10	-2.7	2.8	1011.6	82	0/10
3b	Area-18	Mapping	26/Sep/2009	02h19	UTC-6	70°48.400	135°48.100	Bottom Mapping ↓	629	236	0	10	-2.5	2.9	1011.8	82	0/10
3b	Area-18	Mapping	26/Sep/2009	04h14	UTC-6	70°38.060	136°40.240	Bottom Mapping ↓	933	58	40	5/10	-2.8	2.8	1012.4	82	0/10
3b	Area-18	Mapping	26/Sep/2009	04h08	UTC-6	70°37.950	136°37.950	Bottom Mapping ↑	654	236	40	5/10	-2.8	2.8	1012.5	80	0/10
3b	Area-18	Mapping	26/Sep/2009	06h05	UTC-6	70°48.770	135°49.560	Bottom Mapping ↑	661	58	4	5/10	-3.4	2.8	1013.4	87	0/10
3b	Area-18	Mapping	26/Sep/2009	06h10	UTC-6	70°49.960	135°46.460	Bottom Mapping ↓	664	237	5	5/10	-3.4	2.8	1013.4	86	0/10
3b	N/A	Weather	26/Sep/2009	06h32	UTC-6	70°46.990	136°01.170	Weather Balloon	721	238	10	10	-3.4	3.0	1013.6	87	0/10
3b	Area-19	Mapping	26/Sep/2009	07h04	UTC-6	70°44.780	136°11.880	CTD ↓	614	334	330	6	-3.5	3.0	1013.8	93	0/10
3b	Area-19	Mapping	26/Sep/2009	07h25	UTC-6	70°44.740	136°12.530	CTD ↑	612	7	20	10	-3.6	2.9	1014.0	92	0/10
3b	Area-19	Piston Core	26/Sep/2009	08h23	UTC-6	70°41.300	136°06.100	Piston Core ↓	640	55	340	1	-3.5	3	1014.6	89	0/10
3b	Area-19	Piston Core	26/Sep/2009	08h47	UTC-6	70°44.300	136°06.900	Piston Core ↑	640	63	340	1	-3.5	3	1014.6	89	0/10
3b	Area-19	Mapping	26/Sep/2009	09h18	UTC-6	70°45.700	136°08.000	Bottom Mapping ↓	683	237	315	1	-3.3	3.1	1014.9	90	0/10
3b	Area-19	Mapping	26/Sep/2009	09h55	UTC-6	70°43.400	136°18.800	Bottom Mapping ↑	678	237	121	3	-2.9	3.0	1015.1	89	0/10
3b	Area-19	Piston Core	26/Sep/2009	10h30	UTC-6	70°44.900	136°28.300	Piston Core ↓	1005	55	22	3	-3.0	2.7	1015.6	88	0/10
3b	Area-19	Piston Core	26/Sep/2009	11h00	UTC-6	70°44.800	136°28.700	Piston Core ↑	1011	90	4	6	-3.2	2.5	1015.8	91	0/10
3b	Area-19	Mapping	26/Sep/2009	11h43	UTC-6	70°42.500	136°17.100	Bottom Mapping ↓	719	57	268	2	-2.9	2.5	1016.6	90	0/10
3b	Area-19	Mapping	26/Sep/2009	12h18	UTC-6	70°44.800	136°06.300	Bottom Mapping ↑	659	56	330	8	-2.9	2.7	1016.3	89	0/10
3b	Area-19	Mapping	26/Sep/2009	12h25	UTC-6	70°44.500	136°05.900	Bottom Mapping ↓	641	233	315	5	-3.0	2.8	1016.3	90	0/10
3b	Area-19	Mapping	26/Sep/2009	13h02	UTC-6	70°42.200	136°16.800	Bottom Mapping ↑	703	237	270	5	-2.6	2.9	1016.7	90	0/10
3b	Area-19	Piston Core	26/Sep/2009	13h35	UTC-6	70°39.500	136°05.600	Piston Core ↓	448	350	300	4	-2.3	2.9	1017.2	88	0/10
3b	Area-19	Piston Core	26/Sep/2009	14h00	UTC-6	70°39.500	136°05.600	Piston Core ↑	448	350	320	2	-2.2	2.9	1017.2	87	0/10
3b	Area-19	Box Core	26/Sep/2009	15h12	UTC-6	70°40.500	136°01.100	Box Core ↓	432	3	295	2	-2.2	2.9	1017.8	88	0/10
3b	Area-19	Box Core	26/Sep/2009	15h30	UTC-6	70°40.400	136°01.100	Box Core ↑	440	24	310	3	-2.2	2.9	1017.9	88	0/10
3b	Area-19	Piston Core	26/Sep/2009	16h18	UTC-6	70°40.400	136°01.150	Piston Core ↓	440	39	Calm	Calm	-2.2	3.0	1018.2	87	0/10
3b	Area-19	Piston Core	26/Sep/2009	16h35	UTC-6	70°40.400	136°01.170	Piston Core ↑	440	39	Calm	Calm	-1.6	3.0	1018.4	85	0/10

Appendix 2 - Scientific log of activities conducted during the 2009 ArcticNet Expedition

Leg	Station ID	Station Type	Local Date	Local Time	UTC to local	Latitude (N)	Longitude (W)	Activity	Depth (m)	Heading (°)	Wind		Air (ºC)	Water (ºC)	Pr Baro	Hum (%)	Ice
											Dir	Speed					
3b	Area-19	Mapping	26/Sep/2009	17h07	UTC-6	70°39.400	136°01.500	Bottom Mapping ↓	355	150	Calm	Calm	-1.4	3.1	1018.6	86	0/10
3b	Area-19	Mapping	26/Sep/2009	17h26	UTC-6	70°36.800	135°57.800	Bottom Mapping ↑	212	152	Calm	Calm	-1.5	3.1	1018.6	84	0/10
3b	Area-19	Mapping	26/Sep/2009	17h36	UTC-6	70°36.530	135°59.330	Bottom Mapping ↓	210	335	Calm	Calm	-1.5	3.1	1018.6	84	0/10
3b	Area-19	Mapping	26/Sep/2009	17h55	UTC-6	70°39.610	136°03.590	Bottom Mapping ↑	220	335	Calm	Calm	N/A	N/A	N/A	84	0/10
3b	Area-19	Piston Core	26/Sep/2009	18h26	UTC-6	70°40.480	136°01.190	Piston Core ↓	440	52	240	6	-1.3	3.1	1018.8	79	0/10
3b	Area-19	Piston Core	26/Sep/2009	18h49	UTC-6	70°40.500	136°01.260	Piston Core ↑	440	17	240	6	-1.0	3.2	1018.9	77	0/10
3b	Area-20	Mapping	26/Sep/2009	19h14	UTC-6	70°40.560	136°02.540	CTD ↓	457	344	240	2	-1.2	3.2	1019.0	79	0/10
3b	Area-20	Mapping	26/Sep/2009	19h31	UTC-6	70°40.520	136°03.230	CTD ↑	461	310	194	6	-1.1	3.3	1019.5	79	0/10
3b	Area-20	Mapping	26/Sep/2009	20h00	UTC-6	70°41.770	136°05.690	Bottom Mapping ↓	500	237	240	8	-1.0	3.3	1019.0	79	0/10
3b	Area-20	Mapping	26/Sep/2009	21h18	UTC-6	70°38.300	136°42.100	Bottom Mapping ↑	973	237	291	12	-0.4	2.8	1019.0	79	0/10
3b	Area-20	Mapping	26/Sep/2009	21h25	UTC-6	70°39.000	136°43.600	Bottom Mapping ↓	1081	57	291	12	-0.4	2.8	1019.0	79	0/10
3b	Area-20	Mapping	26/Sep/2009	23h16	UTC-6	78°50.300	135°51.400	Bottom Mapping ↑	687	57	284	8	-1.2	3.0	1019.9	92	0/10
3b	Area-20	Mapping	26/Sep/2009	23h23	UTC-6	70°49.800	135°50.500	Bottom Mapping ↓	672	237	284	8	-1.2	3.0	1019.9	92	0/10
3b	Area-20	Mapping	27/Sep/2009	00h39	UTC-6	70°42.700	136°24.000	Bottom Mapping ↑	861	238	280	6	-1.4	3.0	1020.2	92	0/10
3b	Area-20	Mapping	27/Sep/2009	00h50	UTC-6	70°43.800	136°25.000	Bottom Mapping ↓	950	55	290	9	-1.3	3.0	1020.2	92	0/10
3b	Area-20	Mapping	27/Sep/2009	02h19	UTC-6	70°50.800	135°51.800	Bottom Mapping ↑	694	56	280	7	-0.8	3.0	1020.6	78	0/10
3b	Area-20	Mapping	27/Sep/2009	02h26	UTC-6	70°51.200	135°53.300	Bottom Mapping ↓	699	236	260	7	-0.8	3.0	1020.5	77	0/10
3b	Area-20	Mapping	27/Sep/2009	04h17	UTC-6	70°40.030	136°46.140	Bottom Mapping ↑	1152	237	230	10/15	-0.3	2.9	1020.5	83	0/10
3b	Area-20	Mapping	27/Sep/2009	04h23	UTC-6	70°39.480	136°47.340	Bottom Mapping ↓	1147	150	230	10/15	-0.3	2.9	1020.5	82	0/10
3b	Area-20	Mapping	27/Sep/2009	04h45	UTC-6	70°34.310	136°38.420	Bottom Mapping ↑	643	150	243	15	-0.1	2.5	1021.0	85	0/10
3b	Area-20	Piston Core	27/Sep/2009	06h43	UTC-6	70°40.210	135°42.210	Piston Core ↓	246	N/A	250	10/12	0.0	3.3	1021.7	82	0/10
3b	Area-20	Piston Core	27/Sep/2009	06h55	UTC-6	70°40.230	135°42.230	Piston Core ↑	246	N/A	250	10	0.0	3.3	1021.6	82	0/10
3b	Area-20	Box Core	27/Sep/2009	08h51	UTC-6	70°35.400	135°45.100	Box Core ↓	76	310	268	14	0.2	3.5	1021.7	86	0/10
3b	Area-20	Box Core	27/Sep/2009	08h59	UTC-6	70°35.400	135°45.100	Box Core ↑	76	270	268	14	0.2	3.5	1021.7	86	0/10
3b	Area-20	Piston Core	27/Sep/2009	09h50	UTC-6	70°35.400	135°45.100	Piston Core ↓	76	264	257	14	0.3	3.6	1021.9	80	0/10
3b	Area-20	Piston Core	27/Sep/2009	10h00	UTC-6	70°35.400	135°45.200	Piston Core ↑	74	290	257	14	0.3	3.6	1021.9	80	0/10
3b	Area-21	Mapping	27/Sep/2009	10h23	UTC-6	70°35.400	135°44.900	CTD ↓	74	269	253	13	0.3	3.6	1021.8	82	0/10
3b	Area-21	Mapping	27/Sep/2009	10h30	UTC-6	70°35.400	135°44.900	CTD ↑	74	287	236	15	0.3	3.6	1021.8	82	0/10
3b	Area-21	Piston Core	27/Sep/2009	11h00	UTC-6	70°35.400	135°45.100	Piston Core ↓	74	265	240	14	-0.6	3.6	1021.9	88	0/10
3b	Area-21	Piston Core	27/Sep/2009	11h07	UTC-6	70°35.400	135°45.000	Piston Core ↑	74	278	244	12	-0.6	3.6	1021.9	88	0/10
3b	Area-21	Mapping	27/Sep/2009	11h20	UTC-6	70°35.200	135°46.600	Bottom Mapping ↓	70	244	250	9	0.0	3.6	1021.6	85	0/10
3b	Area-21	Mapping	27/Sep/2009	11h37	UTC-6	70°34.400	135°51.500	Bottom Mapping ↑	65	244	279	9	0.1	3.6	1021.7	84	0/10
3b	Area-21	Mapping	27/Sep/2009	11h40	UTC-6	70°34.500	135°51.400	Bottom Mapping ↓	66	64	279	9	0.1	3.6	1021.7	84	0/10
3b	Area-21	Mapping	27/Sep/2009	11h58	UTC-6	70°36.300	135°40.300	Bottom Mapping ↑	67	64	275	11	0.0	3.6	1022.0	84	0/10
3b	Area-21	Mapping	27/Sep/2009	12h02	UTC-6	70°36.400	135°41.000	Bottom Mapping ↓	68	244	275	11	0.0	3.6	1022.0	84	0/10
3b	Area-21	Mapping	27/Sep/2009	12h19	UTC-6	70°34.600	135°52.300	Bottom Mapping ↑	66	244	250	9	0.1	3.5	1021.6	86	0/10
3b	Area-21	Mapping	27/Sep/2009	12h23	UTC-6	70°34.800	135°51.700	Bottom Mapping ↓	68	62	260	12	0.2	3.5	1021.6	85	0/10
3b	Area-21	Mapping	27/Sep/2009	12h41	UTC-6	70°36.600	135°40.300	Bottom Mapping ↑	68	65	245	10	0.4	3.5	1022.2	80	0/10
3b	Area-21	Mapping	27/Sep/2009	12h46	UTC-6	70°36.200	135°40.300	Bottom Mapping ↓	67	243	260	12	0.4	3.5	1022.2	80	0/10
3b	Area-21	Mapping	27/Sep/2009	12h55	UTC-6	70°35.200	135°46.600	Bottom Mapping ↑	67	244	265	11	0.4	3.5	1021.8	82	0/10
3b	Area-21	Box Core	27/Sep/2009	13h25	UTC-6	70°37.400	135°45.100	Box Core ↓	110	275	255	16	-0.8	3.5	1022.1	95	0/10
3b	Area-21	Box Core	27/Sep/2009	13h35	UTC-6	70°37.400	135°45.000	Box Core ↑	110	350	255	17	-0.6	3.6	1021.9	92	0/10
3b	Area-21	Piston Core	27/Sep/2009	14h08	UTC-6	70°37.400	135°45.100	Piston Core ↓	110	266	248	16	0.2	3.6	1022.0	79	0/10
3b	Area-21	Piston Core	27/Sep/2009	14h27	UTC-6	70°37.400	135°45.100	Piston Core ↑	110	282	235	18	-0.2	3.6	1022.1	85	0/10
3b	Area-21	Mapping	27/Sep/2009	14h43	UTC-6	70°37.600	135°46.500	Bottom Mapping ↓	145	294	240	20	0.0	3.6	1022.1	80	0/10

Appendix 2 - Scientific log of activities conducted during the 2009 ArcticNet Expedition

Leg	Station ID	Station Type	Local Date	Local Time	UTC to local	Latitude (N)	Longitude (W)	Activity	Depth (m)	Heading (°)	Wind		Air (ºC)	Water (ºC)	Pr Baro	Hum (%)	Ice
											Dir	Speed					
3b	Area-21	Mapping	27/Sep/2009	15h34	UTC-6	70°40.600	136°05.600	Bottom Mapping (interrupted)	460	295	250	20	-0.3	3.4	1021.5	86	0/10
3b	Area-22	Mapping	27/Sep/2009	15h47	UTC-6	70°40.500	136°05.900	CTD ↓	461	229	250	20	-0.3	3.4	1021.5	86	0/10
3b	Area-22	Mapping	27/Sep/2009	16h09	UTC-6	70°40.300	136°05.600	CTD ↑	455	236	250	20	-0.3	3.3	1021.5	86	0/10
3b	Area-22	Mapping	27/Sep/2009	17h00	UTC-6	70°43.660	136°21.150	Bottom Mapping ↓	700	57	250	20	-0.4	3.0	1021.5	86	0/10
3b	Area-22	Mapping	27/Sep/2009	17h38	UTC-6	70°46.370	136°07.600	Bottom Mapping ↑	620	58	250	20	-0.6	2.7	1021.5	75	0/10
3b	Area-22	Mapping	27/Sep/2009	18h30	UTC-6	70°43.960	136°21.840	Bottom Mapping ↓	617	58	250	20	-0.6	2.7	1021.3	80	0/10
3b	Area-22	Mapping	27/Sep/2009	19h18	UTC-6	70°46.010	136°08.850	Bottom Mapping ↑	717	58	240	15/20	-0.1	2.5	1020.7	80	0/10
3b	Area-22	Mapping	27/Sep/2009	19h22	UTC-6	70°46.640	136°09.470	Bottom Mapping ↓	671	241	250	15/20	-0.1	2.5	1020.7	80	0/10
3b	Area-22	Mapping	27/Sep/2009	19h55	UTC-6	70°44.100	136°21.600	Bottom Mapping ↑	747	241	245	20	-0.4	2.4	1020.7	82	0/10
3b	Area-22	Mapping	27/Sep/2009	20h01	UTC-6	70°44.400	136°20.800	Bottom Mapping ↓	674	57	245	20	-0.4	2.4	1020.7	82	0/10
3b	Area-22	Mapping	27/Sep/2009	20h09	UTC-6	70°45.000	136°18.500	Bottom Mapping ↑	627	57	249	15	-0.4	2.4	1020.7	82	0/10
3b	Area-22	Mapping	27/Sep/2009	20h24	UTC-6	70°44.700	136°21.400	Bottom Mapping ↓	719	57	251	17	-0.4	2.4	1020.3	82	0/10
3b	Area-22	Mapping	27/Sep/2009	21h00	UTC-6	70°47.100	136°10.400	Bottom Mapping ↑	714	57	251	17	-0.3	2.3	1020.3	85	0/10
3b	Area-22	Mapping	27/Sep/2009	21h10	UTC-6	70°47.300	136°10.400	Bottom Mapping ↓	721	237	251	17	-0.3	2.3	1020.2	87	0/10
3b	Area-22	Mapping	27/Sep/2009	21h47	UTC-6	70°44.900	136°21.700	Bottom Mapping ↑	759	237	238	20	-0.3	2.5	1019.7	87	0/10
3b	Area-22	Mapping	27/Sep/2009	21h50	UTC-6	70°45.200	136°22.200	Bottom Mapping ↓	717	57	261	18	-0.2	2.4	1019.5	86	0/10
3b	Area-22	Mapping	27/Sep/2009	22h32	UTC-6	70°47.500	136°11.600	Bottom Mapping ↑	732	57	283	15	-1.0	2.3	1020.0	92	0/10
3b	Area-22	Mapping	27/Sep/2009	22h40	UTC-6	70°47.400	136°13.000	Bottom Mapping ↓	732	237	285	12	-0.7	2.4	1019.8	88	0/10
3b	Area-22	Mapping	27/Sep/2009	23h17	UTC-6	70°45.300	136°22.700	Bottom Mapping ↑	732	237	280	16	-0.9	2.5	1019.8	87	0/10
3b	Area-22	Mapping	27/Sep/2009	23h30	UTC-6	70°46.200	136°20.700	Bottom Mapping ↓	659	57	290	13	-1.8	2.0	1020.3	84	0/10
3b	Area-22	Mapping	28/Sep/2009	00h00	UTC-6	70°48.000	136°12.400	Bottom Mapping ↑	753	56	325	17	-1.9	2.2	1020.3	89	0/10
3b	Area-22	Mapping	28/Sep/2009	00h08	UTC-6	70°47.800	136°14.700	Bottom Mapping ↓	753	236	330	16	-2.1	2.3	1020.2	92	0/10
3b	Area-22	Mapping	28/Sep/2009	00h45	UTC-6	70°45.800	136°23.400	Bottom Mapping ↑	680	242	320	16	-2.4	2.3	1020.5	88	0/10
3b	Area-22	Mapping	28/Sep/2009	00h58	UTC-6	70°46.000	136°23.500	Bottom Mapping ↓	689	53	320	17	-2.4	2.3	1020.5	88	0/10
3b	Area-22	Mapping	28/Sep/2009	01h32	UTC-6	70°48.300	136°12.900	Bottom Mapping ↑	742	55	310	15	-3.3	2.1	1021.1	88	0/10
3b	Area-22	Mapping	28/Sep/2009	01h41	UTC-6	70°48.400	136°13.500	Bottom Mapping ↓	755	240	330	13	-3.5	2.1	1021.1	85	0/10
3b	Area-22	Mapping	28/Sep/2009	02h17	UTC-6	70°46.100	136°24.200	Bottom Mapping ↑	702	237	330	13	-3.3	2.1	1021.3	82	0/10
3b	Area-22	Mapping	28/Sep/2009	02h27	UTC-6	70°46.300	136°24.400	Bottom Mapping ↓	724	57	330	14	-3.2	2.1	1021.3	80	0/10
3b	Area-22	Mapping	28/Sep/2009	02h33	UTC-6	70°46.600	136°22.600	Bottom Mapping ↑	689	57	320	15	-3.5	2.2	1021.4	79	0/10
3b	Area-22	Mapping	28/Sep/2009	02h45	UTC-6	70°47.000	136°23.900	Bottom Mapping ↓	707	238	320	10	-3.6	2.3	1021.4	80	0/10
3b	Area-22	Mapping	28/Sep/2009	02h50	UTC-6	70°46.700	136°25.500	Bottom Mapping ↑	716	236	330	12	-3.5	2.3	1021.4	81	0/10
3b	Area-22	Mapping	28/Sep/2009	03h00	UTC-6	70°46.600	136°24.900	Bottom Mapping ↓	714	58	340	9	-3.6	2.3	1021.6	80	0/10
3b	Area-22	Mapping	28/Sep/2009	03h36	UTC-6	70°48.900	136°14.100	Bottom Mapping ↑	755	58	330	12	-4.0	2.2	1021.8	77	0/10
3b	Area-22	Mapping	28/Sep/2009	03h44	UTC-6	70°48.700	136°13.900	Bottom Mapping ↓	760	235	340	9	-3.9	2.1	1021.8	80	0/10
3b	Area-22	Mapping	28/Sep/2009	04h19	UTC-6	70°46.420	136°24.970	Bottom Mapping ↑	699	235	330	5/10	-3.6	2.2	1021.8	80	0/10
3b	Area-22	Mapping	28/Sep/2009	04h30	UTC-6	70°46.060	136°23.600	Bottom Mapping ↓	688	236	330	5/10	-3.8	2.3	1021.9	78	0/10
3b	Area-22	Mapping	28/Sep/2009	05h30	UTC-6	70°40.890	136°48.040	Bottom Mapping ↑	1079	236	300	10	-3.7	2.3	1021.8	75	0/10
3b	Area-22	Mapping	28/Sep/2009	05h41	UTC-6	70°40.490	136°46.790	Bottom Mapping ↓	1079	236	300	10	-3.7	2.3	1021.8	75	0/10
3b	Area-22	Mapping	28/Sep/2009	06h22	UTC-6	70°45.570	136°22.870	Weather Balloon	673	56	285	12	-3.9	1.9	1022.2	75	0/10
3b	Area-22	Mapping	28/Sep/2009	06h22	UTC-6	70°45.570	136°22.870	Bottom Mapping ↓	675	56	285	12	-3.9	1.9	1022.2	75	0/10
3b	Area-22	Mapping	28/Sep/2009	07h02	UTC-6	70°47.960	136°11.870	Bottom Mapping ↑	749	56	290	8	-3.8	2.3	1021.9	80	0/10
3b	Area-23	Mapping	28/Sep/2009	07h07	UTC-6	70°47.960	136°11.810	CTD ↓	749	278	290	8	-3.8	2.3	1021.9	80	0/10
3b	Area-23	Mapping	28/Sep/2009	07h37	UTC-6	70°48.010	136°12.190	CTD ↑	750	259	287	6	-3.6	2.4	1021.7	79	0/10
3b	Area-23	Piston Core	28/Sep/2009	08h45	UTC-6	70°43.200	136°02.800	Piston Core ↓	550	265	229	9	-3.1	2.8	1021.4	80	0/10
3b	Area-23	Piston Core	28/Sep/2009	09h01	UTC-6	70°43.200	136°02.800	Piston Core ↑	550	275	190	10	-3.3	2.8	1021.3	86	0/10

Appendix 2 - Scientific log of activities conducted during the 2009 ArcticNet Expedition

Leg	Station ID	Station Type	Local Date	Local Time	UTC to local	Latitude (N)	Longitude (W)	Activity	Depth (m)	Heading (°)	Wind		Air (ºC)	Water (ºC)	Pr Baro	Hum (%)	Ice
											Dir	Speed					
3b	Area-23	Piston Core	28/Sep/2009	11h20	UTC-6	70°43.200	135°51.600	Piston Core ↓	511	305	303	13	-3.4	2.8	1021.0	85	0/10
3b	Area-23	Piston Core	28/Sep/2009	11h47	UTC-6	70°43.200	135°51.600	Piston Core ↑	518	320	309	12	-3.4	2.9	1021.0	80	0/10
3b	Area-23	Mapping	28/Sep/2009	12h18	UTC-6	70°44.400	136°00.000	Bottom Mapping ↓	586	341	320	13	-3.5	2.8	1020.9	87	0/10
3b	Area-23	Mapping	28/Sep/2009	12h30	UTC-6	70°45.900	136°01.500	Bottom Mapping ↑	689	343	315	13	-3.8	2.8	1020.9	83	0/10
3b	Area-23	Mapping	28/Sep/2009	12h38	UTC-6	70°45.500	136°03.000	Bottom Mapping ↓	666	163	320	14	-3.8	2.8	1020.9	83	0/10
3b	Area-23	Mapping	28/Sep/2009	12h47	UTC-6	70°44.400	136°02.110	Bottom Mapping ↑	596	162	300	18	-3.5	2.8	1021.2	81	0/10
3b	Area-23	Piston Core	28/Sep/2009	13h40	UTC-6	70°43.200	135°53.400	Piston Core ↓	495	320	305	10	-3.9	2.8	1021.4	80	0/10
3b	Area-23	Piston Core	28/Sep/2009	13h58	UTC-6	70°43.200	135°53.400	Piston Core ↑	495	320	305	10	-3.9	2.8	1021.4	80	0/10
3b	Area-23	Piston Core	28/Sep/2009	15h27	UTC-6	70°40.200	135°37.800	Piston Core ↓	202	341	335	10	-3.7	2.9	1021.3	79	0/10
3b	Area-23	Piston Core	28/Sep/2009	15h37	UTC-6	70°40.100	135°37.700	Piston Core ↑	202	350	345	9	-3.7	2.9	1021.3	82	0/10
3b	Area-23	Mapping	28/Sep/2009	15h54	UTC-6	70°40.100	137°37.700	Bottom Mapping ↓	192	45	5	10	-4.0	2.9	1021.3	82	0/10
3b	Area-23	Mapping	28/Sep/2009	16h45	UTC-6	70°46.000	135°20.000	Bottom Mapping ↓	196	238	338	15	-4.4	3.0	1020.9	89	0/10
3b	Area-23	Mapping	28/Sep/2009	17h01	UTC-6	70°43.000	135°29.700	Bottom Mapping ↑	250	238	330	13	-4.6	3.0	1021.1	90	0/10
3b	Area-23	Mapping	28/Sep/2009	17h07	UTC-6	70°43.400	135°29.500	Bottom Mapping ↓	276	56	325	13	-4.6	3.0	1021.1	90	0/10
3b	Area-23	Mapping	28/Sep/2009	17h24	UTC-6	70°45.400	135°19.700	Bottom Mapping ↑	170	56	325	12	-4.8	3.0	1021.3	85	0/10
3b	Area-23	Piston Core	28/Sep/2009	18h00	UTC-6	70°45.200	135°33.150	Piston Core ↓	377	Var	310	9	-4.8	3.0	1021.4	83	0/10
3b	Area-23	Piston Core	28/Sep/2009	18h18	UTC-6	70°45.190	135°33.170	Piston Core ↑	377	319	312	9	-4.8	2.9	1021.8	81	0/10
3b	Area-24	Mapping	28/Sep/2009	19h03	UTC-6	70°45.460	135°33.860	CTD ↓ (calibration)	392	311	314	10	-4.9	2.9	1021.7	83	0/10
3b	Area-24	Mapping	28/Sep/2009	19h13	UTC-6	70°45.510	135°33.910	CTD ↑ (calibration)	394	300	320	10	-5.0	2.9	1021.8	85	0/10
3b	Area-24	MVP	28/Sep/2009	19h28	UTC-6	70°45.360	135°33.660	MVP ↓	385	Var	319	11	-5.0	2.9	1021.7	86	0/10
3b	Area-24	Mapping	28/Sep/2009	19h49	UTC-6	70°43.740	135°30.910	Bottom Mapping ↓	339	57	318	15	-4.3	2.8	1021.6	86	0/10
3b	Area-24	Mapping	28/Sep/2009	20h12	UTC-6	70°46.000	135°19.800	Bottom Mapping ↑	192	57	305	14	-5.3	2.8	1021.5	84	0/10
3b	Area-24	Mapping	28/Sep/2009	20h26	UTC-6	70°45.700	135°20.100	Bottom Mapping ↓	186	238	316	9	-5.4	2.9	1021.5	83	0/10
3b	Area-24	Mapping	28/Sep/2009	20h55	UTC-6	70°43.500	135°30.600	Bottom Mapping ↑	303	238	323	10	-5.0	3.0	1021.6	86	0/10
3b	Area-24	Mapping	28/Sep/2009	20h57	UTC-6	70°43.200	135°30.800	Bottom Mapping ↓	285	143	323	10	-5.0	3.0	1021.6	86	0/10
3b	Area-24	Mapping	28/Sep/2009	21h17	UTC-6	70°40.900	135°25.300	Bottom Mapping ↑	92	143	325	13	-4.9	3.0	1021.5	84	0/10
3b	Area-24	Mapping	28/Sep/2009	21h19	UTC-6	70°40.600	135°25.400	Bottom Mapping ↓	83	238	325	13	-4.9	3.0	1021.5	84	0/10
3b	Area-24	Mapping	28/Sep/2009	23h31	UTC-6	70°25.500	136°42.000	Bottom Mapping ↑	82	238	338	9	-5.1	3.1	1021.2	85	0/10
3b	Area-24	Mapping	28/Sep/2009	23h54	UTC-6	70°26.400	136°43.700	Bottom Mapping ↓	301	53	320	10	-5.2	3.0	1021.3	85	0/10
3b	Area-24	Mapping	29/Sep/2009	01h06	UTC-6	70°35.000	136°03.100	Bottom Mapping ↑	158	57	320	10	-5.7	3.0	1020.9	88	0/10
3b	Area-24	Mapping	29/Sep/2009	01h14	UTC-6	70°35.300	136°04.800	Bottom Mapping ↓	223	237	320	6	-5.6	3.0	1020.8	87	0/10
3b	Area-24	Mapping	29/Sep/2009	02h22	UTC-6	70°26.700	136°45.500	Bottom Mapping ↑	346	238	345	5	-5.3	3.0	1020.7	85	0/10
3b	Area-24	Mapping	29/Sep/2009	02h29	UTC-6	70°27.300	136°45.400	Bottom Mapping ↓	387	57	340	9	-5.2	3.0	1020.6	85	0/10
3b	Area-24	Mapping	29/Sep/2009	03h40	UTC-6	70°35.900	136°04.800	Bottom Mapping ↑	257	57	330	10	-5.4	2.3	1020.3	87	0/10
3b	Area-24	Mapping	29/Sep/2009	03h48	UTC-6	70°36.300	136°06.400	Bottom Mapping ↓	271	237	310	7	-5.3	2.9	1020.2	85	0/10
3b	Area-24	Mapping	29/Sep/2009	04h55	UTC-6	70°27.530	136°48.540	Bottom Mapping ↑	440	237	340	7	-4.6	3.0	1019.6	81	0/10
3b	Area-24	Mapping	29/Sep/2009	05h03	UTC-6	70°28.130	136°47.830	Bottom Mapping ↓	458	59	313	7	-4.6	3.0	1019.6	81	0/10
3b	Area-24	Mapping	29/Sep/2009	06h15	UTC-6	70°36.920	136°06.430	Bottom Mapping ↑	320	59	325	7	-5.0	2.9	1019.3	82	0/10
3b	Area-24	Mapping	29/Sep/2009	06h22	UTC-6	70°37.490	136°08.360	Bottom Mapping ↓	390	240	320	8	-5.0	2.9	1019.3	82	0/10
3b	Area-24	Mapping	29/Sep/2009	06h52	UTC-6	70°33.230	136°08.360	Bottom Mapping ↑	484	237	303	6	-5.1	2.9	1019.1	81	0/10
3b	Area-25	Mapping	29/Sep/2009	07h08	UTC-6	70°33.280	136°28.840	CTD ↓	487	308	303	6	-5.1	2.9	1019.1	81	0/10
3b	Area-25	Mapping	29/Sep/2009	07h25	UTC-6	70°33.360	136°28.940	CTD ↑	492	332	305	5	-5.2	2.9	1019.0	81	0/10
3b	Area-25	Mapping	29/Sep/2009	08h12	UTC-6	70°37.300	136°07.500	Bottom Mapping ↓	366	238	315	5	-5.0	2.9	1018.4	81	0/10
3b	Area-25	Mapping	29/Sep/2009	09h02	UTC-6	70°32.100	136°34.900	Bottom Mapping ↑	495	238	315	5	-5.0	2.9	1018.4	81	0/10
3b	Area-25	Mapping	29/Sep/2009	09h05	UTC-6	70°32.100	136°34.600	Bottom Mapping ↓	496	58	315	5	-5.0	2.9	1018.4	81	0/10

Appendix 2 - Scientific log of activities conducted during the 2009 ArcticNet Expedition

Leg	Station ID	Station Type	Local Date	Local Time	UTC to local	Latitude (N)	Longitude (W)	Activity	Depth (m)	Heading (°)	Wind		Air (ºC)	Water (ºC)	Pr Baro	Hum (%)	Ice
											Dir	Speed					
3b	Area-25	Mapping	29/Sep/2009	09h48	UTC-6	70°37.600	136°08.800	Bottom Mapping ↑	426	58	29	6	-4.4	3.1	1017.8	80	0/10
3b	Area-25	Mapping	29/Sep/2009	10h59	UTC-6	70°35.700	136°04.800	Bottom Mapping ↓	228	238	17	6	-4.3	3.2	1017.6	78	0/10
3b	Area-25	Mapping	29/Sep/2009	11h05	UTC-6	70°35.000	136°08.900	Bottom Mapping ↑	240	238	47	7	-4.0	3.2	1017.6	77	0/10
3b	Area-25	Mapping	29/Sep/2009	16h12	UTC-6	70°37.500	136°00.260	Zodiac Recovered	N/A	260	20	7	-4.3	3.0	1016.7	73	0/10
3b	Area-25	ROV	29/Sep/2009	16h49	UTC-6	70°37.500	136°00.840	ROV ↑	N/A	262	5	10	-4.1	3.0	1016.6	70	0/10
3b	Area-25	Mooring	29/Sep/2009	18h34	UTC-6	70°43.600	136°00.700	Met/Ocean Buoy Recovered	547	63	35	3	-5.4	2.1	1016.2	80	0/10
3b	Area-25	Mapping	29/Sep/2009	22h15	UTC-6	70°32.100	136°18.300	Bottom Mapping ↓	317	58	322	4	-5.0	2.6	1015.3	80	0/10
3b	Area-25	Mapping	29/Sep/2009	22h40	UTC-6	70°35.100	136°04.000	Bottom Mapping ↑	200	58	322	4	-5.0	2.6	1015.3	80	0/10
3b	Area-25	Mapping	29/Sep/2009	22h46	UTC-6	70°34.700	136°03.900	Bottom Mapping ↓	133	238	322	4	-5.0	2.6	1015.3	80	0/10
3b	Area-25	Mapping	29/Sep/2009	23h57	UTC-6	70°26.200	136°43.500	Bottom Mapping ↑	274	238	12	5	-4.7	2.7	1015.2	79	0/10
3b	Area-25	Mapping	30/Sep/2009	00h02	UTC-6	70°25.800	136°42.000	Bottom Mapping ↓	150	58	0	8	-4.7	2.7	1015.3	80	0/10
3b	Area-25	Mapping	30/Sep/2009	01h09	UTC-6	70°34.300	136°02.100	Bottom Mapping ↑	111	58	310	9	-4.6	2.7	1014.9	84	0/10
3b	Area-25	Mapping	30/Sep/2009	01h19	UTC-6	70°33.500	136°01.200	Bottom Mapping ↓	81	237	Calm	Calm	-4.5	2.7	1014.9	81	0/10
3b	Area-25	Mapping	30/Sep/2009	02h28	UTC-6	70°25.000	136°41.600	Bottom Mapping ↑	67	237	Calm	Calm	-4.4	2.8	1014.6	85	0/10
3b	Area-25	Mapping	30/Sep/2009	02h34	UTC-6	70°25.000	136°44.300	Bottom Mapping ↓	106	326	290	7	-4.4	2.8	1014.6	84	0/10
3b	Area-25	Mapping	30/Sep/2009	02h49	UTC-6	70°27.800	136°42.800	Bottom Mapping ↑	446	326	250	8	-4.4	2.7	1014.6	86	0/10
3b	Area-25	Mapping	30/Sep/2009	02h55	UTC-6	70°28.600	136°48.300	Bottom Mapping ↓	468	57	280	7	-4.4	2.7	1014.7	86	0/10
3b	Area-25	Mapping	30/Sep/2009	03h20	UTC-6	70°31.590	136°34.500	Bottom Mapping ↑	460	57	266	8	-4.2	2.7	1014.7	86	0/10
3b	Area-25	Mapping	30/Sep/2009	03h23	UTC-6	70°32.100	136°34.860	Bottom Mapping ↓	470	237	260	8	-4.2	2.7	1014.7	89	0/10
3b	Area-25	Mapping	30/Sep/2009	03h48	UTC-6	70°28.970	136°49.930	Bottom Mapping ↑	497	237	286	6	-3.7	2.7	1014.2	90	0/10
3b	Area-25	Mapping	30/Sep/2009	03h51	UTC-6	70°29.050	136°50.820	Bottom Mapping ↓	494	57	285	8	-3.7	2.7	1014.5	90	0/10
3b	Area-25	Mapping	30/Sep/2009	05h05	UTC-6	70°38.520	136°08.140	Bottom Mapping ↑	469	57	256	10	-3.5	2.6	1014.0	92	0/10
3b	Area-25	Mapping	30/Sep/2009	05h10	UTC-6	70°38.720	136°10.050	Bottom Mapping ↓	494	237	255	9	-3.5	2.6	1014.0	92	0/10
3b	Area-25	Mapping	30/Sep/2009	05h50	UTC-6	70°33.700	136°33.190	Bottom Mapping ↑	532	237	250	7	-3.2	2.5	1014.0	92	0/10
3b	Area-25	Mapping	30/Sep/2009	05h54	UTC-6	70°33.790	136°30.840	Bottom Mapping ↓	553	82	266	9	-3.0	2.6	1013.4	91	0/10
3b	N/A	MVP	30/Sep/2009	06h57	UTC-6	70°37.730	135°50.560	MVP ↓	191	82	330	6	-3.2	2.7	1013.6	92	0/10
3b	N/A	MVP	30/Sep/2009	07h27	UTC-6	70°39.950	135°40.000	MVP ↑	205	82	340	10	-3.3	2.8	1013.6	92	0/10
3b	Area-25	Mapping	30/Sep/2009	07h50	UTC-6	70°42.420	135°28.220	Bottom Mapping ↑	154	58	330	7	-3.3	2.8	1013.6	92	0/10
3b	Area-25	Mapping	30/Sep/2009	07h58	UTC-6	70°41.600	135°28.800	Bottom Mapping ↓	146	238	352	10	-3.4	2.6	1013.5	86	0/10
3b	Area-25	Mapping	30/Sep/2009	08h12	UTC-6	70°40.100	135°36.300	Bottom Mapping ↑	170	238	333	6	-3.2	2.6	1013.7	80	0/10
3b	B	Mooring	30/Sep/2009	08h45	UTC-6	70°39.400	135°36.200	Mixed Layer Buoy B Recovered	126	338	335	9	-3.2	2.6	1013.7	80	0/10
3b	Area-25	Mapping	30/Sep/2009	11h30	UTC-6	70°28.600	135°27.100	Bottom Mapping ↓	60	173	198	7	-3.3	2.9	1013.6	86	0/10
3b	Area-25	Mapping	30/Sep/2009	13h38	UTC-6	70°00.200	135°16.500	Bottom Mapping ↑	27	170	Calm	Calm	-3.5	2.7	1014.5	72	0/10
3b	Area-25	Mapping	30/Sep/2009	13h48	UTC-6	70°00.500	135°18.200	Bottom Mapping ↓	28	354	Calm	Calm	-3.4	2.6	1014.6	72	0/10
3b	Area-25	Mapping	30/Sep/2009	14h06	UTC-6	70°04.800	135°26.400	Bottom Mapping ↑	35	352	Calm	Calm	-3.5	2.7	1014.5	72	0/10
3b	Area-25	Mapping	30/Sep/2009	14h36	UTC-6	70°07.500	135°31.000	Bottom Mapping ↓	48	83	330	5	-3.4	2.5	1014.5	69	0/10
3b	Area-25	Mapping	30/Sep/2009	14h55	UTC-6	70°08.200	135°11.300	Weather Balloon	45	84	Calm	Calm	-3.3	2.6	1014.6	70	0/10
3b	Area-25	Mapping	30/Sep/2009	15h14	UTC-6	70°08.400	135°05.500	Bottom Mapping ↑	45	83	Calm	Calm	-3.3	2.6	1014.5	70	0/10
3b	Area-25	Mapping	30/Sep/2009	15h35	UTC-6	70°09.765	135°10.483	Dead Whale Found	46	288	Calm	Calm	-3.4	2.5	1014.6	70	0/10
3b	Area-25	Mapping	30/Sep/2009	15h49	UTC-6	70°10.100	135°14.000	Bottom Mapping ↓	50	263	Calm	Calm	-3.4	2.5	1014.6	69	0/10
3b	Area-25	Mapping	30/Sep/2009	16h24	UTC-6	70°10.580	135°35.030	Bottom Mapping ↑	50	263	Calm	Calm	-3.1	2.6	1014.6	68	0/10
3b	Area-25	Mapping	30/Sep/2009	16h30	UTC-6	70°11.290	135°33.940	Bottom Mapping ↓	55	81	Calm	Calm	-3.1	2.6	1014.6	68	0/10
3b	Area-25	Mapping	30/Sep/2009	17h00	UTC-6	70°12.160	135°13.470	Bottom Mapping ↑	44	81	Calm	Calm	-3.2	2.6	1014.5	68	0/10
3b	Area-25	Mapping	30/Sep/2009	17h10	UTC-6	70°14.130	135°14.280	Bottom Mapping ↓	48	70	Calm	Calm	-3.2	2.6	1014.5	68	0/10
3b	Area-25	Mapping	30/Sep/2009	18h20	UTC-6	70°12.470	136°00.510	Bottom Mapping ↑	43	270	170	3	-3.0	2.5	1014.4	68	0/10

Appendix 2 - Scientific log of activities conducted during the 2009 ArcticNet Expedition

Leg	Station ID	Station Type	Local Date	Local Time	UTC to local	Latitude (N)	Longitude (W)	Activity	Depth (m)	Heading (°)	Wind		Air (ºC)	Water (ºC)	Pr Baro	Hum (%)	Ice
											Dir	Speed					
3b	Area-25	Mapping	30/Sep/2009	18h30	UTC-6	70°10.610	135°56.380	Bottom Mapping ↓	40	82	Calm	Calm	-3.0	2.5	1014.4	68	0/10
3b	Area-25	Mapping	30/Sep/2009	21h00	UTC-6	70°33.200	136°00.100	Bottom Mapping ↓	70	238	Calm	Calm	-3.6	2.8	1014.7	78	0/10
3b	Area-25	Mapping	30/Sep/2009	22h09	UTC-6	70°24.600	136°40.400	Bottom Mapping ↑	62	238	Calm	Calm	-3.9	2.8	1015.1	80	0/10
3b	Area-25	Mapping	30/Sep/2009	22h13	UTC-6	70°24.700	136°41.100	Bottom Mapping ↓	64	58	Calm	Calm	-3.9	2.8	1015.1	80	0/10
3b	Area-25	Mapping	30/Sep/2009	22h23	UTC-6	78°33.400	136°00.400	Bottom Mapping ↑	81	58	Calm	Calm	-3.8	2.8	1015.1	79	N/A
3b	Area-25	Mapping	30/Sep/2009	23h28	UTC-6	70°33.900	136°01.000	Bottom Mapping ↓	88	238	Calm	Calm	-3.8	2.8	1015.1	79	N/A
3b	Area-25	Mapping	01/Oct/2009	00h37	UTC-6	70°25.100	136°42.500	Bottom Mapping ↑	73	238	330	5	-3.5	2.7	1015.3	74	0/10
3b	Area-25	Mapping	01/Oct/2009	00h44	UTC-6	70°25.100	136°46.100	Bottom Mapping ↓	190	326	270	5	-3.6	2.7	1015.4	76	0/10
3b	Area-25	Mapping	01/Oct/2009	01h05	UTC-6	70°28.900	136°53.800	Bottom Mapping ↑	573	327	260	5	-3.9	2.7	1015.4	77	0/10
3b	Area-25	Mapping	01/Oct/2009	01h14	UTC-6	70°30.000	136°50.500	Bottom Mapping ↓	531	57	Calm	Calm	-3.9	2.7	1015.5	80	0/10
3b	Area-25	Mapping	01/Oct/2009	01h47	UTC-6	70°34.000	136°31.900	Bottom Mapping ↑	532	57	19	9	-4.2	2.6	1015.4	89	0/10
3b	Area-25	Mapping	01/Oct/2009	01h54	UTC-6	70°34.600	136°35.300	Bottom Mapping ↓	605	238	350	10	-4.2	2.6	1015.4	89	0/10
3b	Area-25	Mapping	01/Oct/2009	02h24	UTC-6	70°30.900	136°52.800	Bottom Mapping ↑	619	237	0	12	-4.3	2.6	1015.7	92	0/10
3b	Area-25	Mapping	01/Oct/2009	02h30	UTC-6	70°30.500	136°51.300	Bottom Mapping ↓	550	54	345	16	-4.6	2.5	1015.7	93	0/10
3b	Area-25	Mapping	01/Oct/2009	03h17	UTC-6	70°36.100	136°24.900	Bottom Mapping ↑	670	57	0	12	-4.7	2.5	1015.7	90	0/10
3b	Area-25	Mapping	01/Oct/2009	03h56	UTC-6	70°38.400	136°48.500	Bottom Mapping ↓	1041	336	340	6	-5.2	2.5	1016.1	91	0/10
3b	Area-25	Mapping	01/Oct/2009	04h19	UTC-6	70°43.220	136°51.940	Bottom Mapping ↑	1266	336	0	10/15	-5.0	2.4	1015.9	90	0/10
3b	Area-25	Mapping	01/Oct/2009	04h22	UTC-6	70°43.250	136°51.810	Bottom Mapping ↓	1192	56	0	10/15	-6.0	2.0	1016.3	88	0/10
3b	Area-25	Mapping	01/Oct/2009	05h52	UTC-6	70°54.590	135°58.590	Bottom Mapping ↑	814	55	337	10	-6.7	1.0	1016.8	88	0/10
3b	Area-25	Mapping	01/Oct/2009	06h00	UTC-6	70°55.340	136°01.070	Bottom Mapping ↓	849	240	335	8	-6.7	1.0	1016.8	88	0/10
3b	Area-25	Mapping	01/Oct/2009	06h18	UTC-6	70°52.370	136°16.320	Weather Balloon	865	240	335	6	-6.7	0.7	1016.9	88	0/10
3b	Area-25	Mapping	01/Oct/2009	07h27	UTC-6	70°44.300	136°53.070	Bottom Mapping ↑	1212	240	4	10	-6.0	0.9	1017.3	84	0/10
3b	Area-26	Mapping	01/Oct/2009	08h33	UTC-6	70°45.000	136°38.300	CTD ↓	1205	45	296	9	-5.9	1.5	1017.9	83	0/10
3b	Area-26	Mapping	01/Oct/2009	09h06	UTC-6	70°45.000	136°38.200	CTD ↑	1200	15	296	8	-5.8	1.7	1018.2	82	0/10
3b	A1-09	Mooring	01/Oct/2009	10h26	UTC-6	70°45.600	136°00.500	CTD ↓	669	62	316	9	-6.0	0.9	1018.5	83	0/10
3b	A1-09	Mooring	01/Oct/2009	10h47	UTC-6	70°45.500	136°00.700	CTD ↑	672	17	286	10	-5.8	0.9	1018.5	83	0/10
3b	A1-09	Mooring	01/Oct/2009	11h51	UTC-6	70°45.400	136°00.900	Mooring A1-09 Recovered	656	60	304	13	-6.0	0.8	1019.1	88	0/10
3b	A	Mooring	01/Oct/2009	14h50	UTC-6	70°39.800	136°14.200	Mixed Layer Buoy A Recovered	546	0	330	10	-6.2	0.7	1020.7	84	1/10
3b	Area-26	Mapping	01/Oct/2009	19h20	UTC-6	70°47.760	136°14.490	Bottom Mapping ↓	737	56	290	15	-4.1	0.2	1022.7	76	0/10
3b	Area-26	Mapping	01/Oct/2009	20h45	UTC-6	70°55.600	135°32.200	Bottom Mapping ↑	625	57	302	18	-5.0	0.1	1023.6	83	0/10
3b	Area-26	Mapping	01/Oct/2009	20h50	UTC-6	70°55.500	135°32.900	Bottom Mapping ↓	625	237	302	18	-5.0	0.1	1023.6	83	0/10
3b	Area-26	Mapping	01/Oct/2009	21h24	UTC-6	70°44.300	135°40.800	Bottom Mapping ↑	701	237	303	19	-5.1	0.0	1024.0	86	1/10
3b	Area-26	Mapping	01/Oct/2009	21h29	UTC-6	70°50.800	135°51.800	Bottom Mapping ↓	681	57	303	19	-5.1	0.0	1024.0	86	1/10
3b	Area-26	Mapping	01/Oct/2009	22h11	UTC-6	70°55.500	135°29.500	Bottom Mapping ↑	611	57	301	19	-5.2	0.0	1024.4	87	1/10
3b	Area-26	Mapping	01/Oct/2009	22h17	UTC-6	70°55.000	135°28.900	Bottom Mapping ↓	611	237	301	19	-5.2	0.0	1024.4	87	1/10
3b	Area-26	Mapping	01/Oct/2009	23h00	UTC-6	70°50.400	135°50.700	Bottom Mapping ↑	674	237	300	19	-5.4	0.0	1024.9	88	1/10
3b	Area-26	Mapping	01/Oct/2009	23h04	UTC-6	70°49.800	135°50.300	Bottom Mapping ↓	673	57	300	19	-5.4	0.0	1024.9	88	1/10
3b	Area-26	Mapping	01/Oct/2009	23h50	UTC-6	70°54.400	135°27.800	Bottom Mapping ↑	574	57	305	13	-5.5	0.0	1025.3	85	1/10
3b	Area-26	Mapping	01/Oct/2009	23h53	UTC-6	70°54.000	135°27.900	Bottom Mapping ↓	564	237	305	13	-5.6	-0.1	1025.9	83	1/10
3b	Area-26	Mapping	02/Oct/2009	00h31	UTC-6	70°49.400	135°49.400	Bottom Mapping ↑	637	237	290	9	-5.6	-0.1	1025.9	86	1/10
3b	Area-26	Mapping	02/Oct/2009	00h37	UTC-6	70°49.000	135°48.000	Bottom Mapping ↓	639	56	310	15	-5.6	-0.1	1026.1	86	1/10
3b	Area-26	Mapping	02/Oct/2009	01h32	UTC-6	70°55.100	135°19.300	Bottom Mapping ↑	539	56	315	19	-5.4	-0.1	1026.9	79	1/10
3b	Area-26	Mapping	02/Oct/2009	01h38	UTC-6	70°54.600	135°18.900	Bottom Mapping ↓	514	237	300	15	-5.4	-0.1	1026.9	80	1/10
3b	Area-26	Mapping	02/Oct/2009	02h28	UTC-6	70°48.500	135°48.000	Bottom Mapping ↑	661	238	310	17	-4.8	-0.1	1027.3	76	1/10
3b	Area-26	Mapping	02/Oct/2009	02h34	UTC-6	70°48.100	135°46.600	Bottom Mapping ↓	614	55	300	17	-4.7	-0.1	1027.3	75	1/10

Appendix 2 - Scientific log of activities conducted during the 2009 ArcticNet Expedition

Leg	Station ID	Station Type	Local Date	Local Time	UTC to local	Latitude (N)	Longitude (W)	Activity	Depth (m)	Heading (°)	Wind		Air (ºC)	Water (ºC)	Pr Baro	Hum (%)	Ice
											Dir	Speed					
3b	Area-26	Mapping	02/Oct/2009	03h28	UTC-6	70°54.300	135°17.000	Bottom Mapping ↑	495	55	300	16	-4.8	-0.1	1028.1	80	1/10
3b	Area-26	Mapping	02/Oct/2009	03h34	UTC-6	70°53.800	135°16.700	Bottom Mapping ↓	457	236	300	11	-4.8	-0.1	1028.0	79	1/10
3b	Area-26	Mapping	02/Oct/2009	04h25	UTC-6	70°47.760	135°45.490	Bottom Mapping ↑	579	236	318	15	-4.4	-0.1	1028.5	76	1/10
3b	Area-26	Mapping	02/Oct/2009	04h28	UTC-6	70°48.000	135°44.310	Bottom Mapping ↓	583	56	318	15	-4.4	-0.1	1028.5	76	1/10
3b	Area-26	Mapping	02/Oct/2009	04h53	UTC-6	70°49.020	135°35.460	Bottom Mapping ↑	501	56	300	12	-4.5	-0.1	1029.0	76	1/10
3b	Area-26	ROV	02/Oct/2009	06h30	UTC-6	70°47.440	136°05.530	ROV ↓	785	Var	300	13	-4.3	0.0	1030.2	72	0/10
3b	Area-26	ROV	02/Oct/2009	09h47	UTC-6	70°46.800	136°05.800	ROV ↑	785	45	303	9	-4.3	0.1	1032.3	79	0/10
3b	A1-09	Mooring	02/Oct/2009	13h28	UTC-6	70°45.600	136°00.500	Mooring A1-09 Deployed	666	60	320	8	-4.0	0.0	1033.9	80	1/10
3b	Area-26	Mapping	02/Oct/2009	14h50	UTC-6	70°44.500	136°22.500	Weather Balloon	789	0	230	5	-4.1	0.0	1034.6	71	1/10
3b	Area-26	ROV	02/Oct/2009	15h31	UTC-6	70°44.500	136°22.600	ROV ↓	800	81	Calm	Calm	-3.5	0.0	1034.9	68	1/10
3b	Area-26	ROV	02/Oct/2009	17h15	UTC-6	70°44.500	136°22.700	ROV ↑	800	80	Calm	Calm	-3.7	0.1	1035.2	70	1/10
3b	Area-26	Mapping	02/Oct/2009	22h01	UTC-6	70°43.800	135°30.700	Bottom Mapping ↓	303	238	139	7	-3.2	0.6	1035.4	73	1/10
3b	Area-26	Mapping	02/Oct/2009	23h05	UTC-6	70°36.600	136°05.100	Bottom Mapping ↑	282	238	104	8	-2.6	0.5	1035.0	70	1/10
3b	Area-26	Mapping	02/Oct/2009	23h10	UTC-6	70°36.900	136°06.200	Bottom Mapping ↓	325	58	104	8	-2.6	0.5	1034.9	68	1/10
3b	Area-26	Mapping	03/Oct/2009	00h39	UTC-6	70°46.400	135°21.300	Bottom Mapping ↑	272	57	90	13	-2.7	0.2	1034.9	69	1/10
3b	Area-26	Mapping	03/Oct/2009	00h46	UTC-6	70°46.700	135°22.800	Bottom Mapping ↓	288	236	100	11	-2.9	0.2	1034.9	82	1/10
3b	Area-26	Mapping	03/Oct/2009	02h09	UTC-6	70°37.300	136°07.700	Bottom Mapping ↑	365	237	70	15	-2.4	0.1	1034.3	74	1/10
3b	Area-26	Mapping	03/Oct/2009	02h16	UTC-6	70°37.800	136°08.200	Bottom Mapping ↓	433	57	65	15	-2.5	0.1	1034.1	80	1/10
3b	Area-26	Mapping	03/Oct/2009	03h44	UTC-6	70°47.300	135°23.100	Bottom Mapping ↑	324	57	90	19	-2.1	0.2	1033.1	81	1/10
3b	Area-26	Mapping	03/Oct/2009	03h51	UTC-6	70°47.600	135°24.700	Bottom Mapping ↓	352	237	100	20	-2.1	0.2	1033.4	79	1/10
3b	Area-26	Mapping	03/Oct/2009	05h10	UTC-6	70°38.200	136°09.600	Bottom Mapping ↑	468	237	115	20	-1.6	0.1	1032.9	75	1/10
3b	Area-26	Mapping	03/Oct/2009	05h25	UTC-6	70°35.910	136°05.390	Bottom Mapping ↓	249	57	100	15	-1.1	0.2	1031.4	72	1/10
3b	Area-26	Mapping	03/Oct/2009	06h33	UTC-6	70°43.440	135°29.410	Bottom Mapping ↑	280	57	127	15	-1.0	0.3	1032.0	73	1/10
3b	Area-26	Mapping	03/Oct/2009	06h40	UTC-6	70°42.630	135°30.410	Bottom Mapping ↓	220	237	125	15	-1.1	0.3	1032.0	73	1/10
3b	C-09	Mooring	03/Oct/2009	08h10	UTC-6	70°35.100	136°05.500	CTD ↓	213	136	110	21	-1.0	0.7	1031.4	63	1/10
3b	C-09	Mooring	03/Oct/2009	08h20	UTC-6	70°35.100	136°05.500	CTD ↑	313	136	104	20	-1.2	0.9	1031.2	64	1/10
3b	C-09	Mooring	03/Oct/2009	10h15	UTC-6	70°29.400	135°07.900	ROV ↓	57	125	112	20	-2.3	1.4	1030.6	65	1/10
3b	C-09	Mooring	03/Oct/2009	12h25	UTC-6	70°29.700	135°08.100	ROV ↑	57	110	110	22	-2.9	1.4	1029.6	70	0/10
3b	C-09	Mooring	03/Oct/2009	13h31	UTC-6	70°29.800	135°08.100	Mooring C-09 Recovered	60	128	118	21	-3.1	1.5	1029.4	74	0/10
3b	Area-26	Piston Core	03/Oct/2009	15h45	UTC-6	70°45.900	136°04.200	Piston Core ↓	697	118	101	26	-3.2	0.6	1028.5	78	1/10
3b	Area-26	Piston Core	03/Oct/2009	16h20	UTC-6	70°45.950	136°03.420	Piston Core ↑	692	120	102	28	-3.2	0.6	1028.1	76	1/10
3b	Area-26	Piston Core	03/Oct/2009	18h15	UTC-6	70°48.730	136°06.050	Piston Core ↓	782	115	98	28	-2.4	0.4	1026.6	77	1/10
3b	Area-26	Piston Core	03/Oct/2009	18h48	UTC-6	70°48.860	136°06.080	Piston Core ↑	792	91	106	24	-2.3	0.4	1026.3	77	1/10
3b	Area-26	Mapping	03/Oct/2009	21h02	UTC-6	70°52.900	135°14.600	Bottom Mapping ↓	403	237	95	25	-1.1	0.5	1024.8	76	1/10
3b	Area-26	Mapping	03/Oct/2009	21h44	UTC-6	70°47.800	135°39.200	Bottom Mapping ↑	513	237	120	26	-0.9	0.6	1023.7	82	1/10
3b	Area-26	Mapping	03/Oct/2009	21h49	UTC-6	70°47.400	135°37.800	Bottom Mapping ↓	483	57	120	26	-0.9	0.6	1023.7	82	1/10
3b	Area-26	Mapping	03/Oct/2009	22h33	UTC-6	70°52.300	135°14.200	Bottom Mapping ↑	381	57	109	23	-0.9	0.5	1024.0	80	1/10
3b	Area-26	Mapping	03/Oct/2009	22h38	UTC-6	70°52.000	135°12.900	Bottom Mapping ↓	341	237	109	23	-0.9	0.5	1024.5	78	1/10
3b	Area-26	Mapping	03/Oct/2009	23h19	UTC-6	70°47.100	135°36.200	Bottom Mapping ↑	465	237	116	25	-1.0	0.5	1024.3	80	1/10
3b	Area-26	Mapping	03/Oct/2009	23h24	UTC-6	70°46.500	135°35.800	Bottom Mapping ↓	477	57	116	25	-1.1	0.5	1024.0	81	1/10
3b	Area-26	Mapping	04/Oct/2009	00h39	UTC-6	70°51.500	135°11.800	Bottom Mapping ↑	315	57	100	27	-0.2	0.4	1022.9	78	1/10
3b	Area-26	Mapping	04/Oct/2009	00h46	UTC-6	70°51.000	135°11.500	Bottom Mapping ↓	291	237	100	25	-0.4	0.4	1022.9	77	1/10
3b	Area-26	Mapping	04/Oct/2009	01h17	UTC-6	70°47.300	135°29.500	Bottom Mapping ↑	398	237	98	23	-0.8	0.5	1023.1	80	1/10
3b	Area-26	Mapping	04/Oct/2009	01h21	UTC-6	70°47.300	135°30.900	Bottom Mapping ↓	418	283	109	19	-0.8	0.5	1023.1	80	1/10
3b	Area-26	Mapping	04/Oct/2009	01h36	UTC-6	70°48.600	135°39.600	Bottom Mapping ↑	536	283	101	21	-0.6	0.5	1023.2	79	1/10

Appendix 2 - Scientific log of activities conducted during the 2009 ArcticNet Expedition

Leg	Station ID	Station Type	Local Date	Local Time	UTC to local	Latitude (N)	Longitude (W)	Activity	Depth (m)	Heading (°)	Wind		Air (ºC)	Water (ºC)	Pr Baro	Hum (%)	Ice
											Dir	Speed					
3b	Area-26	Mapping	04/Oct/2009	01h36	UTC-6	70°48.600	135°39.600	Bottom Mapping ↓	536	10	101	21	-0.6	0.5	1023.2	79	1/10
3b	Area-26	Mapping	04/Oct/2009	02h23	UTC-6	70°55.900	135°35.600	Bottom Mapping ↑	644	10	107	25	-0.3	0.8	1022.5	81	1/10
3b	Area-26	Mapping	04/Oct/2009	02h30	UTC-6	70°56.300	135°35.500	Bottom Mapping ↓	652	237	94	27	-0.6	0.6	1022.5	80	1/10
3b	Area-26	Mapping	04/Oct/2009	03h03	UTC-6	70°52.400	135°53.900	Bottom Mapping ↑	733	237	104	25	-1.1	0.4	1022.6	81	1/10
3b	Area-26	Mapping	04/Oct/2009	03h12	UTC-6	70°52.600	135°52.500	Bottom Mapping ↓	748	57	113	26	-1.1	0.4	1022.6	81	1/10
3b	Area-26	Mapping	04/Oct/2009	03h47	UTC-6	70°56.900	135°35.400	Bottom Mapping ↑	666	57	106	25	-0.6	0.3	1021.8	81	1/10
3b	Area-26	Mapping	04/Oct/2009	03h50	UTC-6	70°57.400	135°36.500	Bottom Mapping ↓	660	237	105	25	-0.6	0.3	1021.8	81	1/10
3b	Area-26	Mapping	04/Oct/2009	04h25	UTC-6	70°53.150	135°56.090	Bottom Mapping ↑	759	237	105	25	-0.6	0.3	1021.8	81	1/10
3b	Area-26	Mapping	04/Oct/2009	04h33	UTC-6	70°53.510	135°57.270	Bottom Mapping ↓	776	57	95	25	-1.0	0.2	1022.4	81	1/10
3b	Area-26	Mapping	04/Oct/2009	04h56	UTC-6	70°56.310	135°45.290	Bottom Mapping ↑	707	57	98	15/25	-0.9	0.2	1021.6	84	1/10
3b	Area-26	Mapping	04/Oct/2009	05h02	UTC-6	70°56.080	135°48.470	Bottom Mapping ↓	729	37	100	20/25	-0.9	0.2	1021.6	84	1/10
3b	Area-26	Mapping	04/Oct/2009	06h20	UTC-6	70°56.040	135°46.140	Bottom Mapping ↑	718	37	100	20	-1.2	0.2	1022.2	90	1/10
3b	Area-26	Mapping	04/Oct/2009	06h25	UTC-6	70°56.200	135°44.710	Bottom Mapping ↓	732	57	100	20	-1.2	0.2	1022.2	90	1/10
3b	Area-26	Mapping	04/Oct/2009	06h50	UTC-6	70°59.240	135°32.890	Bottom Mapping ↑	677	57	95	20	-0.8	0.1	1021.4	91	1/10
3b	Area-26	Mapping	04/Oct/2009	06h57	UTC-6	71°00.020	135°35.680	Bottom Mapping ↓	733	237	95	20	-0.8	0.1	1021.4	92	1/10
3b	Area-26	Mapping	04/Oct/2009	07h40	UTC-6	70°54.400	136°02.150	Bottom Mapping ↑	816	237	100	20	-1.0	0.1	1021.6	89	1/10
3b	Area-26	Piston Core	04/Oct/2009	08h30	UTC-6	70°52.300	136°12.200	Piston Core ↓	890	100	86	18	-0.5	0.2	1020.8	86	1/10
3b	Area-26	Piston Core	04/Oct/2009	09h10	UTC-6	70°52.300	136°12.200	Piston Core ↑	890	100	86	18	-0.5	0.2	1020.8	86	1/10
3b	Area-26	Piston Core	04/Oct/2009	10h55	UTC-6	70°48.100	136°03.900	Piston Core ↓	779	90	84	17	-0.2	0.2	1020.1	97	0/10
3b	Area-26	Piston Core	04/Oct/2009	11h26	UTC-6	70°48.100	136°04.100	Piston Core ↑	779	90	84	17	-0.2	0.2	1020.1	97	0/10
3b	Area-26	Piston Core	04/Oct/2009	13h15	UTC-6	70°44.000	136°01.500	Piston Core ↓	575	75	90	15	0.2	0.7	1019.4	97	0/10
3b	Area-26	Piston Core	04/Oct/2009	13h30	UTC-6	70°44.000	136°01.500	Piston Core ↑	572	75	90	15	0.2	0.7	1019.4	97	0/10
3b	Area-26	Piston Core	04/Oct/2009	14h30	UTC-6	70°47.900	136°18.700	Piston Core ↓	692	98	80	15	0.1	0.5	1019.2	96	1/10
3b	Area-26	Piston Core	04/Oct/2009	15h00	UTC-6	70°47.900	136°18.600	Piston Core ↑	692	94	80	16	0.0	0.5	1019.3	97	1/10
3b	Area-27	Mapping	04/Oct/2009	15h33	UTC-6	70°47.900	136°18.700	CTD ↓	687	100	90	13	0.1	0.4	1019.3	98	1/10
3b	Area-27	Mapping	04/Oct/2009	16h00	UTC-6	70°47.900	136°18.700	CTD ↑	687	100	80	13	0.1	0.4	1019.2	97	1/10
3b	Area-27	Mapping	04/Oct/2009	16h40	UTC-6	70°50.970	136°27.570	Bottom Mapping ↓	938	60	77	12	0.0	0.3	1019.0	98	1/10
3b	Area-27	Mapping	04/Oct/2009	17h26	UTC-6	70°56.300	136°02.300	Bottom Mapping ↑	870	56	80	14	-0.1	0.3	1018.6	99	1/10
3b	Area-27	Mapping	04/Oct/2009	17h37	UTC-6	70°58.170	136°05.370	Bottom Mapping ↓	919	243	85	15	-0.2	0.3	1018.6	99	1/10
3b	Area-27	Mapping	04/Oct/2009	19h06	UTC-6	70°46.890	136°58.970	Bottom Mapping ↑	1400	235	85	13	-0.3	0.2	1018.9	99	1/10
3b	Area-27	Mapping	04/Oct/2009	19h10	UTC-6	70°48.220	136°55.540	Bottom Mapping ↓	1344	55	75	11	-0.3	0.2	1018.8	99	1/10
3b	Area-27	Mapping	04/Oct/2009	20h43	UTC-6	70°58.400	136°07.300	Bottom Mapping ↑	931	57	59	13	-0.8	0.2	1018.6	99	1/10
3b	Area-27	Mapping	04/Oct/2009	20h47	UTC-6	70°58.900	136°07.900	Bottom Mapping ↓	977	237	59	13	-0.8	0.2	1018.6	99	1/10
3b	Area-27	Mapping	04/Oct/2009	21h32	UTC-6	70°53.500	136°33.800	Bottom Mapping ↑	1005	237	68	15	-0.9	0.2	1018.6	99	1/10
3b	Area-27	Mapping	04/Oct/2009	21h36	UTC-6	70°54.000	136°34.300	Bottom Mapping ↓	1033	57	68	15	-0.9	0.3	1018.5	99	1/10
3b	Area-27	Mapping	04/Oct/2009	22h21	UTC-6	70°59.300	136°09.200	Bottom Mapping ↑	1032	57	68	15	-1.0	0.3	1018.5	99	1/10
3b	Area-27	Mapping	04/Oct/2009	22h26	UTC-6	70°59.700	136°10.200	Bottom Mapping ↓	1062	237	68	15	-1.0	0.3	1018.5	99	1/10
3b	Area-27	Mapping	04/Oct/2009	22h32	UTC-6	70°54.400	136°35.400	Bottom Mapping ↑	1039	237	66	16	-0.9	0.3	1018.4	99	1/10
3b	Area-27	Mapping	04/Oct/2009	23h36	UTC-6	70°54.700	136°37.000	Bottom Mapping ↓	1054	57	61	12	-0.7	0.2	1017.9	99	1/10
3b	Area-27	Mapping	05/Oct/2009	00h21	UTC-6	71°00.300	136°10.500	Bottom Mapping ↑	1064	57	60	14	-0.8	0.3	1017.6	99	1/10
3b	Area-27	Mapping	05/Oct/2009	00h28	UTC-6	71°00.600	136°12.100	Bottom Mapping ↓	1089	237	65	13	-1.0	0.3	1017.5	99	1/10
3b	Area-27	Mapping	05/Oct/2009	01h27	UTC-6	70°55.100	136°38.100	Bottom Mapping ↑	1051	237	57	15	-1.1	0.3	1018.3	99	1/10
3b	Area-27	Mapping	05/Oct/2009	01h32	UTC-6	70°55.500	136°39.300	Bottom Mapping ↓	1098	57	57	15	-1.1	0.3	1018.3	99	1/10
3b	Area-27	Mapping	05/Oct/2009	02h18	UTC-6	71°01.200	136°11.900	Bottom Mapping ↑	1090	57	50	19	-1.3	0.3	1017.5	97	2/10
3b	Area-27	Mapping	05/Oct/2009	02h18	UTC-6	71°01.200	136°11.900	Bottom Mapping ↓	1094	109	50	19	-1.3	0.3	1017.5	97	2/10

Appendix 2 - Scientific log of activities conducted during the 2009 ArcticNet Expedition

Leg	Station ID	Station Type	Local Date	Local Time	UTC to local	Latitude (N)	Longitude (W)	Activity	Depth (m)	Heading (°)	Wind		Air (ºC)	Water (ºC)	Pr Baro	Hum (%)	Ice
											Dir	Speed					
3b	Area-27	Mapping	05/Oct/2009	03h13	UTC-6	70°57.300	135°37.600	Bottom Mapping ↑	722	109	50	20	-1.6	0.2	1017.8	97	3/10
3b	Area-27	Mapping	05/Oct/2009	03h15	UTC-6	70°57.300	135°36.400	Bottom Mapping ↓	676	57	50	20	-1.6	0.2	1017.8	97	3/10
3b	Area-27	Mapping	05/Oct/2009	03h24	UTC-6	70°58.900	135°30.700	Bottom Mapping ↑	700	57	50	20	-1.6	0.2	1017.6	96	3/10
3b	Area-27	Mapping	05/Oct/2009	03h33	UTC-6	70°59.100	135°34.100	Bottom Mapping ↓	700	237	57	15	-1.6	0.1	1017.6	96	3/10
3b	Area-27	Mapping	05/Oct/2009	03h43	UTC-6	70°58.900	135°38.500	Bottom Mapping ↑	700	237	50	18	-1.7	0	1018.4	96	2/10
3b	Area-27	Mapping	05/Oct/2009	03h46	UTC-6	70°59.300	135°39.500	Bottom Mapping ↓	714	57	56	16	-1.7	0	1018.4	96	2/10
3b	Area-27	Mapping	05/Oct/2009	03h58	UTC-6	70°59.900	135°34.900	Bottom Mapping ↑	725	57	60	19	-1.6	0	1018.1	96	2/10
3b	Area-27	Mapping	05/Oct/2009	04h05	UTC-6	71°01.060	135°34.460	Bottom Mapping ↓	772	237	60	15/20	-1.6	0	1018.6	96	2/10
3b	Area-27	Mapping	05/Oct/2009	04h42	UTC-6	70°55.240	135°01.500	Bottom Mapping ↑	842	237	55	15	-1.5	0	1018.6	96	2/10
3b	Area-27	Mapping	05/Oct/2009	04h46	UTC-6	70°55.850	136°01.470	Bottom Mapping ↓	861	57	55	15	-1.5	0	1018.6	96	2/10
3b	Area-27	Mapping	05/Oct/2009	05h20	UTC-6	70°59.340	135°48.160	Bottom Mapping ↑	781	57	57	14	-2.0	0.1	1018.1	96	4/10
3b	Area-27	Mapping	05/Oct/2009	05h50	UTC-6	70°56.520	135°04.280	Bottom Mapping ↓	890	57	50	17	-2.0	0.1	1018.7	96	1/10
3b	Area-27	Mapping	05/Oct/2009	06h10	UTC-6	70°59.700	135°52.600	Bottom Mapping ↑	822	57	70	15	-2.0	0.1	1018.5	94	1/10
3b	Area-27	Mapping	05/Oct/2009	06h15	UTC-6	71°00.040	135°50.950	Weather Balloon	811	57	65	15	-2.0	0.1	1018.2	95	4/10
3b	Area-27	Mapping	05/Oct/2009	06h20	UTC-6	70°59.580	135°51.370	Bottom Mapping ↓	828	237	70	15	-2.0	0.1	1018.2	95	4/10
3b	Area-27	Mapping	05/Oct/2009	07h18	UTC-6	70°52.580	135°26.090	Bottom Mapping ↑	940	237	55	15	-2.1	0.1	1018.8	96	1/10
3b	Area-27	Mapping	05/Oct/2009	07h24	UTC-6	70°53.290	135°25.660	Bottom Mapping ↓	945	57	55	15	-2.1	0.1	1018.8	96	1/10
3b	Area-27	Mapping	05/Oct/2009	07h50	UTC-6	70°55.600	136°13.500	Bottom Mapping ↑	945	57	55	15	-2.3	0.0	1018.7	95	1/10
3b	Area-27	Piston Core	05/Oct/2009	08h28	UTC-6	70°55.600	136°13.500	Piston Core ↓	952	65	34	15	-2.7	0.1	1018.7	94	1/10
3b	Area-27	Piston Core	05/Oct/2009	08h54	UTC-6	70°55.700	136°13.600	Piston Core ↑	952	50	47	14	-2.5	0.1	1018.8	93	1/10
3b	Area-27	Piston Core	05/Oct/2009	10h05	UTC-6	70°46.100	136°18.800	Piston Core ↓	648	60	35	13	-2.6	0.1	1018.8	91	1/10
3b	Area-27	Piston Core	05/Oct/2009	10h30	UTC-6	70°46.100	136°19.000	Piston Core ↑	648	60	35	13	-2.6	0.1	1018.8	91	1/10
3b	Area-27	Piston Core	05/Oct/2009	11h19	UTC-6	70°41.400	136°27.100	Piston Core ↓	794	55	23	14	-2.7	0.4	1018.9	91	0/10
3b	Area-27	Piston Core	05/Oct/2009	11h40	UTC-6	70°41.300	136°27.000	Piston Core ↑	794	70	26	15	-2.7	0.4	1018.9	91	0/10
3b	Area-27	Piston Core	05/Oct/2009	13h15	UTC-6	70°43.900	136°39.800	Piston Core ↓	1262	45	35	16	-3.0	0.5	1019.0	81	1/10
3b	Area-27	Piston Core	05/Oct/2009	14h00	UTC-6	70°43.900	136°39.500	Piston Core ↑	1262	55	10	18	-3.5	0.6	1019.2	86	1/10
3b	Area-27	Piston Core	05/Oct/2009	15h07	UTC-6	70°47.800	136°38.900	Piston Core ↓	1073	54	14	17	-4.0	0.5	1019.6	84	1/10
3b	Area-27	Piston Core	05/Oct/2009	15h37	UTC-6	70°47.800	136°38.600	Piston Core ↑	1073	45	15	13	-4.2	0.4	1019.8	84	1/10
3b	Area-27	Piston Core	05/Oct/2009	18h32	UTC-6	70°42.920	136°32.460	Piston Core ↓	1118	38	23	15	-5.6	0.2	1020.0	90	1/10
3b	Area-27	Piston Core	05/Oct/2009	19h15	UTC-6	70°42.940	136°32.470	Piston Core ↑	1118	36	24	16	-6.3	0.2	1020.6	95	1/10
3b	Area-27	MVP	05/Oct/2009	21h25	UTC-6	70°34.000	135°59.200	MVP ↓	82	238	30	15	-5.7	0.8	1022.4	95	1/10
3b	Area-27	MVP	05/Oct/2009	22h24	UTC-6	70°30.000	136°18.400	MVP ↑	71	238	30	15	-5.7	0.8	1022.4	95	1/10
3b	Area-27	Mapping	05/Oct/2009	23h09	UTC-6	70°25.300	136°41.800	Bottom Mapping ↓	78	58	10	12	-5.8	1.0	1022.4	95	1/10
3b	Area-27	Mapping	06/Oct/2009	00h20	UTC-6	70°34.000	136°01.300	Bottom Mapping ↑	94	56	0	19	-6.5	1.0	1022.1	95	0/10
3b	Area-27	Mapping	06/Oct/2009	00h25	UTC-6	70°33.500	136°00.800	Bottom Mapping ↓	83	237	7	15	-6.7	1.0	1022.3	94	0/10
3b	Area-27	Mapping	06/Oct/2009	01h35	UTC-6	70°24.800	136°41.500	Bottom Mapping ↑	65	237	25	17	-6.4	1.1	1024.0	95	0/10
3b	Area-27	Mapping	06/Oct/2009	01h42	UTC-6	70°25.600	136°42.400	Bottom Mapping ↓	92	57	0	14	-6.2	1.2	1024.1	95	0/10
3b	Area-27	Mapping	06/Oct/2009	02h55	UTC-6	70°34.400	136°01.200	Bottom Mapping ↑	108	57	17	15	-6.9	1.1	1024.4	94	0/10
3b	Area-27	Mapping	06/Oct/2009	02h59	UTC-6	70°34.500	136°02.000	Bottom Mapping ↓	110	237	9	18	-6.9	1.1	1024.4	94	0/10
3b	Area-27	Mapping	06/Oct/2009	03h18	UTC-6	70°32.100	136°13.000	Bottom Mapping ↑	122	237	26	16	-6.6	1.1	1025.2	94	0/10
3b	Area-27	Mapping	06/Oct/2009	03h21	UTC-6	70°32.300	136°14.400	Bottom Mapping ↓	154	57	0	16	-6.6	1.1	1025.2	94	0/10
3b	Area-27	Mapping	06/Oct/2009	03h42	UTC-6	70°34.700	136°02.600	Bottom Mapping ↑	123	57	0	15	-6.9	1.0	1025.0	94	0/10
Leg 4a																	
4a	408	Full	09/Oct/2009	09h10	UTC-6	71°20.800	127°47.700	Mooring CA05-08 Interrogation	207	0	105	9	-2.6	1.8	1043.9	74	0/10
4a	408	Full	09/Oct/2009	09h35	UTC-6	71°18.700	127°34.800	CTD ↓	213	35	110	7	-2.7	1.8	1043.8	76	0/10

Appendix 2 - Scientific log of activities conducted during the 2009 ArcticNet Expedition

Leg	Station ID	Station Type	Local Date	Local Time	UTC to local	Latitude (N)	Longitude (W)	Activity	Depth (m)	Heading (°)	Wind		Air (ºC)	Water (ºC)	Pr Baro	Hum (%)	Ice
											Dir	Speed					
4a	408	Full	09/Oct/2009	09h55	UTC-6	71°18.800	127°35.100	CTD ↑	212	26	131	13	-3.2	1.8	1043.8	77	0/10
4a	CA05-08	Mooring	09/Oct/2009	10h20	UTC-6	71°18.800	127°35.200	Mooring CA05-08 Recovered	212	248	132	8	-3.8	1.8	1043.9	79	0/10
4a	CA05-08	Mooring	09/Oct/2009	10h45	UTC-6	71°18.900	127°35.500	Mooring CA05-08 Recovered (end)	213	236	147	7	-4.1	1.8	1043.8	79	0/10
4a	408	Full	09/Oct/2009	11h29	UTC-6	71°24.600	127°38.400	CTD ↓	243	12	100	6	-3.6	1.8	1043.8	78	0/10
4a	408	Full	09/Oct/2009	11h40	UTC-6	71°24.700	127°38.800	CTD ↑	244	22	100	8	-2.8	1.9	1043.7	77	0/10
4a	CA05-MMP-08	Mooring	09/Oct/2009	12h50	UTC-6	71°24.460	127°38.549	Mooring CA05-MMP-08 Recovered	242	250	147	7	-3.8	2.0	1043.5	77	0/10
4a	N/A	N/A	10/Oct/2009	12h15	UTC-6	71°35.975	134°24.057	Ice Coring ↓	1400	4	132	30	-2.0	0.0	1024.5	87	0/10
4a	N/A	N/A	10/Oct/2009	17h35	UTC-6	71°37.600	134°18.378	Ice Coring ↑	1359	90	120	30	-2.0	-0.1	1022.4	87	0/10
4a	N/A	N/A	10/Oct/2009	19h05	UTC-6	71°38.794	134°19.857	Radiometry	1358	2	120	30	-1.6	-0.1	1022.7	88	0/10
4a	CA16-08	Mooring	11/Oct/2009	22h00	UTC-6	71°48.080	126°30.860	Mooring CA16-08 Recovered (canceled?)	306	355	148	22	-0.1	0.5	1027.3	80	0/10
4a	437	Full	11/Oct/2009	23h01	UTC-6	71°47.060	126°29.160	CTD-Rosette ↓	315	348	155	24	0.5	0.5	1026.9	79	0/10
4a	437	Full	11/Oct/2009	23h36	UTC-6	71°47.050	126°29.480	CTD-Rosette ↑	317	340	140	24	2.5	0.5	1026.9	73	0/10
4a	437	Full	11/Oct/2009	23h55	UTC-6	71°47.040	126°29.360	Vertical Net Tow ↓	317	325	150	20	2.5	0.5	1026.9	80	0/10
4a	437	Full	12/Oct/2009	00h18	UTC-6	71°47.174	126°29.100	Vertical Net Tow ↑	313	334	150	26	-1.1	0.5	1026.9	83	0/10
4a	437	Full	12/Oct/2009	00h43	UTC-6	71°47.514	126°29.834	Horizontal Net Tow ↓	309	243	157	24	-1.8	0.5	1026.8	75	0/10
4a	437	Full	12/Oct/2009	00h58	UTC-6	71°47.391	126°30.987	Horizontal Net Tow ↑	321	135	154	23	-0.8	0.5	1026.4	82	0/10
4a	437	Full	12/Oct/2009	02h02	UTC-6	71°47.748	126°29.571	CTD-Rosette ↓	297	347	152	20	0.0	0.5	1026.3	79	0/10
4a	437	Full	12/Oct/2009	02h25	UTC-6	71°47.798	126°29.680	CTD-Rosette ↑	296	326	150	21	0.4	0.5	1026.3	77	0/10
4a	437	Full	12/Oct/2009	09h35	UTC-6	71°46.950	126°29.110	CTD ↓	323	335	150	24	-0.1	0.6	1024.2	82	0/10
4a	CA16-08	Mooring	12/Oct/2009	10h50	UTC-6	71°47.500	126°29.330	Mooring CA16-08 Recovered	307	346	160	22	0.3	0.6	1023.7	80	0/10
4a	437	Full	12/Oct/2009	10h53	UTC-6	71°46.960	126°29.260	CTD ↑	329	340	163	21	0.8	0.6	1024.0	80	0/10
4a	CA16-08	Mooring	12/Oct/2009	11h30	UTC-6	71°47.650	126°29.120	Mooring CA16-08 Recovered (end)	302	8	148	23	-0.6	0.6	1023.8	84	0/10
4a	437	Full	12/Oct/2009	13h43	UTC-6	71°47.655	126°30.578	IOPs ↓	308	339	170	20	-0.9	0.6	1023.2	86	0/10
4a	437	Full	12/Oct/2009	13h58	UTC-6	71°47.770	126°30.515	IOPs ↑	303	325	160	21	-0.5	0.6	1023.8	84	0/10
4a	437	Full	12/Oct/2009	14h33	UTC-6	71°47.221	126°32.570	Zodiac Deployed	340	255	170	27	-1.0	0.6	1022.6	86	0/10
4a	437	Full	12/Oct/2009	15h00	UTC-6	71°47.394	126°30.056	Zodiac Recovered	313	239	166	20	-0.7	0.6	1022.1	85	0/10
4a	437	Full	12/Oct/2009	15h06	UTC-6	71°47.630	126°30.757	PNF ↓	310	0	158	21	-0.9	0.6	1022.4	86	0/10
4a	437	Full	12/Oct/2009	15h04	UTC-6	71°47.737	126°30.651	PNF ↑	307	306	167	21	0.0	0.6	1022.5	84	0/10
4a	437	Full	12/Oct/2009	15h50	UTC-6	71°47.068	126°29.812	CTD-Rosette ↓↑	319	340	164	19	3.4	0.6	1022.0	73	0/10
4a	437	Full	12/Oct/2009	17h05	UTC-6	71°47.215	126°29.230	Box Core ↓	310	336	168	21	1.1	0.6	1021.1	80	0/10
4a	437	Full	12/Oct/2009	17h10	UTC-6	71°47.223	126°29.107	Box Core ↑	311	344	164	21	0.3	0.6	1021.1	83	0/10
4a	437	Full	12/Oct/2009	19h30	UTC-6	71°47.184	126°30.510	Box Core ↓	323	333	165	23	0.9	0.6	1019.1	80	0/10
4a	437	Full	12/Oct/2009	19h35	UTC-6	71°47.155	126°30.541	Box Core ↑	323	339	163	20	1.1	0.6	1019.1	80	0/10
4a	437	Full	12/Oct/2009	19h57	UTC-6	71°47.806	126°30.272	Box Core ↓	322	334	164	24	-0.3	0.7	1018.9	86	0/10
4a	437	Full	12/Oct/2009	20h03	UTC-6	71°47.113	126°30.240	Box Core ↑	322	343	170	22	0.3	0.7	1018.8	84	0/10
4a	437	Full	12/Oct/2009	20h10	UTC-6	71°47.080	126°30.090	Box Core ↑	321	350	167	23	-0.3	0.7	1018.6	85	0/10
4a	437	Full	12/Oct/2009	20h33	UTC-6	71°47.440	126°30.130	Agassiz Trawl ↓	311	318	176	21	-0.5	0.7	1018.4	87	0/10
4a	437	Full	12/Oct/2009	21h06	UTC-6	71°48.010	126°32.320	Agassiz Trawl ↑	320	212	170	23	-0.5	0.7	1018.4	87	0/10
4a	N/A	Mapping	12/Oct/2009	22h10	UTC-6	71°46.520	126°36.280	Bottom Mapping ↓	405	220	170	23	0.0	0.6	1017.1	86	0/10
4a	N/A	Mapping	13/Oct/2009	03h55	UTC-6	71°18.470	127°34.716	Bottom Mapping ↑	204	176	198	24	-0.4	0.9	1013.0	75	0/10
4a	408	Full	13/Oct/2009	04h09	UTC-6	71°18.435	127°35.155	CTD-Rosette ↓	201	15	208	25	-0.5	0.9	1013.7	74	0/10
4a	408	Full	13/Oct/2009	04h32	UTC-6	71°18.501	127°35.330	CTD-Rosette ↑	202	356	214	23	-0.8	0.9	1013.8	75	0/10
4a	408	Full	13/Oct/2009	04h50	UTC-6	71°18.589	127°35.542	Vertical Net Tow ↓	202	16	217	23	-0.3	0.9	1013.4	73	0/10
4a	408	Full	13/Oct/2009	05h04	UTC-6	71°18.546	127°35.718	Vertical Net Tow ↑	202	36	216	23	-0.9	0.9	1013.4	73	0/10
4a	408	Full	13/Oct/2009	05h21	UTC-6	71°18.618	127°35.953	Horizontal Net Tow ↓	200	42	216	23	0.4	0.9	1013.4	71	0/10

Leg	Station ID	Station Type	Local Date	Local Time	UTC to local	Latitude (N)	Longitude (W)	Activity	Depth (m)	Heading (°)	Wind		Air (ºC)	Water (ºC)	Pr Baro	Hum (%)	Ice
											Dir	Speed					
4a	408	Full	13/Oct/2009	05h40	UTC-6	71°18.207	127°35.420	Horizontal Net Tow ↑	207	350	217	22	0.0	0.9	1013.7	71	0/10
4a	408	Full	13/Oct/2009	06h40	UTC-6	71°18.994	127°35.609	CTD-Rosette ↓	205	46	233	22	-1.1	1.0	1012.6	77	0/10
4a	408	Full	13/Oct/2009	07h00	UTC-6	71°19.036	127°35.649	CTD-Rosette ↑	205	39	229	22	-0.5	1.0	1012.6	76	0/10
4a	408	Full	13/Oct/2009	08h35	UTC-6	71°18.980	127°35.220	Hydrobios ↓	207	62	230	18	-0.6	1.0	1012.2	82	0/10
4a	408	Full	13/Oct/2009	08h52	UTC-6	71°19.160	127°35.250	Hydrobios ↑	209	62	230	17	0.7	1.0	1011.8	79	0/10
4a	408	Full	13/Oct/2009	11h24	UTC-6	71°19.120	127°34.120	RMT ↓	211	340	250	13	-0.5	1.0	1011.3	90	0/10
4a	408	Full	13/Oct/2009	11h46	UTC-6	71°19.550	127°35.640	RMT ↑	210	320	250	13	-0.3	1.0	1011.4	91	0/10
4a	408	Full	13/Oct/2009	12h48	UTC-6	71°18.479	127°35.430	Secchi Disk ↓↑	199	18	280	10	-0.4	1.0	1011.3	94	0/10
4a	408	Full	13/Oct/2009	12h50	UTC-6	71°18.543	127°35.327	PNF ↓	201	16	280	10	0.4	1.0	1011.0	94	0/10
4a	408	Full	13/Oct/2009	12h57	UTC-6	71°18.575	127°35.293	PNF ↑	202	20	280	12	0.4	1.0	1011.0	94	0/10
4a	408	Full	13/Oct/2009	13h15	UTC-6	71°18.668	127°34.673	CTD-Rosette ↓	205	169	280	9	0.6	1.0	1011.5	94	0/10
4a	408	Full	13/Oct/2009	13h42	UTC-6	71°18.816	127°34.233	CTD-Rosette ↑	210	156	280	11	1.2	1.0	1011.9	93	N/A
4a	408	Full	13/Oct/2009	14h23	UTC-6	71°19.060	127°33.688	IOPs ↓	215	51	310	8	0.1	1.0	1009.5	95	N/A
4a	408	Full	13/Oct/2009	14h38	UTC-6	71°19.142	127°33.527	IOPs ↑	219	67	320	10	-0.2	1.0	1011.9	95	N/A
4a	408	Full	13/Oct/2009	15h25	UTC-6	71°19.440	127°33.197	Weather Balloon	220	81	335	10	-0.4	1.0	1011.9	96	N/A
4a	CA05-09	Mooring	13/Oct/2009	19h10	UTC-6	71°19.720	127°35.602	Mooring CA05-09 Deployed	206	177	31	9	-2.0	1.0	1012.9	97	0/10
4a	408	Full	13/Oct/2009	19h52	UTC-6	71°19.314	127°35.448	CTD ↓	208	228	14	9	-1.8	1.0	1012.9	97	0/10
4a	408	Full	13/Oct/2009	20h00	UTC-6	71°19.320	127°35.560	CTD ↑	208	260	22	8	-2.3	0.9	1012.9	96	0/10
4a	408	Full	13/Oct/2009	20h43	UTC-6	71°17.160	127°46.930	Box Core ↓	152	82	68	3	-2.3	0.9	1012.9	96	0/10
4a	408	Full	13/Oct/2009	20h50	UTC-6	71°17.170	127°47.060	Box Core ↑	152	75	68	3	-2.3	0.9	1012.9	96	0/10
4a	408	Full	13/Oct/2009	21h08	UTC-6	71°17.180	127°47.390	Box Core ↓	151	133	27	5	-2.3	0.9	1012.9	96	0/10
4a	408	Full	13/Oct/2009	21h15	UTC-6	71°17.180	127°47.490	Box Core ↑	151	140	27	5	-2.6	0.9	1012.9	96	0/10
4a	408	Full	13/Oct/2009	21h38	UTC-6	71°17.200	127°48.000	Box Core ↓	151	190	60	4	-2.6	0.8	1013.0	96	0/10
4a	408	Full	13/Oct/2009	21h45	UTC-6	71°17.200	127°48.060	Box Core ↑	152	191	60	4	-2.6	0.8	1013.0	96	0/10
4a	408	Full	13/Oct/2009	22h00	UTC-6	71°17.100	127°48.290	Agassiz Trawl ↓	148	160	50	5	-2.3	0.8	1012.9	97	0/10
4a	408	Full	13/Oct/2009	22h30	UTC-6	71°17.300	127°48.410	Agassiz Trawl ↑	149	130	40	6	-2.3	0.8	1012.9	97	0/10
4a	416	Nutrient	13/Oct/2009	23h50	UTC-6	71°18.120	127°44.220	CTD-Rosette ↓	167	48	240	2	-2.0	0.8	1013.3	97	0/10
4a	416	Nutrient	14/Oct/2009	00h14	UTC-6	71°18.185	127°44.588	CTD-Rosette ↑	167	55	55	0	-1.8	0.8	1013.2	97	0/10
4a	415	CTD	14/Oct/2009	01h03	UTC-6	71°21.690	127°33.299	CTD ↓	242	323	28	1	-2.4	0.9	1013.7	98	0/10
4a	415	CTD	14/Oct/2009	01h13	UTC-6	71°21.691	127°33.462	CTD ↑	241	311	92	0	-2.5	1.0	1013.1	98	0/10
4a	414	Nutrient	14/Oct/2009	01h50	UTC-6	71°25.326	127°21.664	CTD-Rosette ↓	306	22	231	3	-2.7	1.0	1013.2	98	0/10
4a	414	Nutrient	14/Oct/2009	02h16	UTC-6	71°25.363	127°22.007	CTD-Rosette ↑	306	343	226	2	-2.8	1.0	1013.7	98	0/10
4a	413	CTD	14/Oct/2009	03h13	UTC-6	71°29.687	127°08.074	CTD ↓	375	64	305	4	-2.5	1.1	1013.2	98	0/10
4a	413	CTD	14/Oct/2009	03h28	UTC-6	71°29.669	127°08.089	CTD ↑	373	42	320	3	-2.5	1.1	1013.3	98	0/10
4a	412	Nutrient	14/Oct/2009	04h11	UTC-6	71°33.847	126.55.549	CTD-Rosette ↓	418	265	244	3	-2.4	1.0	1013.2	98	0/10
4a	412	Nutrient	14/Oct/2009	04h47	UTC-6	71°33.938	126°55.307	CTD-Rosette ↑	414	348	230	5	-2.2	1.0	1013.2	98	0/10
4a	411	CTD	14/Oct/2009	05h50	UTC-6	71°37.786	126°42.516	CTD ↓	438	352	243	5	-2.3	0.9	1012.7	99	0/10
4a	411	CTD	14/Oct/2009	06h08	UTC-6	71°37.815	126°42.437	CTD ↑	438	346	222	3	-2.2	0.9	1012.5	99	0/10
4a	410	Nutrient	14/Oct/2009	06h57	UTC-6	71°41.920	126°29.327	CTD-Rosette ↓	408	98	219	3	-1.8	0.8	1012.4	99	0/10
4a	410	Nutrient	14/Oct/2009	07h33	UTC-6	71°41.985	126°28.846	CTD-Rosette ↑	399	170	183	3	-1.5	0.8	1012.2	99	0/10
4a	410	Nutrient	14/Oct/2009	08h35	UTC-6	71°46.730	126°28.640	Box Core ↓	320	337	196	8	-0.9	0.7	1011.9	98	0/10
4a	410	Nutrient	14/Oct/2009	08h50	UTC-6	71°46.790	126°28.430	Box Core ↑	322	305	200	6	-1.6	0.7	1012.0	98	0/10
4a	410	Nutrient	14/Oct/2009	09h02	UTC-6	71°46.870	126°28.350	Box Core ↓	318	293	195	8	-1.5	0.7	1012.0	98	0/10
4a	410	Nutrient	14/Oct/2009	09h15	UTC-6	71°46.950	126°28.320	Box Core ↑	315	282	191	5	-1.5	0.7	1012.0	98	0/10
4a	437	Full	14/Oct/2009	12h50	UTC-6	71°45.247	126°30.355	CTD ↓	367	281	185	8	-1.4	0.7	1011.6	99	0/10

Appendix 2 - Scientific log of activities conducted during the 2009 ArcticNet Expedition

Leg	Station ID	Station Type	Local Date	Local Time	UTC to local	Latitude (N)	Longitude (W)	Activity	Depth (m)	Heading (°)	Wind		Air (ºC)	Water (ºC)	Pr Baro	Hum (%)	Ice
											Dir	Speed					
4a	437	Full	14/Oct/2009	13h05	UTC-6	71°45.338	126°30.346	CTD ↑	367	284	204	8	-1.5	0.7	1011.0	99	0/10
4a	CA16-MMP-08	Mooring	14/Oct/2009	13h50	UTC-6	71°45.134	126°30.331	Mooring CA16-MMP-08 Recovered	354	131	188	7	-1.4	0.7	1011.6	99	0/10
4a	CA16-MMP-08	Mooring	14/Oct/2009	14h19	UTC-6	71°45.225	126°29.747	Mooring CA16-MMP-08 Recovered (end)	351	114	238	5	-1.2	0.8	1011.5	99	0/10
4a	437	Full	14/Oct/2009	14h51	UTC-6	71°47.200	126°29.429	Zodiac Recovered	313	323	222	5	-1.6	0.7	1011.6	99	0/10
4a	437	Full	14/Oct/2009	15h12	UTC-6	71°47.192	126°29.051	CTD-Rosette ↓	311	110	190	8	-1.1	0.7	1011.4	99	0/10
4a	437	Full	14/Oct/2009	15h37	UTC-6	71°47.234	126°28.226	CTD-Rosette ↑	303	121	185	7	-0.9	0.8	1011.1	99	0/10
4a	437	Full	14/Oct/2009	16h40	UTC-6	71°47.134	126°30.056	IOPs ↓	320	319	191	7	-1.3	0.8	1010.8	99	0/10
4a	437	Full	14/Oct/2009	16h55	UTC-6	71°47.189	126°29.985	IOPs ↑	318	278	188	6	-1.3	0.8	1010.7	99	0/10
4a	437	Full	14/Oct/2009	17h15	UTC-6	71°47.280	126°29.987	Zodiac Recovered	315	277	186	8	-1.4	0.8	1010.7	99	0/10
4a	CA16-MMP-09	Mooring	14/Oct/2009	20h00	UTC-6	71°45.210	126°30.500	Mooring CA16-MMP-09 Deployed	354	195	170	10	-0.8	-0.8	1010.4	99	0/10
4a	CA16-MMP-09	Mooring	14/Oct/2009	20h23	UTC-6	71°45.300	126°30.530	Mooring CA16-MMP-09 Deployed (end)	354	285	193	10	-0.9	-0.9	1010.4	99	0/10
4a	437	Full	14/Oct/2009	21h10	UTC-6	71°45.440	126°31.150	CTD ↓	355	0	165	7	-0.7	-0.7	1010.2	98	0/10
4a	437	Full	14/Oct/2009	21h27	UTC-6	71°45.510	126°31.100	CTD ↑	354	340	185	7	-0.4	-0.4	1009.9	97	0/10
4a	405	Basic	15/Oct/2009	05h32	UTC-6	70°39.881	122°59.841	CTD-Rosette ↓	560	44	157	9	0.4	0.4	1009.0	92	0/10
4a	405	Basic	15/Oct/2009	06h10	UTC-6	70°39.870	123°00.277	CTD-Rosette ↑	560	72	162	10	0.8	0.8	1009.0	91	0/10
4a	405	Basic	15/Oct/2009	06h28	UTC-6	70°39.828	122°59.232	Vertical Net Tow ↓	565	177	151	9	0.6	0.6	1008.9	92	0/10
4a	405	Basic	15/Oct/2009	07h00	UTC-6	70°39.732	122°59.774	Vertical Net Tow ↑	576	257	155	9	0.1	0.1	1009.1	92	0/10
4a	405	Basic	15/Oct/2009	07h16	UTC-6	70°39.690	123°00.238	Horizontal Net Tow ↓	585	263	149	8	0.1	0.1	1009.1	92	0/10
4a	405	Basic	15/Oct/2009	07h31	UTC-6	70°39.193	123°01.270	Horizontal Net Tow ↑	601	163	152	7	0.3	0.3	1009.1	92	0/10
4a	405	Basic	15/Oct/2009	08h10	UTC-6	70°39.84	122°59.740	CTD-Rosette ↓	561	69	170	6	0.8	0.8	1008.9	90	0/10
4a	405	Basic	15/Oct/2009	08h47	UTC-6	70°39.800	123°00.400	CTD-Rosette ↑	579	100	170	6	1.2	1.2	1008.9	89	0/10
4a	405	Basic	15/Oct/2009	09h01	UTC-6	70°39.800	123°00.530	RMT ↓	584	350	162	6	0.2	0.2	1009.0	88	0/10
4a	405	Basic	15/Oct/2009	09h25	UTC-6	70°39.800	123°03.300	RMT ↑	559	20	162	6	0.1	0.1	1009.0	88	0/10
4a	405	Basic	15/Oct/2009	10h00	UTC-6	70°39.700	123°00.180	Secchi Disk + PNF ↓ Mooring CA18-08 Interrogation	583	118	180	3	0.3	0.3	1009.1	83	0/10
4a	405	Basic	15/Oct/2009	10h30	UTC-6	70°39.610	123°00.440	Secchi Disk + PNF ↑ Mooring Interrogation	585	100	138	3	0.2	0.2	1009.1	85	0/10
4a	405	Basic	15/Oct/2009	10h40	UTC-6	70°39.840	122°59.830	Mooring CA18-08 Interrogation	585	30	85	2	0.1	0.1	1009.1	85	0/10
4a	405	Basic	15/Oct/2009	11h03	UTC-6	70°39.780	123°00.220	CTD-Rosette ↓	585	48	97	4	0.1	1.0	1009.2	85	0/10
4a	405	Basic	15/Oct/2009	11h55	UTC-6	70°39.540	123°01.190	CTD-Rosette ↑	585	47	93	6	0.1	1.0	1009.3	91	0/10
4a	CA05-MMP-09	Mooring	15/Oct/2009	20h35	UTC-6	71°24.790	127°38.890	Mooring CA05-MMP-09 Deployed	237	245	75	16	1.2	1.2	1010.1	86	0/10
4a	N/A	MVP	15/Oct/2009	21h45	UTC-6	71°24.341	127°09.110	MVP ↓	237	116	67	13	0.2	1.2	1009.4	91	0/10
4a	N/A	MVP	16/Oct/2009	04h00	UTC-6	70°54.950	124°11.200	MVP ↑	560	114	100	21	-0.4	1.5	1008.5	78	0/10
4a	CA18-08	Mooring	16/Oct/2009	05h15	UTC-6	70°46.213	123°39.635	Mooring CA18-08 Interrogation	578	198	67	25	-1.7	1.3	1008.8	91	0/10
4a	CA18-08	Mooring	16/Oct/2009	05h45	UTC-6	70°45.150	123°32.795	Mooring CA18-08 Interrogation	549	340	64	22	-1.5	1.2	1008.4	92	0/10
4a	CA18-08	Mooring	16/Oct/2009	06h05	UTC-6	70°44.043	123°25.764	Mooring CA18-08 Interrogation	415	325	69	23	-1.7	1.3	1006.1	92	0/10
4a	CA18-08	Mooring	16/Oct/2009	06h30	UTC-6	70°42.995	123°19.223	Mooring CA18-08 Interrogation	444	245	60	16	-2.4	1.3	1008.5	95	0/10
4a	CA18-08	Mooring	16/Oct/2009	06h55	UTC-6	70°41.827	123°12.432	Mooring CA18-08 Interrogation	521	233	54	20	-2.5	1.3	1008.3	95	0/10
4a	CA18-08	Mooring	16/Oct/2009	07h22	UTC-6	70°40.713	123°05.659	Mooring CA18-08 Interrogation	487	227	65	25	-2.5	1.1	1008.1	94	0/10
4a	CA18-08	Mooring	16/Oct/2009	07h45	UTC-6	70°39.872	122°59.728	Mooring CA18-08 Interrogation (Lost)	560	67	51	23	-2.4	1.0	1008.1	94	0/10
4a	408	Full	16/Oct/2009	08h24	UTC-6	70°39.840	123°00.430	Hydrobios ↓	573	230	50	23	-1.8	0.9	1008.3	88	0/10
4a	408	Full	16/Oct/2009	08h56	UTC-6	70°39.900	123°00.850	Hydrobios ↑	553	230	60	23	-2.6	0.9	1008.5	84	0/10
4a	408	Full	16/Oct/2009	09h38	UTC-6	70°39.790	123°02.180	IOPs ↓	567	240	60	22	-2.7	0.8	1008.5	82	0/10
4a	408	Full	16/Oct/2009	09h53	UTC-6	70°39.820	123°02.500	IOPs ↑	559	226	63	23	-3.0	0.8	1008.3	86	0/10
4a	408	Full	16/Oct/2009	10h10	UTC-6	70°39.740	123°03.150	Zodiac Deployed	564	225	60	18	-2.3	0.8	1008.3	82	0/10

Leg	Station ID	Station Type	Local Date	Local Time	UTC to local	Latitude (N)	Longitude (W)	Activity	Depth (m)	Heading (°)	Wind		Air (ºC)	Water (ºC)	Pr Baro	Hum (%)	Ice
											Dir	Speed					
4a	408	Full	16/Oct/2009	10h33	UTC-6	70°39.810	123°03.080	CTD-Rosette ↓	558	250	60	20	-2.5	0.8	1008.5	82	0/10
4a	408	Full	16/Oct/2009	11h05	UTC-6	70°39.850	123°03.380	CTD-Rosette ↑	553	240	60	24	-2.5	0.8	1008.3	82	0/10
4a	408	Full	16/Oct/2009	11h40	UTC-6	70°39.680	123°04.440	Zodiac Recovered	563	235	70	24	-3.2	0.8	1008.0	85	0/10
4a	408	Full	16/Oct/2009	12h43	UTC-6	70°39.903	122°59.870	Box Core ↓	558	245	61	19	-2.8	0.8	1008.3	83	0/10
4a	408	Full	16/Oct/2009	13h07	UTC-6	70°39.895	122°00.025	Box Core ↑	557	231	64	28	-2.7	0.8	1008.4	82	0/10
4a	408	Full	16/Oct/2009	13h23	UTC-6	70°39.879	122°59.743	Box Core ↓	559	238	62	26	-1.6	0.8	1008.3	80	0/10
4a	408	Full	16/Oct/2009	13h42	UTC-6	70°39.860	122°59.916	Box Core ↑	564	235	60	21	-2.3	0.8	1008.5	82	0/10
4a	408	Full	16/Oct/2009	13h58	UTC-6	70°39.720	122°00.625	Agassiz Trawl ↓	577	233	68	24	-2.7	0.8	1008.5	83	0/10
4a	408	Full	16/Oct/2009	14h39	UTC-6	70°38.216	122°00.435	Agassiz Trawl ↑	615	127	62	28	-3.8	0.7	1008.4	86	0/10
4a	446	CTD	17/Oct/2009	01h30	UTC-6	71°38.976	119°41.518	CTD ↓	142	305	40	14	-11.2	0.0	1014.0	77	0/10
4a	446	CTD	17/Oct/2009	01h38	UTC-6	71°38.871	119°41.793	CTD ↑	143	318	40	11	-11.1	0.0	1013.9	77	0/10
4a	450	Basic	17/Oct/2009	05h01	UTC-6	72°05.555	119°47.497	CTD-Rosette ↓	95	213	350	9	-14.3	0.11	1016.3	86	0/10
4a	450	Basic	17/Oct/2009	05h33	UTC-6	72°05.412	119°47.674	CTD-Rosette ↑	95	237	13	12	-12.0	0.0	1016.6	83	N/A
4a	450	Basic	17/Oct/2009	05h52	UTC-6	72°05.328	119°47.980	Vertical Net Tow ↓	95	137	15	10	-13.3	0.0	1016.5	87	N/A
4a	450	Basic	17/Oct/2009	06h01	UTC-6	72°05.317	119°48.058	Vertical Net Tow ↑	95	137	9	10	-13.5	0.0	1016.6	88	N/A
4a	450	Basic	17/Oct/2009	06h30	UTC-6	72°04.721	119°48.815	Agassiz Trawl ↓	97	N/A	6	9	-12.9	0.0	1016.6	87	N/A
4a	450	Basic	17/Oct/2009	06h50	UTC-6	72°04.544	119°48.631	Agassiz Trawl ↑	95	N/A	14	12	-13.0	-0.1	1016.8	88	N/A
4a	308	Full	19/Oct/2009	17h05	UTC-6	74°06.153	108°49.614	Secchi Disk ↓	545	338	1	9	-15.8	-0.5	1012.8	82	N/A
4a	308	Full	19/Oct/2009	17h07	UTC-6	74°06.154	108°49.615	Secchi Disk ↑	545	338	1	9	-15.8	-0.5	1012.8	82	N/A
4a	308	Full	19/Oct/2009	17h15	UTC-6	74°06.152	108°49.796	CTD-Rosette ↓	587	270	1	9	-15.6	-0.5	1012.8	82	N/A
4a	308	Full	19/Oct/2009	18h11	UTC-6	74°06.147	108°49.842	CTD-Rosette ↑	544	301	349	7	-15.5	-0.5	1012.7	84	N/A
4a	308	Full	19/Oct/2009	18h35	UTC-6	74°06.166	108°49.842	Vertical Net Tow ↓	545	113	351	7	-15.9	-0.5	1012.9	85	N/A
4a	308	Full	19/Oct/2009	19h10	UTC-6	74°06.177	108°49.818	Vertical Net Tow ↑	546	21	338	8	-15.6	-0.5	1013.0	86	N/A
4a	308	Full	19/Oct/2009	19h37	UTC-6	74°06.172	108°49.824	Vertical Net Tow ↓	545	18	337	8	-15.4	-0.5	1013.0	86	N/A
4a	308	Full	19/Oct/2009	20h02	UTC-6	74°06.171	108°49.833	Vertical Net Tow ↑	545	18	321	7	-15.6	-0.5	1013.2	86	N/A
4a	308	Full	19/Oct/2009	20h12	UTC-6	74°06.170	108°49.844	IOPs ↓	557	12	330	7	-15.2	-0.5	1013.2	87	9/10
4a	308	Full	19/Oct/2009	20h30	UTC-6	74°06.133	108°49.883	IOPs ↑	556	13	325	9	-15.3	-0.5	1013.2	87	9/10
4a	308	Full	19/Oct/2009	20h49	UTC-6	74°06.157	108°50.034	CTD-Rosette ↓	554	171	342	10	-14.9	-0.4	1013.1	87	9/10
4a	308	Full	19/Oct/2009	21h22	UTC-6	74°06.157	108°50.028	CTD-Rosette ↑	544	262	346	9	-15.6	-0.4	1013.2	86	9/10
4a	308	Full	19/Oct/2009	22h00	UTC-6	74°06.152	108°50.084	Hydrobios ↓	544	260	352	10	-15.0	-0.4	1013.2	87	9/10
4a	308	Full	19/Oct/2009	22h32	UTC-6	74°06.148	108°50.118	Hydrobios ↑	543	257	0	12	-14.7	-0.3	1013.2	87	9/10
4a	308	Full	19/Oct/2009	23h25	UTC-6	74°06.090	108°50.006	Box Core ↓	541	66	350	14	-15.6	-0.4	1013.5	87	9/10
4a	308	Full	19/Oct/2009	23h45	UTC-6	74°06.087	108°50.041	Box Core ↑	541	66	353	12	-15.7	-0.4	1013.6	87	9/10
4a	308	Full	20/Oct/2009	00h02	UTC-6	74°06.073	108°50.148	Box Core ↓	541	88	353	14	-15.4	-0.4	1013.5	87	9/10
4a	308	Full	20/Oct/2009	00h22	UTC-6	74°06.072	108°50.263	Box Core ↑	541	110	352	10	-15.4	-0.4	1013.5	86	9/10
4a	N/A	ROV	20/Oct/2010	08h22	UTC-6	74°05.878	108°52.866	ROV ↓	532	245	5	22	-12.9	0.1	1016.0	85	9+/10
4a	N/A	ROV	20/Oct/2011	12h04	UTC-6	74°05.142	108°52.828	ROV ↑	497	243	350	25	-12.4	0.2	1015.4	84	9/10
4a	N/A	N/A	21/Oct/2012	20h03	UTC-6	74°19.720	102°47.747	Ice Raid ↓	200	20	547	15	-15.4	-0.7	1020.2	86	9+/10
4a	N/A	N/A	21/Oct/2012	20h52	UTC-6	74°19.464	102°47.359	Ice Raid ↑	220	20	350	12	-14.3	-0.5	1020.4	88	9+/10
4a	N/A	N/A	22/Oct/2012	07h25	UTC-6	74°18.429	102°46.020	Ice Raid ↓	220	45	348	12	-14.7	0.6	1022.7	85	9+/10
4a	N/A	N/A	22/Oct/2012	08h10	UTC-6	74°18.192	102°45.532	Ice Raid ↑	225	45	350	12	-14.9	0.1	1022.9	83	9+/10
4a	N/A	N/A	22/Oct/2012	09h50	UTC-6	74°17.977	102°45.460	Ice Raid ↓	226	226	340	10	-14.7	0.1	1023.5	86	9/10
4a	N/A	N/A	22/Oct/2012	10h22	UTC-6	74°17.878	102°45.185	Ice Raid ↑	223	225	350	10	-15.0	0.0	1023.8	86	9/10
4a	334	Nutrient	22/Oct/2012	11h05	UTC-6	74°17.845	102°45.044	CTD-Rosette ↓	223	242	350	8	-15.4	0.0	1023.9	86	9/10
4a	334	Nutrient	22/Oct/2012	10h28	UTC-6	74°17.750	102°44.920	CTD-Rosette ↑	223	181	356	7	-15.4	-0.1	1023.8	86	9/10

Leg	Station ID	Station Type	Local Date	Local Time	UTC to local	Latitude (N)	Longitude (W)	Activity	Depth (m)	Heading (°)	Wind		Air (ºC)	Water (ºC)	Pr Baro	Hum (%)	Ice
											Dir	Speed					
4a	304	Full	23/Oct/2012	17h22	UTC-6	74°18.738	091°20.014	CTD-Rosette ↓	340	314	312	6	-8.9	-0.7	1021.2	84	9/10
4a	304	Full	23/Oct/2012	18h05	UTC-6	74°18.760	091°20.866	CTD-Rosette ↑	340	281	312	3	-8.9	-0.7	1021.4	89	9/10
4a	304	Full	23/Oct/2012	18h35	UTC-6	74°18.790	091°21.293	IOPs ↓	335	352	340	5	-8.9	-0.7	1021.5	88	9/10
4a	304	Full	23/Oct/2012	18h53	UTC-6	74°18.810	091°21.963	IOPs ↑	345	52	345	6	-9.2	-0.7	1021.7	88	9/10
4a	304	Full	23/Oct/2012	19h00	UTC-6	74°18.810	091°21.963	Vertical Net Tow ↓	335	52	345	6	-9.2	-0.7	1021.7	88	9/10
4a	304	Full	23/Oct/2012	19h36	UTC-6	74°18.838	091°22.511	Vertical Net Tow ↑	335	55	316	5	-9.3	-0.7	1021.7	90	9/10
4a	304	Full	23/Oct/2012	19h56	UTC-6	74°18.894	091°23.004	CTD-Rosette ↓	332	258	317	7	-8.9	-0.6	1021.6	91	9/10
4a	304	Full	23/Oct/2012	20h18	UTC-6	74°18.922	091°23.326	CTD-Rosette ↑	331	253	320	7	-8.7	-0.5	1021.5	90	9/10
4a	304	Full	23/Oct/2012	20h45	UTC-6	74°18.957	091°23.707	Hydrobios ↓	331	255	335	5	-8.6	-0.5	1021.4	90	9/10
4a	304	Full	23/Oct/2012	21h05	UTC-6	74°18.981	091°23.911	Hydrobios ↑	336	255	325	5	-8.5	-0.5	1021.5	90	9/10
4a	304	Full	23/Oct/2012	21h33	UTC-6	74°19.014	091°24.160	Box Core ↓	331	254	335	5	-8.4	-0.5	1021.4	90	9/10
4a	304	Full	23/Oct/2012	21h47	UTC-6	74°19.035	091°24.267	Box Core ↑	336	254	355	6	-8.3	0.4	1021.5	90	9/10
4a	304	Full	23/Oct/2012	22h03	UTC-6	74°19.058	091°24.378	Box Core ↓	331	253	335	5	-8.2	-0.4	1021.4	90	9/10
4a	304	Full	23/Oct/2012	22h15	UTC-6	74°19.072	091°24.444	Box Core ↑	334	253	355	5	-8.2	-0.4	1021.4	90	9/10
4a	330	Nutrient	24/Oct/2012	05h42	UTC-6	74°08.399	087°51.368	CTD-Rosette ↓	419	312	70	12	-9.6	-0.9	1020.9	89	9/10
4a	330	Nutrient	24/Oct/2012	06h34	UTC-6	74°08°719	087°51.369	CTD-Rosette ↑	420	331	50	11	-9.3	-0.9	1020.9	89	9/10
4a	325	Nutrient	24/Oct/2012	21h40	UTC-6	73°49.083	080°29.813	CTD-Rosette ↓	680	208	30	26	-7.1	-0.9	1015.9	88	1/10
4a	325	Nutrient	24/Oct/2012	22h22	UTC-6	73°48.674	080°28.188	CTD-Rosette ↑	662	252	30	28	-7.6	-0.9	1015.7	90	1/10
4a	324	Nutrient	25/Oct/2012	00h33	UTC-6	73°58.831	080°30.199	CTD-Rosette ↓	767	293	40	28	-8.2	-0.9	1015.2	86	10/10
4a	324	Nutrient	25/Oct/2012	00h40	UTC-6	N/A	N/A	CTD-Rosette ↑ (canceled)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
4a	323	Full	25/Oct/2012	N/A	UTC-6	N/A	080°30.181	Vertical Net Tow ↓	796	212	30	26	-9.0	-0.9	1014.7	86	1/10
4a	323	Full	25/Oct/2012	04h01	UTC-6	74°09.413	080°31.553	Vertical Net Tow ↑	774	206	24	29	-7.8	-0.9	1014.9	86	1/10
4a	323	Full	25/Oct/2012	04h23	UTC-6	74°09.228	080°31.855	Horizontal Net Tow ↓	771	190	26	29	-5.7	-0.9	1014.9	81	1/10
4a	323	Full	25/Oct/2012	04h32	UTC-6	74°09.138	080°32.343	Horizontal Net Tow ↑	773	240	20	36	-7.4	-0.9	1014.8	85	1/10
4a	323	Full	25/Oct/2012	05h24	UTC-6	74°09.690	080°30.555	CTD-Rosette ↓	786	204	20	28	-8.2	-0.9	1015.0	86	1/10
4a	323	Full	25/Oct/2012	06h16	UTC-6	74°09.857	080°31.240	CTD-Rosette ↑	783	203	20	25	-7.3	-0.9	1015.7	84	N/A
4a	323	Full	25/Oct/2012	08h10	UTC-6	74°10.646	080°31.904	CTD-Rosette ↓	778	210	35	25	-8.5	-0.9	1015.7	80	3/10
4a	323	Full	25/Oct/2012	08h23	UTC-6	N/A	N/A	CTD-Rosette ↑	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
4a	323	Full	25/Oct/2012	N/A	UTC-6	N/A	N/A	Horizontal Net Tow ↓↑	755	202	35	30	N/A	N/A	N/A	N/A	3/10
4a	323	Full	25/Oct/2012	09h48	UTC-6	74°11.028	080°35.302	IOPs ↓	764	269	34	27	-8.8	-0.9	1015.6	78	6/10
4a	323	Full	25/Oct/2012	10h10	UTC-6	74°11.141	080°35.875	IOPs ↑	766	220	25	28	-8.1	-0.9	1015.6	76	6/10
4a	323	Full	25/Oct/2012	10h56	UTC-6	74°10.970	080°37.912	Box Core ↓	774	226	20	22	-7.9	-0.9	1015.7	78	6/10
4a	323	Full	25/Oct/2012	11h18	UTC-6	74°10.915	080°38.563	Box Core ↑	773	286	35	25	-6.4	-0.8	1015.8	75	6/10
4a	323	Full	25/Oct/2012	12h21	UTC-6	74°10.349	080°43.539	Box Core ↓	786	206	15	25	-5.9	-0.9	1015.1	73	6/10
4a	323	Full	25/Oct/2012	12h43	UTC-6	74°10.333	080°43.498	Box Core ↑	788	237	20	14	-5.3	-0.9	1015.6	72	2/10
4a	323	Full	25/Oct/2012	13h07	UTC-6	74°10.006	080°44.010	Secchi Disk ↓↑	798	192	30	17	-8.5	-0.8	1015.6	80	2/10
4a	323	Full	25/Oct/2012	13h10	UTC-6	74°10.001	080°43.899	PNF ↓	799	168	0	18	-8.1	-0.8	1015.5	78	2/10
4a	323	Full	25/Oct/2012	13h17	UTC-6	74°09.975	080°43.906	PNF ↑	795	171	25	17	-8.1	-0.8	1015.5	78	2/10
4a	323	Full	25/Oct/2012	14h05	UTC-6	74°09.249	080°33.019	Surface Layer Sampling ↓	775	112	30	22	-8.8	-0.8	1015.3	78	8/10
4a	323	Full	25/Oct/2012	14h28	UTC-6	74°08.959	080°33.868	Surface Layer Sampling ↑	777	79	10	15	-9.0	-0.9	1015.3	77	8/10
4a	323	Full	25/Oct/2012	15h28	UTC-6	74°08.211	080°38.995	CTD-Rosette ↓	798	N/A	10	16	-7.0	-0.9	1015.9	74	8/10
4a	323	Full	25/Oct/2012	16h10	UTC-6	74°07.841	080°39.352	CTD-Rosette ↑	794	292	34	19	-7.7	-0.9	1015.8	88	8/10
4a	323	Full	25/Oct/2012	16h20	UTC-6	74°07.784	080°39.957	Microlayer Sampling ↓	796	140	21	18	-8.1	-0.9	1015.7	90	8/10
4a	323	Full	25/Oct/2012	16h50	UTC-6	74°07.264	080°40.753	Microlayer Sampling ↑	796	102	70	19	-8.8	-0.9	1015.6	88	8/10
4a	323	Full	25/Oct/2012	17h33	UTC-6	74°07.013	080°40.601	CTD-Rosette ↓	783	252	20	25	-7.6	-0.8	1015.7	85	8/10

Appendix 2 - Scientific log of activities conducted during the 2009 ArcticNet Expedition

Leg	Station ID	Station Type	Local Date	Local Time	UTC to local	Latitude (N)	Longitude (W)	Activity	Depth (m)	Heading (°)	Wind Dir	Wind Speed	Air (ºC)	Water (ºC)	Pr Baro	Hum (%)	Ice
4a	323	Full	25/Oct/2012	18h20	UTC-6	74°06.609	080°62.673	CTD-Rosette ↑	781	314	27	20	-8.6	-0.8	1015.6	85	8/10
4a	300	Nutrient	25/Oct/2012	20h05	UTC-6	74°19.544	080°30.732	CTD-Rosette ↓	674	273	26	20	-9.5	-0.9	1015.4	86	9/10
4a	300	Nutrient	25/Oct/2012	20h48	UTC-6	74°18.820	080°33.384	CTD-Rosette ↑	701	277	30	23	-9.4	-0.9	1015.4	87	9/10
4a	322	Nutrient	25/Oct/2012	23h25	UTC-6	74°29.595	080°36.709	CTD-Rosette ↓	660	298	30	17	-8.5	-0.9	1015.7	83	8/10
4a	322	Nutrient	26/Oct/2012	00h15	UTC-6	74°28.824	080°42.373	CTD-Rosette ↑	662	246	40	14	-7.8	-0.9	1015.9	85	8/10
4a	103	Full	26/Oct/2012	18h43	UTC-6	76°21.277	076°32.194	CTD-Rosette ↓	155	218	351	27	-10.2	-1.0	1015.9	87	9/10
4a	103	Full	26/Oct/2012	19h00	UTC-6	76°20.810	076°32.678	CTD-Rosette ↑	155	263	1	22	-9.4	-1.0	1016.2	88	9/10
4a	103	Full	26/Oct/2012	19h30	UTC-6	76°20.158	076°33.371	IOPs ↓	188	95	349	24	-10.2	-0.9	1016.0	88	9/10
4a	103	Full	26/Oct/2012	19h45	UTC-6	76°19.837	076°33.786	IOPs ↑	188	97	346	27	-10.2	-0.9	1015.9	88	9/10
4a	103	Full	26/Oct/2012	20h03	UTC-6	76°19.453	076°34.555	Vertical Net Tow ↓	202	182	350	20	-10.1	-0.9	1015.9	87	9/10
4a	103	Full	26/Oct/2012	20h13	UTC-6	76°19.311	076°34.667	Vertical Net Tow ↑	204	211	350	26	-8.1	-0.9	1016.2	84	9/10
4a	103	Full	26/Oct/2012	20h55	UTC-6	76°18.081	076°36.966	Hydrobios ↓	190	275	350	22	-9.1	-0.9	1016.2	84	9/10
4a	103	Full	26/Oct/2012	21h10	UTC-6	76°17.770	076°37.275	Hydrobios ↑	192	285	355	24	-10.1	-0.9	1016.2	87	9/10
4a	103	Full	26/Oct/2012	21h32	UTC-6	76°17.161	076°38.276	Microlayer Sampling ↓	193	95	355	28	-10.8	-0.9	1016.0	88	9/10
4a	103	Full	26/Oct/2012	22h10	UTC-6	76°16.409	076°39.760	Microlayer Sampling (continued)	195	43	350	28	-11.0	-0.9	1016.1	85	9/10
4a	103	Full	26/Oct/2012	22h32	UTC-6	76°15.846	076°40.038	Microlayer Sampling ↑	188	18	350	28	-11.0	-0.9	1016.1	85	9/10
4a	103	Full	27/Oct/2012	00h00	UTC-6	76°20.651	076°35.291	CTD-Rosette ↓	161	247	359	27	-11.0	-0.9	1016.6	87	9/10
4a	103	Full	27/Oct/2012	00h25	UTC-6	76°20.234	076°35.900	CTD-Rosette ↑	182	249	340	20	-11.2	-0.9	1016.7	88	9/10
4a	103	Full	27/Oct/2012	01h40	UTC-6	76°18.928	076°38.025	Box Core ↓	195	250	350	22	-10.9	-0.8	1017.0	85	9/10
4a	103	Full	27/Oct/2012	01h55	UTC-6	76°18.610	076°38.717	Box Core ↑	192	226	350	24	-11.1	-0.8	1016.9	85	9/10
4a	103	Full	27/Oct/2012	03h20	UTC-6	N/A	N/A	Weather Balloon	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	9/10
4a	103	Full	27/Oct/2012	04h45	UTC-6	N/A	N/A	EM Sampling ↓	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	9/10
4a	103	Full	27/Oct/2012	05h00	UTC-6	76°17.294	076°49.917	Ice Raid ↓	279	338	303	16	-12.0	-0.8	1017.8	82	9/10
4a	103	Full	27/Oct/2012	06h22	UTC-6	76°15.841	076°50.990	Ice Raid ↑	261	335	286	19	-12.3	-0.8	1017.8	87	9/10
4a	103	Full	27/Oct/2012	07h24	UTC-6	76°15.442	076°50.420	Ice Raid ↓	261	252	302	16	-12.0	-0.8	1017.7	87	9/10
4a	103	Full	27/Oct/2012	07h55	UTC-6	76°14.935	076°50.499	Ice Raid ↑	246	257	305	17	-11.7	-0.8	1017.8	83	9/10
4a	105	Basic	27/Oct/2012	11h32	UTC-6	76°18.710	075°46.144	Hydrobios ↓	327	165	320	24	-9.0	-0.9	1017.2	89	5/10
4a	105	Basic	27/Oct/2012	11h50	UTC-6	76°18.147	075°46.091	Hydrobios ↑	324	162	320	22	-8.4	-0.9	1017.3	87	5/10
4a	105	Basic	27/Oct/2012	12h30	UTC-6	76°15.794	075°51.093	UV Profile ↓	359	225	310	19	-9.3	-0.9	1017.9	89	5/10
4a	105	Basic	27/Oct/2012	12h49	UTC-6	76°15.365	075°50.590	UV Profile ↑	352	86	318	17	-8.7	-0.9	1018.0	90	5/10
4a	105	Basic	27/Oct/2012	12h50	UTC-6	76°15.194	075°50.575	Secchi Disk + PNF ↓	355	75	318	20	-8.7	-0.9	1018.0	90	5/10
4a	105	Basic	27/Oct/2012	12h59	UTC-6	76°14.995	075°50.681	Secchi Disk + PNF ↑	357	68	329	21	-8.7	-0.9	1018.0	90	5/10
4a	105	Basic	27/Oct/2012	13h04	UTC-6	76°14.837	075°50.604	CTD-Rosette ↓	352	182	320	19	-9.2	-0.8	1018.0	90	5/10
4a	105	Basic	27/Oct/2012	13h37	UTC-6	76°14.324	075°50.560	CTD-Rosette ↑	359	163	328	20	-8.4	-0.8	1018.3	88	5/10
4a	105	Basic	27/Oct/2012	14h08	UTC-6	76°13.277	075°53.844	IOPs ↓	367	155	319	18	-8.5	-0.8	1018.4	87	5/10
4a	105	Basic	27/Oct/2012	14h25	UTC-6	76°12.953	075°54.724	IOPs ↑	366	129	335	21	-7.8	-0.8	1018.6	85	5/10
4a	105	Basic	27/Oct/2012	14h42	UTC-6	76°11.711	075°55.790	Microlayer Sampling ↓	340	148	340	15	-6.5	-0.8	1018.7	82	5/10
4a	105	Basic	27/Oct/2012	15h34	UTC-6	76°10.154	075°58.402	Microlayer Sampling ↑	351	253	337	21	-9.0	-0.7	1018.8	88	5/10
4a	105	Basic	27/Oct/2012	15h53	UTC-6	76°09.907	075°57.888	Vertical Net Tow ↓	355	160	319	18	-7.6	-0.7	1019.1	83	5/10
4a	105	Basic	27/Oct/2012	16h15	UTC-6	76°09.540	075°58.458	Vertical Net Tow ↑	355	155	319	15	-8.6	-0.6	1019.2	84	5/10
4a	105	Basic	27/Oct/2012	16h30	UTC-6	76°09.443	075°58.724	Horizontal Net Tow ↓	348	142	328	16	-5.4	-0.6	1019.3	80	5/10
4a	105	Basic	27/Oct/2012	17h02	UTC-6	76°08.338	075°57.798	Horizontal Net Tow ↑	348	130	339	17	-9.1	-0.6	1019.4	89	5/10
4a	105	Basic	27/Oct/2012	18h34	UTC-6	76°17.972	075°44.766	CTD-Rosette ↓	313	177	355	17	-8.7	-0.7	1019.3	93	10/10
4a	105	Basic	27/Oct/2012	18h54	UTC-6	76°17.767	075°45.535	CTD-Rosette ↑	315	188	341	19	-5.6	-0.7	1019.6	86	10/10
4a	105	Basic	27/Oct/2012	19h18	UTC-6	76°17.601	075°45.828	Box Core ↓	313	199	341	17	-3.9	-0.6	1019.8	79	10/10

Appendix 2 - Scientific log of activities conducted during the 2009 ArcticNet Expedition

Leg	Station ID	Station Type	Local Date	Local Time	UTC to local	Latitude (N)	Longitude (W)	Activity	Depth (m)	Heading (°)	Wind Dir	Wind Speed	Air (ºC)	Water (ºC)	Pr Baro	Hum (%)	Ice
4a	105	Basic	27/Oct/2012	19h32	UTC-6	76°17.571	075°45.896	Box Core ↑	313	212	351	17	-5.9	-0.7	1020.0	86	10/10
4a	106	CTD	27/Oct/2012	20h38	UTC-6	76°18.468	075°21.270	CTD ↓	380	174	7	20	-7.0	-0.8	1019.5	92	1/10
4a	106	CTD	27/Oct/2012	20h55	UTC-6	76°18.429	075°21.484	CTD ↑	379	198	0	17	-6.9	-0.8	1019.6	89	1/10
4a	107	Nutrient	27/Oct/2012	21h40	UTC-6	76°16.837	074°59.328	CTD-Rosette ↓	438	200	14	15	-7.6	-0.7	1019.6	88	1/10
4a	107	Nutrient	27/Oct/2012	22h10	UTC-6	76°16.759	074°59.178	CTD-Rosette ↑	437	214	355	21	-7.1	-0.6	1019.6	86	1/10
4a	108	CTD	27/Oct/2012	23h05	UTC-6	76°15.764	074°36.123	CTD ↓	447	204	350	22	-6.3	-0.7	1019.4	78	Icebergs
4a	108	CTD	27/Oct/2012	23h23	UTC-6	76°15.720	074°36.188	CTD ↑	446	155	10	21	-5.4	-0.7	1019.3	80	0/10
4a	109	Full	28/Oct/2012	01h08	UTC-6	76°17.226	074°06.454	Hydrobios ↓	450	170	353	21	-5.8	-0.9	1018.9	83	0/10
4a	109	Full	28/Oct/2012	01h37	UTC-6	76°17.058	074°06.226	Hydrobios ↑	450	168	345	15	-4.7	-0.9	1018.9	77	0/10
4a	109	Full	28/Oct/2012	01h52	UTC-6	76°17.074	074°06.361	Vertical Net Tow ↓	452	173	345	18	-5.7	-0.9	1018.9	79	N/A
4a	109	Full	28/Oct/2012	02h23	UTC-6	76°16.974	074°06.506	Vertical Net Tow ↑	446	154	345	18	-6.1	-0.9	1019.0	79	N/A
4a	109	Full	28/Oct/2012	02h42	UTC-6	76°17.303	074°06.130	Horizontal Net Tow ↓	457	199	342	20	-6.2	-0.9	1018.6	79	N/A
4a	109	Full	28/Oct/2012	03h00	UTC-6	76°17.208	074°04.472	Horizontal Net Tow ↑	455	120	354	21	-6.6	-0.9	1018.8	80	N/A
4a	109	Full	28/Oct/2012	03h27	UTC-6	76°17.424	074°07.317	RMT ↓	452	218	345	21	-6.5	-0.9	1018.8	80	N/A
4a	109	Full	28/Oct/2012	03h44	UTC-6	76°17.241	074°06.666	RMT ↑	452	255	339	22	-6.7	-0.9	1019.0	81	N/A
4a	109	Full	28/Oct/2012	04h17	UTC-6	76°17.211	074°06.953	CTD-Rosette ↓	447	190	322	21	-6.7	-1.0	1018.9	85	N/A
4a	109	Full	28/Oct/2012	04h56	UTC-6	76°17.200	074°05.972	CTD-Rosette ↑	455	177	332	18	-5.8	-0.9	1019.0	84	N/A
4a	109	Full	28/Oct/2012	05h27	UTC-6	76°16.955	074°05.607	IOPs ↓	447	145	338	24	-6.6	-0.9	1018.8	84	N/A
4a	109	Full	28/Oct/2012	05h43	UTC-6	76°16.870	074°05.763	IOPs ↑	450	157	350	20	-6.9	-0.9	1018.8	84	N/A
4a	109	Full	28/Oct/2012	06h03	UTC-6	76°16.574	074°04.780	Microlayer Sampling ↓	448	249	342	22	-8.1	-0.9	1018.7	86	N/A
4a	109	Full	28/Oct/2012	06h15	UTC-6	76°16.244	074°04.166	Microlayer Sampling ↑	443	93	338	24	-7.7	-0.8	1018.6	87	N/A
4a	109	Full	28/Oct/2012	07h12	UTC-6	76°17.199	074°08.049	CTD-Rosette ↓	448	153	350	20	-7.2	-0.9	1018.5	83	N/A
4a	109	Full	28/Oct/2012	07h40	UTC-6	76°17.101	074°08.097	CTD-Rosette ↑	450	179	322	25	-5.1	-1.0	1018.5	78	N/A
4a	109	Full	28/Oct/2012	08h38	UTC-6	76°17.588	074°07.939	Hydrobios ↓	455	160	335	20	-8.5	-1.0	1018.4	82	N/A
4a	109	Full	28/Oct/2012	09h06	UTC-6	76°17.506	074°08.585	Hydrobios ↑	454	166	330	28	-7.8	-0.9	1018.2	82	0/10
4a	109	Full	28/Oct/2012	09h55	UTC-6	76°17.540	074°07.095	Box Core ↓	454	144	350	29	-9.2	-0.9	1017.4	80	N/A
4a	109	Full	28/Oct/2012	10h12	UTC-6	76°17.514	074°07.828	Box Core ↑	452	175	325	25	-8.7	-0.9	1017.9	79	N/A
4a	109	Full	28/Oct/2012	10h28	UTC-6	76°17.370	074°08.213	Box Core ↓	451	168	325	25	-9.3	-0.8	1017.9	80	0/10
4a	109	Full	28/Oct/2012	10h45	UTC-6	76°17.205	074°08.588	Box Core ↑	446	139	336	30	-9.3	-0.8	1018.0	81	N/A
4a	109	Full	28/Oct/2012	11h10	UTC-6	76°16.762	074°08.723	Agassiz Trawl ↓	442	90	330	25	-11.1	-0.8	1017.7	86	N/A
4a	109	Full	28/Oct/2012	11h45	UTC-6	76°17.335	074°05.636	Agassiz Trawl ↑	455	180	318	28	-11.1	-0.8	1017.8	86	N/A
4a	110	Nutrient	28/Oct/2012	13h10	UTC-6	76°17.712	073°37.510	CTD-Rosette ↓	526	142	320	25	-8.1	-0.8	1017.3	85	N/A
4a	110	Nutrient	28/Oct/2012	13h50	UTC-6	76°17.523	073°37.357	CTD-Rosette ↑	522	N/A	306	31	-7.4	-0.7	1017.4	85	N/A
4a	111	Basic	28/Oct/2012	14h43	UTC-6	76°18.065	073°12.598	IOPs ↓	580	150	320	31	-7.5	-0.8	1017.2	79	9/10
4a	111	Basic	28/Oct/2012	14h59	UTC-6	76°17.930	073°13.104	IOPs ↑	566	115	335	25	-8.4	-0.8	1017.1	79	9/10
4a	111	Basic	28/Oct/2012	15h12	UTC-6	76°17.705	073°12.718	CTD-Rosette ↓	559	128	325	28	-8.4	-0.8	1017.1	80	9/10
4a	111	Basic	28/Oct/2012	15h51	UTC-6	76°17.613	073°11.925	CTD-Rosette ↑	557	209	325	25	-6.0	-0.9	1017.3	74	9/10
4a	111	Basic	28/Oct/2012	16h12	UTC-6	76°17.601	073°11.305	Vertical Net Tow ↓	560	194	320	26	-4.1	-0.9	1017.4	70	9/10
4a	111	Basic	28/Oct/2012	16h54	UTC-6	76°17.406	073°11.728	Vertical Net Tow ↑	355	148	330	25	-6.6	-0.9	1017.6	75	9/10
4a	111	Basic	28/Oct/2012	17h17	UTC-6	76°17.334	073°13.579	Horizontal Net Tow (canceled)	68	173	340	30	-7.4	-0.9	1017.6	77	N/A
4a	111	Basic	28/Oct/2012	18h25	UTC-6	76°17.310	073°14.130	CTD-Rosette ↓	560	145	322	26	-8.1	-1.0	1018.2	78	9/10
4a	111	Basic	28/Oct/2012	18h50	UTC-6	76°17.142	073°14.000	CTD-Rosette ↑	565	171	330	25	-7.5	-1.0	1018.4	76	9/10
4a	111	Basic	28/Oct/2012	19h18	UTC-6	76°17.087	073°13.063	Box Core ↓	565	167	314	23	-4.4	-1.0	1018.8	71	9/10
4a	111	Basic	28/Oct/2012	19h39	UTC-6	76°16.989	073°13.220	Box Core ↑	565	176	307	29	-5.8	-1.0	1018.7	78	9/10
4a	111	Basic	28/Oct/2012	19h54	UTC-6	76°17.699	073°13.053	Agassiz Trawl ↓	566	146	340	25	-7.8	-1.0	1018.9	78	9/10

Appendix 2 - Scientific log of activities conducted during the 2009 ArcticNet Expedition

Leg	Station ID	Station Type	Local Date	Local Time	UTC to local	Latitude (N)	Longitude (W)	Activity	Depth (m)	Heading (°)	Wind		Air (ºC)	Water (ºC)	Pr Baro	Hum (%)	Ice
											Dir	Speed					
4a	111	Basic	28/Oct/2012	20h42	UTC-6	76°15.706	073°07.132	Agassiz Trawl ↑	558	136	335	20	-9.1	-0.9	1018.8	81	Icebergs
4a	112	CTD	28/Oct/2012	21h42	UTC-6	76°18.896	072°42.335	CTD ↓	560	155	325	24	-9.0	-0.9	1018.7	78	0/10
4a	112	CTD	28/Oct/2012	22h03	UTC-6	76°18.870	072°42.615	CTD ↑	563	128	335	25	-7.5	-0.9	1019.0	72	0/10
4a	113	Nutrient	28/Oct/2012	22h58	UTC-6	76°19.315	072°13.717	CTD-Rosette ↓	550	120	315	22	-8.0	-0.9	1019.1	73	8/10
4a	113	Nutrient	28/Oct/2012	23h38	UTC-6	76°18.922	072°13.628	CTD-Rosette ↑	543	138	310	22	-6.7	-0.9	1019.4	72	8/10
4a	114	CTD	29/Oct/2012	00h40	UTC-6	76°19.428	072°46.751	CTD ↓	613	141	296	21	-7.7	-1.0	1019.3	74	3/10
4a	114	CTD	29/Oct/2012	01h04	UTC-6	76°19.327	071°46.340	CTD ↑	619	142	290	20	-7.4	-1.0	1019.5	71	3/10
4a	115	Full	29/Oct/2012	02h07	UTC-6	76°19.897	071°11.543	Hydrobios ↓	671	147	290	13	-7.9	-0.9	1019.5	75	N/A
4a	115	Full	29/Oct/2012	02h50	UTC-6	76°19.964	071°10.006	Hydrobios ↑	635	92	299	15	-6.7	-0.8	1019.6	75	N/A
4a	115	Full	29/Oct/2012	03h35	UTC-6	76°22.900	071°10.900	Bottom Mapping ↓	468	120	284	16	-7.5	-0.5	1019.7	74	N/A
4a	115	Full	29/Oct/2012	08h55	UTC-6	76°22.200	071°15.000	Bottom Mapping ↑	645	85	285	18	-8.0	-0.6	1018.3	81	Icebergs
4a	115	Full	29/Oct/2012	09h10	UTC-6	76°19.874	071°13.173	IOPs ↓	646	118	285	18	-8.0	-0.6	1018.3	81	Icebergs
4a	115	Full	29/Oct/2012	09h28	UTC-6	76°19.784	071°12.982	IOPs ↑	655	86	285	20	-7.4	-0.6	1018.6	80	Icebergs
4a	115	Full	29/Oct/2012	09h30	UTC-6	76°19.762	071°12.889	Secchi Disk + PNF ↓	651	80	285	20	-8.2	-0.6	1018.6	80	N/A
4a	115	Full	29/Oct/2012	09h40	UTC-6	76°19.693	071°12.706	Secchi Disk + PNF ↑	651	103	285	18	-8.8	-0.5	1018.5	81	N/A
4a	115	Full	29/Oct/2012	10h00	UTC-6	76°19.907	071°11.735	CTD-Rosette ↓	672	136	280	16	-8.1	-0.5	1018.4	80	N/A
4a	115	Full	29/Oct/2012	10h53	UTC-6	76°19.818	071°12.084	CTD-Rosette ↑	641	85	270	15	-5.9	-0.5	1018.2	73	N/A
4a	115	Full	29/Oct/2012	11h28	UTC-6	76°19.800	071°13.062	Hydrobios ↓	652	82	250	21	-6.1	-0.5	1017.9	73	N/A
4a	115	Full	29/Oct/2012	12h05	UTC-6	76°19.852	071°13.522	Hydrobios ↑	655	145	230	17	-7.1	-0.5	1017.7	78	N/A
4a	115	Full	29/Oct/2012	12h16	UTC-6	76°19.809	071°13.124	UV Profile ↓	653	237	230	14	-8.0	-0.5	1017.6	81	N/A
4a	115	Full	29/Oct/2012	12h35	UTC-6	76°19.833	071°12.192	UV Profile ↑	653	39	230	15	-9.0	-0.5	1017.3	78	N/A
4a	115	Full	29/Oct/2012	12h45	UTC-6	76°19.870	071°11.771	Zodiac Deployed	671	20	220	12	-7.2	-0.4	1017.2	76	N/A
4a	115	Full	29/Oct/2012	14h04	UTC-6	76°20.513	071°12.677	Zodiac Recovered	652	N/A	182	14	-7.9	-0.4	1016.0	66	N/A
4a	115	Full	29/Oct/2012	13h03	UTC-6	76°20.005	071°11.731	CTD-Rosette ↓	669	78	190	17	-8.5	-0.4	1016.9	75	N/A
4a	115	Full	29/Oct/2012	13h56	UTC-6	76°20.430	071°12.853	CTD-Rosette ↑	652	122	190	5	-7.6	-0.4	1016.2	75	N/A
4a	115	Full	29/Oct/2012	14h27	UTC-6	76°20.746	071°13.162	Vertical Net Tow ↓	652	286	150	10	-8.3	-0.4	1015.8	70	N/A
4a	115	Full	29/Oct/2012	15h06	UTC-6	76°21.024	071°14.158	Vertical Net Tow ↑	652	233	100	10	-8.4	-0.3	1015.5	63	N/A
4a	115	Full	29/Oct/2012	15h31	UTC-6	76°19.932	071°12.044	Horizontal Net Tow ↓	672	257	80	7	-8.2	-0.4	1014.9	65	N/A
4a	115	Full	29/Oct/2012	15h47	UTC-6	76°20.090	071°12.926	Horizontal Net Tow ↑	666	247	100	7	-8.1	-0.5	1014.9	67	N/A
4a	115	Full	29/Oct/2012	16h08	UTC-6	76°20.195	071°13.415	RMT ↓	662	263	100	4	-7.7	-0.4	1014.9	75	0/10
4a	115	Full	29/Oct/2012	16h28	UTC-6	76°19.724	071°14.466	RMT ↑	666	133	75	11	-8.4	-0.4	1014.8	75	0/10
4a	115	Full	29/Oct/2012	16h50	UTC-6	76°19.997	071°14.533	CTD-Rosette ↓	666	235	88	10	-8.1	-0.5	1014.5	67	0/10
4a	115	Full	29/Oct/2012	17h31	UTC-6	76°20.369	071°15.142	CTD-Rosette ↑	665	297	83	10	-7.4	-0.4	1014.1	66	0/10
4a	115	Full	29/Oct/2012	17h55	UTC-6	76°19.986	071°14.477	Box Core ↓	667	38	70	10	-7.7	-0.4	1013.8	64	0/10
4a	115	Full	29/Oct/2012	18h20	UTC-6	76°20.062	071°14.262	Box Core ↑	668	266	70	8	-7.3	-0.5	1013.6	65	0/10
4a	115	Full	29/Oct/2012	18h32	UTC-6	76°90.059	071°14.258	Box Core ↓	669	328	88	9	-7.6	-0.5	1013.4	65	0/10
4a	115	Full	29/Oct/2012	18h56	UTC-6	76°20.151	071°14.440	Box Core ↑	669	240	105	10	-7.4	-0.5	1013.2	66	N/A
4a	115	Full	29/Oct/2012	18h40	UTC-6	76°90.000	071°14.000	Weather Balloon	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
4a	115	Full	29/Oct/2012	19h08	UTC-6	76°20.298	071°14.293	Agassiz Trawl ↓	666	247	100	9	-7.7	-0.5	1013.0	66	N/A
4a	115	Full	29/Oct/2012	20h30	UTC-6	76°19.880	071°14.610	Agassiz Trawl ↑	655	43	20	5	-8.0	-0.6	1012.0	78	N/A
4a	115	Full	29/Oct/2012	21h15	UTC-6	76°19.682	071°13.647	ROV ↓	655	135	350	10	-6.7	-0.7	1011.3	61	N/A
4a	115	Full	29/Oct/2012	22h17	UTC-6	76°19.621	071°13.634	ROV ↑	655	96	320	18	-5.4	-0.6	1010.3	61	N/A
4a	136	Basic	30/Oct/2012	09h55	UTC-6	74°46.617	073°34.124	Secchi Disk + PNF ↓	785	116	315	25	-11.6	-1.0	1009.3	78	8/10
4a	136	Basic	30/Oct/2012	10h07	UTC-6	74°46.415	073°33.775	Secchi Disk + PNF ↑	785	151	300	28	-11.6	-1.0	1009.9	78	8/10
4a	136	Basic	30/Oct/2012	10h28	UTC-6	74°45.831	073°26.610	CTD-Rosette ↓	808	135	315	25	-11.4	-1.0	1008.7	77	8/10

Appendix 2 - Scientific log of activities conducted during the 2009 ArcticNet Expedition

Leg	Station ID	Station Type	Local Date	Local Time	UTC to local	Latitude (N)	Longitude (W)	Activity	Depth (m)	Heading (°)	Wind Dir	Wind Speed	Air (ºC)	Water (ºC)	Pr Baro	Hum (%)	Ice
4a	136	Basic	30/Oct/2012	11h22	UTC-6	74°45.172	073°24.242	CTD-Rosette ↑	809	145	300	28	-11.2	-1.0	1008.4	75	8/10
4a	136	Basic	30/Oct/2012	11h43	UTC-6	74°44.767	073°22.943	IOPs ↓	813	134	315	28	-10.9	-1.0	1008.3	73	8/10
4a	136	Basic	30/Oct/2012	11h59	UTC-6	74°44.662	073°22.916	IOPs ↑	811	120	308	23	-12.0	-1.0	1008.2	69	8/10
4a	136	Basic	30/Oct/2012	12h12	UTC-6	74°44.029	073°20.108	UV Profile ↓	822	72	311	22	-13.2	-1.0	1008.3	70	8/10
4a	136	Basic	30/Oct/2012	12h28	UTC-6	74°43.692	073°19.380	UV Profile ↑	822	37	393	26	-13.0	-1.0	1007.9	75	8/10
4a	136	Basic	30/Oct/2012	13h17	UTC-6	74°45.528	073°33.758	CTD-Rosette ↓	784	166	304	29	-12.7	-1.0	1008.0	80	9/10
4a	136	Basic	30/Oct/2012	14h18	UTC-6	74°44.715	073°30.678	CTD-Rosette ↑	791	189	301	33	-12.5	-1.0	1007.4	81	9/10
4a	136	Basic	30/Oct/2012	14h49	UTC-6	74°44.277	073°29.132	Hydrobios ↓	790	176	294	26	-12.3	-1.0	1007.1	82	9/10
4a	136	Basic	30/Oct/2012	15h35	UTC-6	74°43.743	073°26.929	Hydrobios ↑	798	177	296	31	-11.8	-0.9	1006.5	82	9/10
4a	136	Basic	30/Oct/2012	15h58	UTC-6	74°43.371	073°26.214	Vertical Net Tow ↓	800	141	293	32	-11.8	-0.9	1006.3	80	9/10
4a	136	Basic	30/Oct/2012	16h50	UTC-6	74°42.866	073°25.541	Vertical Net Tow ↑	800	101	304	26	-11.9	-0.9	1005.3	77	9/10
4a	136	Basic	30/Oct/2012	17h14	UTC-6	74°42.421	073°24.063	CTD-Rosette ↓	804	191	305	33	-11.9	-0.9	1005.2	79	9/10
4a	136	Basic	30/Oct/2012	17h57	UTC-6	74°42.176	073°22.551	CTD-Rosette ↑	808	151	296	32	-12.7	-0.9	1004.7	79	9/10
4a	136	Basic	30/Oct/2012	18h34	UTC-6	74°41.217	073°20.915	Box Core ↓	810	123	301	22	-8.7	-0.9	1004.9	78	9/10
4a	136	Basic	30/Oct/2012	19h06	UTC-6	74°40.907	073°19.400	Box Core ↑	815	145	297	29	-9.1	-0.9	1003.7	77	9/10
4a	141	Full	31/Oct/2012	20h00	UTC-6	71°27.910	070°02.581	CTD ↓	615	165	290	9	-11.2	-0.9	996.9	79	9/10
4a	141	Full	31/Oct/2012	20h27	UTC-6	71°27.636	070°01.550	CTD ↑	586	185	310	17	-10.4	-0.9	996.7	82	9/10
4a	141	Full	31/Oct/2012	20h55	UTC-6	71°28.347	069°56.048	Bottom Mapping ↓	N/A	228	315	18	-11.8	-0.9	996.4	83	9/10
4a	141	Full	01/Nov/2012	08h25	UTC-5	71°24.918	070°19.986	Bottom Mapping ↑	N/A	227	325	25	-11.6	-0.8	993.5	79	8/10
4a	141	Full	01/Nov/2012	09h25	UTC-5	71°24.799	070°15.340	CTD ↓	680	143	350	17	-12.0	-0.8	993.0	79	8/10
4a	141	Full	01/Nov/2012	09h52	UTC-5	71°24.684	070°15.461	CTD ↑	680	164	340	15	-10.7	-0.7	993.2	76	8/10
4a	141	Full	01/Nov/2012	10h30	UTC-5	71°23.858	070°15.591	Surface Skimmer ↓	667	182	10	15	-11.2	-0.7	993.2	74	8/10
4a	141	Full	01/Nov/2012	12h35	UTC-5	71°22.500	070°15.087	ROV ↓ (test)	643	273	345	12	-11.7	-0.7	993.3	72	8/10
4a	141	Full	01/Nov/2012	15h32	UTC-5	71°21.394	070°15.751	ROV ↑ (test)	N/A	N/A	349	10	-12.9	-0.5	993.6	72	9/10
4a	141	Full	01/Nov/2012	15h32	UTC-5	71°21.394	070°15.762	Weather Balloon	N/A	N/A	349	10	-12.9	-0.5	993.6	72	9/10
4a	141	Full	01/Nov/2012	16h11	UTC-5	71°23.678	070°08.807	CTD-Rosette ↓	423	186	327	12	-13.0	-0.5	993.6	71	9/10
4a	141	Full	01/Nov/2012	16h41	UTC-5	71°23.223	070°08.514	CTD-Rosette ↑	408	245	350	8	-12.0	-0.6	993.7	73	9/10
4a	141	Full	01/Nov/2012	18h15	UTC-5	71°23.723	070°09.107	Microlayer Sampling ↓	462	212	323	12	-13.2	-0.7	993.3	76	9/10
4a	141	Full	01/Nov/2012	18h45	UTC-5	71°23.286	070°09.123	Microlayer Sampling ↑	430	221	330	9	-12.0	-0.6	993.3	71	9/10
4a	141	Full	01/Nov/2012	19h12	UTC-5	71°23.038	070°09.139	Box Core ↓	415	113	313	8	-11.8	-0.5	993.2	69	9/10
4a	141	Full	01/Nov/2012	19h26	UTC-5	71°22.881	070°09.256	Box Core ↑	404	98	328	3	-12.7	-0.5	993.0	69	9/10
4a	141	Full	01/Nov/2012	19h40	UTC-5	71°22.758	070°09.253	Box Core ↓	397	80	308	3	-13.1	-0.5	992.9	71	9/10
4a	141	Full	01/Nov/2012	19h55	UTC-5	71°22.629	070°09.306	Box Core ↑	383	88	Calm	Calm	-13.1	-0.5	992.8	71	9/10
4a	141	Full	01/Nov/2012	20h00	UTC-5	71°22.576	070°09.327	Box Core ↓	376	95	280	6	-12.9	-0.4	992.7	69	9/10
4a	141	Full	01/Nov/2012	20h15	UTC-5	71°22.500	070°09.215	Box Core ↑	263	122	245	5	-12.3	-0.4	992.6	70	9/10
4a	141	Full	01/Nov/2012	20h32	UTC-5	71°22.215	070°08.605	Box Core ↓	289	140	355	2	-11.9	-0.4	992.6	69	9/10
4a	141	Full	01/Nov/2012	20h42	UTC-5	71°22.157	070°08.536	Box Core ↑	280	133	270	5	-11.9	-0.4	992.7	69	9/10
4a	141	Full	01/Nov/2012	21h30	UTC-5	71°21.858	070°06.918	Bottom Mapping ↓	275	48	Calm	Calm	-12.7	-0.6	992.4	69	9/10
4a	141	Full	02/Nov/2012	07h25	UTC-5	71°22.826	070°18.575	Bottom Mapping ↑	670	45	335	2	-14.4	-0.8	996.9	65	9/10
4a	141	Full	02/Nov/2012	08h00	UTC-5	71°23.910	070°09.292	IOPs ↓	474	238	130	5	-14.7	-0.7	997.1	71	9/10
4a	141	Full	02/Nov/2012	08h17	UTC-5	71°23.887	070°09.435	IOPs ↑	480	232	150	5	-14.5	-0.7	997.1	71	9/10
4a	141	Full	02/Nov/2012	08h20	UTC-5	71°23.884	070°09.464	Secchi Disk + PNF ↓	484	232	150	6	-14.5	-0.7	997.1	71	9/10
4a	141	Full	02/Nov/2012	08h28	UTC-5	71°23.885	070°09.492	Secchi Disk + PNF ↑	487	223	170	6	-14.3	-0.6	997.2	71	9/10
4a	141	Full	02/Nov/2012	08h45	UTC-5	71°23.948	070°09.274	CTD-Rosette ↓	470	90	230	12	-13.6	-0.6	997.3	67	9/10
4a	141	Full	02/Nov/2012	09h40	UTC-5	71°24.183	070°07.373	CTD-Rosette ↑	376	148	240	14	-14.1	-0.4	997.9	63	9/10

Appendix 2 - Scientific log of activities conducted during the 2009 ArcticNet Expedition

Leg	Station ID	Station Type	Local Date	Local Time	UTC to local	Latitude (N)	Longitude (W)	Activity	Depth (m)	Heading (°)	Wind		Air (ºC)	Water (ºC)	Pr Baro	Hum (%)	Ice
											Dir	Speed					
4a	141	Full	02/Nov/2012	09h48	UTC-5	71°24.279	070°06.823	UV Profile ↓	358	202	245	11	-14.0	-0.3	997.9	63	9/10
4a	141	Full	02/Nov/2012	10h15	UTC-5	71°24.511	070°06.141	UV Profile ↑	338	220	215	14	-14.3	-0.3	998.1	61	9/10
4a	141	Full	02/Nov/2012	11h50	UTC-5	71°22.775	070°04.180	ROV ↓	263	315	310	12	-14.4	-0.5	999.5	70	9/10
4a	141	Full	02/Nov/2012	17h30	UTC-5	71°22.720	070°04.615	ROV ↑	267	N/A	229	6	-13.7	-0.5	1004.0	55	9/10
4a	141	Full	02/Nov/2012	18h17	UTC-5	71°22.433	070°06.294	Vertical Net Tow ↓	265	346	132	6	-13.4	-0.6	1004.2	56	9/10
4a	141	Full	02/Nov/2012	18h35	UTC-5	71°22.404	070°06.615	Vertical Net Tow ↑	268	387	183	8	-12.9	-0.6	1004.3	58	9/10
4a	N/A	Weather	02/Nov/2012	12h50	UTC-5	68°37.350	063°37.120	Weather Balloon	1508	N/A	240	11	-7.4	-0.4	1007.7	N/A	0/10
4a	N/A	N/A	05/Nov/2012	13h45	UTC-5	63°07.853	067°47.810	Surface Skimmer ↓	541	32	290	7	-7.8	0.3	1009.2	52	0/10
4a	N/A	N/A	05/Nov/2012	15h00	UTC-5	63°07.671	067°47.114	Surface Skimmer ↑	469	63	300	6	-8.3	0.3	1009.6	53	0/10
Leg 4b																	
4b	352	Nutrient	07/Nov/2012	09h10	UTC-5	61°15.935	064°45.228	CTD-Rosette ↓	274	313	220	22	-4.4	0.1	1013.8	59	0/10
4b	352	Nutrient	07/Nov/2012	09h50	UTC-5	61°16.072	064°48.205	CTD-Rosette ↑	263	113	205	25	-4.4	0.1	1013.3	65	N/A
4b	354	Nutrient	07/Nov/2012	11h36	UTC-5	61°00.517	064°44.272	CTD-Rosette ↓	496	37	180	22	-6.0	0.1	1012.4	66	N/A
4b	354	Nutrient	07/Nov/2012	12h12	UTC-5	61°00.975	064°43.896	CTD-Rosette ↑	473	N/A	178	26	-3.2	0.1	1012.1	55	0/10
4b	600	Basic	08/Nov/2012	02h05	UTC-5	59°05.342	063°25.895	Hydrobios ↓	204	33	210	8	-4.3	0.7	997.2	62	0/10
4b	600	Basic	08/Nov/2012	02h23	UTC-5	59°05.260	063°25.920	Hydrobios ↑	203	78	250	6	-5.1	0.7	997.2	64	0/10
4b	600	Basic	08/Nov/2012	02h42	UTC-5	59°05.250	063°25.840	IOPs ↓	203	72	210	14	-4.4	0.7	996.9	62	0/10
4b	600	Basic	08/Nov/2012	02h55	UTC-5	59°05.280	063°25.780	IOPs ↑	201	24	230	10	-3.8	0.7	996.6	62	0/10
4b	600	Basic	08/Nov/2012	N/A	UTC-5	59°05.275	063°25.951	CTD-Rosette ↓	203	84	248	5	-4.9	0.7	996.2	62	0/10
4b	600	Basic	08/Nov/2012	04h11	UTC-5	59°05.275	063°26.009	Vertical Net Tow ↓	204	45	197	11	-4.8	0.8	995.4	61	0/10
4b	600	Basic	08/Nov/2012	04h25	UTC-5	59°05.306	063°26.036	Vertical Net Tow ↑	204	32	232	8	-2.8	0.8	995.2	57	0/10
4b	600	Basic	08/Nov/2012	04h45	UTC-5	59°05.182	063°26.052	Horizontal Net Tow ↓	204	40	243	8	-4.6	0.8	994.8	64	0/10
4b	600	Basic	08/Nov/2012	05h06	UTC-5	59°05.549	063°25.522	Horizontal Net Tow ↑	204	7	223	8	-4.7	0.8	994.4	63	0/10
4b	600	Basic	08/Nov/2012	05h43	UTC-5	59°05.194	063°25.762	CTD-Rosette ↓	204	98	240	10	-3.8	0.7	993.6	61	0/10
4b	600	Basic	08/Nov/2012	06h08	UTC-5	59°05.255	063°25.767	CTD-Rosette ↑	203	92	253	7	-3.6	0.8	993.7	63	0/10
4b	600	Basic	08/Nov/2012	06h25	UTC-5	59°05.324	063°25.885	Box Core ↓	204	57	238	8	-3.3	0.8	993.5	64	0/10
4b	600	Basic	08/Nov/2012	06h34	UTC-5	59°05.329	063°25.823	Box Core ↑	204	33	232	8	-4.1	0.8	993.4	64	0/10
4b	600	Basic	08/Nov/2012	06h52	UTC-5	59°05.125	063°25.925	Agassiz Trawl ↓	201	44	239	6	-4.2	0.8	993.4	64	0/10
4b	600	Basic	08/Nov/2012	07h20	UTC-5	59°05.783	063°25.809	Agassiz Trawl ↑	197	290	239	8	-4.0	0.8	993.2	66	0/10
4b	600	Basic	08/Nov/2012	07h23	UTC-5	59°05.799	063°25.892	Agassiz Trawl ↓	196	278	231	8	-4.0	0.8	993.2	66	0/10
4b	600	Basic	08/Nov/2012	08h12	UTC-5	59°05.406	063°26.166	Agassiz Trawl ↑	205	263	255	4	-3.3	0.7	992.2	71	0/10
4b	601	Nutrient	08/Nov/2012	09h03	UTC-5	59°02.976	063°36.388	CTD-Rosette ↓	165	170	285	5	-3.3	0.7	992.2	71	0/10
4b	601	Nutrient	08/Nov/2012	09h24	UTC-5	59°02.945	063°36.142	CTD-Rosette ↑ (canceled)	167	176	320	3	-2.5	0.7	991.9	71	0/10
4b	601	Nutrient	08/Nov/2012	09h35	UTC-5	59°03.014	063°36.520	CTD-Rosette ↓	167	235	245	6	-2.6	0.7	991.8	72	0/10
4b	601	Nutrient	08/Nov/2012	09h52	UTC-5	59°02.984	063°36.461	CTD-Rosette ↑	166	184	280	6	-3.1	0.7	991.5	74	0/10
4b	606 (off McCormick)	Piston Core	08/Nov/2012	14h48	UTC-5	59°02.575	063°42.284	Piston Core ↓	158	227	238	2	-1.2	0.8	989.0	70	0/10
4b	606 (off McCormick)	Piston Core	08/Nov/2012	15h10	UTC-5	59°02.601	063°42.226	Piston Core ↑	159	145	245	3	-1.1	0.9	989.1	72	0/10
4b	602	Basic	08/Nov/2012	16h50	UTC-5	59°03.205	063°52.164	Hydrobios ↓	151	70	285	7	-1.5	0.7	989.7	91	0/10
4b	602	Basic	08/Nov/2012	17h02	UTC-5	59°03.175	063°52.144	Hydrobios ↑	151	129	254	5	-2.1	0.7	989.9	97	0/10
4b	602	Basic	08/Nov/2012	18h10	UTC-5	59°03.131	063°52.226	Vertical Net Tow ↓	150	144	110	2	-1.7	0.8	990.1	97	0/10
4b	602	Basic	08/Nov/2012	18h19	UTC-5	59°03.146	063°52.248	Vertical Net Tow ↑	150	162	Calm	Calm	-1.2	0.8	990.2	98	0/10
4b	602	Basic	08/Nov/2012	18h37	UTC-5	59°03.124	063°52.207	Horizontal Net Tow ↓	150	83	Calm	Calm	-1.6	0.9	990.3	98	0/10

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Leg	Station ID	Station Type	Local Date	Local Time	UTC to local	Latitude (N)	Longitude (W)	Activity	Depth (m)	Heading (°)	Wind		Air (ºC)	Water (ºC)	Pr Baro	Hum (%)	Ice
											Dir	Speed					
4b	602	Basic	08/Nov/2012	18h53	UTC-5	59°03.452	063°51.569	Horizontal Net Tow ↑	155	340	Calm	Calm	-1.7	0.9	990.4	98	0/10
4b	602	Basic	08/Nov/2012	19h08	UTC-5	59°03.139	063°52.300	CTD-Rosette ↓	150	127	Calm	Calm	-1.6	0.8	990.6	98	0/10
4b	602	Basic	08/Nov/2012	19h26	UTC-5	59°03.056	063°52.276	CTD-Rosette ↑	150	127	Calm	Calm	-1.7	0.7	990.7	98	0/10
4b	602 (off McCormick)	Piston Core	08/Nov/2012	20h38	UTC-5	59°03.159	063°52.206	Piston Core ↓	151	195	90	5	-2.2	0.8	991.0	98	0/10
4b	602 (off McCormick)	Piston Core	08/Nov/2012	21h10	UTC-5	59°03.154	063°52.621	Piston Core ↑	151	162	90	5	-2.2	0.8	991.1	98	0/10
4b	602	Basic	08/Nov/2012	21h37	UTC-5	59°03.148	063°52.109	Box Core ↓	151	93	90	5	-2.1	0.8	991.2	98	0/10
4b	602	Basic	08/Nov/2012	21h43	UTC-5	59°03.158	063°52.148	Box Core ↑	151	90	90	3	-2.1	0.8	991.2	98	0/10
4b	604	Nutrient	08/Nov/2012	22h45	UTC-5	58°59.587	063°53.697	CTD-Rosette ↓	62	308	170	4	-1.9	0.8	991.4	98	0/10
4b	604	Nutrient	08/Nov/2012	23h30	UTC-5	58°59.672	063°53.540	CTD-Rosette ↑	62	278	170	4	-2.4	0.9	991.8	98	0/10
4b	N/A	MVP	08/Nov/2012	N/A	UTC-5	N/A	N/A	MVP ↓↑	63	348	N/A	N/A	N/A	N/A	N/A	N/A	N/A
4b	612	CTD	09/Nov/2012	06h36	UTC-5	58°28.162	062°59.090	CTD ↓	44	303	266	2	-1.2	0.8	997.3	98	0/10
4b	612	CTD	09/Nov/2012	06h45	UTC-5	58°28.150	062°59.129	CTD ↑	44	294	274	1	-1.2	0.8	997.6	98	0/10
4b	613	Nutrient	09/Nov/2012	08h15	UTC-5	58°28.999	063°13.172	CTD ↓	240	345	315	8	-0.7	0.7	998.8	94	0/10
4b	613	Nutrient	09/Nov/2012	08h47	UTC-5	58°29.001	063°12.982	CTD ↑	240	355	350	13	0.3	0.8	999.0	81	0/10
4b	613	Nutrient	09/Nov/2012	12h37	UTC-5	58°28.974	063°13.319	Surface Skimmer ↓	240	336	236	7	0.4	0.9	1002.8	77	0/10
4b	613	Nutrient	09/Nov/2012	13h07	UTC-5	58°29.065	063°13.129	CTD-Rosette ↓	241	175	311	22	-0.7	0.9	1003.3	75	0/10
4b	613	Nutrient	09/Nov/2012	13h20	UTC-5	58°29.004	063°12.824	CTD-Rosette ↑	241	79	324	21	1.7	1.0	1003.4	64	0/10
4b	613	Nutrient	09/Nov/2012	14h15	UTC-5	58°28.971	063°11.514	Surface Skimmer ↑	243	28	285	10	1.2	1.0	1004.6	65	0/10
4b	618	Piston Core	09/Nov/2012	15h20	UTC-5	58°28.813	063°13.417	Piston Core ↓	241	172	306	10	1.2	1.0	1005.9	65	0/10
4b	618	Piston Core	09/Nov/2012	15h37	UTC-5	58°28.834	063°13.360	Piston Core ↑	239	159	315	12	2.0	1.0	1006.4	62	0/10
4b	614	CTD	09/Nov/2012	16h42	UTC-5	58°24.122	063°23.391	CTD ↓	100	140	277	5	1.1	0.9	1007.3	63	0/10
4b	614	CTD	09/Nov/2012	16h50	UTC-5	58°24.110	063°23.355	CTD ↑	100	141	263	10	1.5	0.8	1007.4	59	0/10
4b	615	Basic	09/Nov/2012	18h11	UTC-5	58°19.381	063°32.505	CTD-Rosette ↓	138	224	320	8	0.4	0.8	1008.4	58	0/10
4b	615	Basic	09/Nov/2012	18h31	UTC-5	58°19.372	063°32.461	CTD-Rosette ↑	138	169	320	9	0.3	0.8	1008.6	58	0/10
4b	615	Basic	09/Nov/2012	18h45	UTC-5	58°19.405	063°32.436	Vertical Net Tow ↓	138	110	270	4	0.1	0.9	1008.8	59	0/10
4b	615	Basic	09/Nov/2012	18h55	UTC-5	58°19.432	063°32.491	Vertical Net Tow ↑	138	101	N/A	0	0.3	0.9	1008.8	58	0/10
4b	615	Basic	09/Nov/2012	19h08	UTC-5	58°19.402	063°32.354	Horizontal Net Tow ↓	138	60	170	6	0.4	0.9	1009.0	57	0/10
4b	615	Basic	09/Nov/2012	19h22	UTC-5	58°19.837	063°32.232	Horizontal Net Tow ↑	138	296	310	3	-0.1	0.9	1009.2	62	0/10
4b	615	Basic	09/Nov/2012	19h45	UTC-5	58°19.335	063°32.423	Hydrobios ↓	138	145	310	4	-1.5	0.9	1009.4	64	0/10
4b	615	Basic	09/Nov/2012	19h55	UTC-5	58°19.376	063°32.272	Hydrobios ↑	136	138	300	12	0.2	0.9	1009.6	60	0/10
4b	615	Basic	09/Nov/2012	20h17	UTC-5	58°19.406	063°32.423	Box Core ↓	138	305	290	4	-1.4	0.9	1009.9	66	0/10
4b	615	Basic	09/Nov/2012	20h24	UTC-5	58°19.430	063°32.413	Box Core ↑	138	315	290	8	-1.4	0.9	1009.9	66	0/10
4b	N/A	MVP	09/Nov/2012	21h03	UTC-5	58°19.661	063°32.216	MVP ↓	137	339	Calm	Calm	-2.0	0.9	1010.3	70	0/10
4b	N/A	MVP	09/Nov/2012	22h00	UTC-5	58°22.471	63°25.625	MVP ↑ (winch problem)	170	30	250	6	-2.2	0.8	1010.6	65	0/10
4b	N/A	MVP	09/Nov/2012	23h47	UTC-5	58°26.604	063°20.042	MVP ↓ (canceled)	183	36	Calm	Calm	-2.2	0.8	1010.7	57	0/10
4b	610	Nutrient	10/Nov/2012	02h22	UTC-5	58°31.260	062°50.402	CTD-Rosette ↓	134	100	262	14	-2.1	0.9	1010.3	58	0/10
4b	610	Nutrient	10/Nov/2012	02h43	UTC-5	58°28.960	062°47.750	CTD-Rosette ↑	120	142	276	12	-1.6	0.9	1010.5	59	0/10
4b	617	Basic	10/Nov/2012	03h28	UTC-5	58°30.000	062°41.375	Vertical Net Tow ↓	136	72	251	12	-2.8	0.9	1010.6	63	0/10
4b	617	Basic	10/Nov/2012	03h39	UTC-5	58°29.936	062°41.244	Vertical Net Tow ↑	135	106	240	16	-2.9	0.9	1010.6	61	0/10
4b	617	Basic	10/Nov/2012	03h55	UTC-5	58°30.063	062°41.223	Horizontal Net Tow ↓	142	11	252	12	-3.1	0.9	1010.6	61	0/10
4b	617	Basic	10/Nov/2012	04h12	UTC-5	58°20.069	062°41.780	Horizontal Net Tow ↑	155	170	267	7	-3.5	0.9	1010.7	61	0/10
4b	617	Basic	10/Nov/2012	04h48	UTC-5	58°30.127	062°41.234	Hydrobios ↓	138	74	216	15	-2.9	0.9	1010.8	61	0/10
4b	617	Basic	10/Nov/2012	04h59	UTC-5	58°30.072	062°41.214	Hydrobios ↑	138	36	226	9	-3.6	0.9	1010.7	62	0/10

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Leg	Station ID	Station Type	Local Date	Local Time	UTC to local	Latitude (N)	Longitude (W)	Activity	Depth (m)	Heading (°)	Wind		Air (ºC)	Water (ºC)	Pr Baro	Hum (%)	Ice
											Dir	Speed					
4b	617	Basic	10/Nov/2012	05h12	UTC-5	58°30.027	062°41.377	Agassiz Trawl ↓	136	33	225	11	-3.2	0.9	1010.7	58	0/10
4b	617	Basic	10/Nov/2012	05h40	UTC-5	58°30.596	062°40.697	Agassiz Trawl ↑	76	353	236	12	-4.4	0.9	1010.6	60	0/10
4b	617	Basic	10/Nov/2012	06h08	UTC-5	58°29.931	062°41.286	Box Core ↓	134	46	220	9	-4.3	0.9	1010.6	58	0/10
4b	617	Basic	10/Nov/2012	06h14	UTC-5	58°29.924	062°41.273	Box Core ↑	134	69	230	8	-4.4	0.9	1010.7	58	0/10
4b	617	Basic	10/Nov/2012	06h51	UTC-5	58°29.970	062°41.307	CTD-Rosette ↓	135	57	230	11	-4.6	0.9	1010.6	60	0/10
4b	617	Basic	10/Nov/2012	07h35	UTC-5	58°30.080	062°41.061	CTD-Rosette ↑	137	61	225	9	-1.9	0.9	1010.5	58	0/10
4b	617	Basic	10/Nov/2012	07h05	UTC-5	58°29.980	062°41.266	Secchi Disk + PNF ↓	134	53	226	10	-3.1	0.9	1010.6	60	0/10
4b	617	Basic	10/Nov/2012	07h12	UTC-5	58°29.999	062°41.215	Secchi Disk + PNF ↑	135	51	215	8	-3.2	0.9	1010.5	60	0/10
4b	617	Basic	10/Nov/2012	07h48	UTC-5	58°30.113	062°41.029	IOPs ↓	138	61	222	8	-3.2	0.9	1010.4	61	0/10
4b	617	Basic	10/Nov/2012	08h03	UTC-5	58°30.052	062°40.966	IOPs ↑	138	69	220	10	-4.5	0.9	1010.3	69	0/10
4b	633	Basic	10/Nov/2012	22h43	UTC-5	57°36.352	061°53.800	Hydrobios ↓	181	138	325	17	-1.2	1.2	1013.7	76	0/10
4b	633	Basic	10/Nov/2012	22h58	UTC-5	57°36.350	061°53.792	Hydrobios ↑	180	146	320	12	-2.7	1.3	1013.9	90	0/10
4b	633	Basic	10/Nov/2012	23h15	UTC-5	57°36.362	061°53.957	IOPs ↓	181	135	290	12	-2.6	1.3	1013.9	92	0/10
4b	633	Basic	10/Nov/2012	23h30	UTC-5	57°36.325	061°53.894	IOPs ↑	180	160	270	12	-1.4	1.3	1014.0	88	0/10
4b	633	Basic	10/Nov/2012	23h57	UTC-5	57°36.207	061°53.473	CTD-Rosette ↓	169	81	307	17	-2.6	1.3	1014.1	91	0/10
4b	633	Basic	11/Nov/2012	00h18	UTC-5	57°36.050	061°53.282	CTD-Rosette ↑	153	152	284	19	-4.3	1.3	1014.1	81	0/10
4b	633	Basic	11/Nov/2012	00h31	UTC-5	57°36.380	061°53.625	IOPs ↓	180	123	300	18	-3.8	1.4	1014.1	81	0/10
4b	633	Basic	11/Nov/2012	00h46	UTC-5	57°36.372	061°53.600	IOPs ↑	180	120	300	16	-2.2	1.4	1014.4	75	0/10
4b	633	Basic	11/Nov/2012	00h51	UTC-5	57°36.360	061°53.525	Vertical Net Tow ↓	178	126	300	13	-2.6	1.4	1014.4	76	0/10
4b	633	Basic	11/Nov/2012	01h10	UTC-5	57°36.301	061°53.525	Vertical Net Tow ↑	174	150	300	14	-2.7	1.4	1014.7	73	0/10
4b	633	Basic	11/Nov/2012	01h20	UTC-5	57°36.340	061°53.593	Horizontal Net Tow ↓	179	57	300	9	-2.0	1.4	1014.9	70	0/10
4b	633	Basic	11/Nov/2012	01h40	UTC-5	57°36.348	061°53.440	Horizontal Net Tow ↑	180	25	283	10	-3.6	1.4	1015.1	70	0/10
4b	633	Basic	11/Nov/2012	02h03	UTC-5	57°36.284	061°53.485	RMT ↓	173	84	292	16	-3.9	1.4	1015.1	67	0/10
4b	633	Basic	11/Nov/2012	02h20	UTC-5	57°36.127	061°53.269	RMT ↑	175	187	300	20	-3.5	1.4	1014.9	66	0/10
4b	633	Basic	11/Nov/2012	02h50	UTC-5	57°36.401	061°53.771	Box Core ↓	182	114	286	14	-4.0	1.4	1015.0	64	0/10
4b	633	Basic	11/Nov/2012	03h00	UTC-5	57°36.402	061°53.720	Box Core ↑	183	136	275	15	-3.0	1.3	1015.3	62	0/10
4b	633	Basic	11/Nov/2012	03h11	UTC-5	57°36.459	061°53.597	Agassiz Trawl ↓	183	26	263	13	-2.5	1.4	1015.4	64	0/10
4b	633	Basic	11/Nov/2012	03h46	UTC-5	57°36.501	061°53.545	Agassiz Trawl ↑	182	348	252	8	-3.8	1.3	1015.8	67	0/10
4b	632	Nutrient	11/Nov/2012	05h13	UTC-5	57°39.999	062°03.391	CTD-Rosette ↓	83	153	307	7	-5.2	1.1	1016.1	69	0/10
4b	632	Nutrient	11/Nov/2012	05h25	UTC-5	57°33.986	062°03.339	CTD-Rosette ↑	83	192	320	3	-3.9	1.1	1016.3	67	0/10
4b	632	Nutrient	11/Nov/2012	06h42	UTC-5	57°34.000	062°03.301	Box Core ↓	83	108	294	5	-4.3	1.1	1016.3	64	0/10
4b	632	Nutrient	11/Nov/2012	06h48	UTC-5	57°33.991	062°03.327	Box Core ↑	83	108	322	6	-4.3	1.1	1016.3	64	0/10
4b	632	Nutrient	11/Nov/2012	11h15	UTC-5	57°33.973	062°03.299	Piston Core ↓	90	124	280	14	-3.1	1.1	1016.3	59	0/10
4b	632	Nutrient	11/Nov/2012	11h18	UTC-5	57°33.960	062°03.279	Piston Core (bottom)	90	129	280	13	-3.1	1.1	1016.3	59	0/10
4b	632	Nutrient	11/Nov/2012	11h30	UTC-5	57°34.049	062°03.229	Piston Core ↑	91	135	270	14	-1.1	1.2	1016.4	58	0/10
4b	631	Nutrient	11/Nov/2012	14h20	UTC-5	57°29.722	062°11.191	Surface Skimmer ↓	91	352	244	10	-3.2	1.2	1017.5	58	0/10
4b	631	Nutrient	11/Nov/2012	14h40	UTC-5	57°29.575	062°11.621	CTD-Rosette ↓	93	68	259	9	-4.2	1.2	1017.7	60	0/10
4b	631	Nutrient	11/Nov/2012	14h53	UTC-5	57°29.584	062°11.674	CTD-Rosette ↑	91	25	260	6	-4.1	1.1	1017.8	60	0/10
4b	631	Nutrient	11/Nov/2012	15h12	UTC-5	57°29.640	062°11.465	IOPs ↓	92	353	240	7	-5.3	1.1	1018.0	61	0/10
4b	631	Nutrient	11/Nov/2012	15h21	UTC-5	57°29.300	062°11.500	IOPs ↑	92	353	270	7	-5.3	1.1	1018.0	61	0/10
4b	631	Nutrient	11/Nov/2012	15h45	UTC-5	57°29.601	062°11.684	Box Core ↓	92	229	270	5	-5.3	1.1	1017.9	61	0/10
4b	631	Nutrient	11/Nov/2012	15h48	UTC-5	57°29.596	062°11.673	Box Core ↑	92	214	300	5	-5.5	1.1	1018.1	62	0/10
4b	631	Nutrient	11/Nov/2012	16h10	UTC-5	57°29.493	062°11.554	Surface Skimmer ↑	89	200	305	6	-5.2	1.1	1018.3	65	0/10
4b	630	Basic	11/Nov/2012	18h07	UTC-5	57°28.337	062°26.501	CTD-Rosette ↓	51	87	270	8	-8.1	1.1	1019.0	67	Frasil
4b	630	Basic	11/Nov/2012	18h20	UTC-5	57°28.318	062°26.500	CTD-Rosette ↑	51	89	270	7	-8.3	1.1	1019.1	67	Frasil

Appendix 2 - Scientific log of activities conducted during the 2009 ArcticNet Expedition

Leg	Station ID	Station Type	Local Date	Local Time	UTC to local	Latitude (N)	Longitude (W)	Activity	Depth (m)	Heading (°)	Wind		Air (ºC)	Water (ºC)	Pr Baro	Hum (%)	Ice
											Dir	Speed					
4b	630	Basic	11/Nov/2012	18h32	UTC-5	57°28.278	062°26.573	Vertical Net Tow ↓	50	102	270	6	-8.9	1.3	1019.3	74	Frasil
4b	630	Basic	11/Nov/2012	18h37	UTC-5	57°28°278	062°26.545	Vertical Net Tow ↑	50	67	270	6	-8.9	1.3	1019.3	74	Frasil
4b	630	Basic	11/Nov/2012	18h55	UTC-5	57°28.243	062°26.568	Horizontal Net Tow ↓	50	145	300	4	-9.3	1.4	1019.5	71	Frasil
4b	630	Basic	11/Nov/2012	19h00	UTC-5	57°28.161	062°26.375	Horizontal Net Tow ↑	66	91	300	8	-8.8	1.5	1019.5	71	Frasil
4b	630	Basic	11/Nov/2012	19h15	UTC-5	57°28.287	062°26.792	RMT ↓	48	115	290	6	-8.9	1.5	1019.6	72	Frasil
4b	630	Basic	11/Nov/2012	19h25	UTC-5	57°28.259	062°26.509	RMT ↑	50	70	270	6	-9.3	1.5	1019.6	73	Frasil
4b	630	Basic	11/Nov/2012	19h30	UTC-5	57°28.242	062°26.490	RMT ↓	50	108	300	5	-9.9	1.6	1019.5	75	Frasil
4b	630	Basic	11/Nov/2012	19h35	UTC-5	57°28.199	062°26.276	RMT ↑	52	74	300	5	-9.9	1.6	1019.5	75	Frasil
4b	630	Basic	11/Nov/2012	N/A	UTC-5	N/A	N/A	Hydrobios ↓	50	N/A	270	9	N/A	N/A	N/A	N/A	N/A
4b	630	Basic	11/Nov/2012	20h10	UTC-5	57°28.305	062°26.318	Hydrobios ↓	295	173	295	6	-10.0	1.6	1019.3	82	0/10
4b	630	Basic	11/Nov/2012	20h18	UTC-5	57°28.242	062°26.230	Hydrobios ↑	285	101	285	8	-10.0	1.6	1019.3	82	0/10
4b	630	Basic	11/Nov/2012	20h39	UTC-5	57°28.313	062°26.559	Box Core ↓	310	107	310	8	-11.3	1.7	1019.2	84	0/10
4b	630	Basic	11/Nov/2012	20h45	UTC-5	57°28.287	062°26.555	Box Core ↑	300	72	300	6	-11.3	1.7	1019.2	84	0/10
4b	630	Basic	11/Nov/2012	21h12	UTC-5	57°28.142	062°26.348	CTD ↓	280	50	280	7	-11.9	1.8	1019.1	90	0/10
4b	630	Basic	11/Nov/2012	21h16	UTC-5	57°28.126	062°26.255	CTD ↑	280	91	280	7	-11.9	1.8	1019.1	90	0/10
4b	634	CTD	12/Nov/2012	01h51	UTC-5	57°34.134	061°56.419	CTD-Rosette ↓	193	327	193	6	-9.8	1.0	1017.2	83	0/10
4b	634	CTD	12/Nov/2012	02h07	UTC-5	57°34.135	061°56.421	CTD-Rosette ↑	182	81	182	7	-9.5	1.0	1017.1	82	0/10
4b	634	CTD	12/Nov/2012	02h28	UTC-5	57°34.167	061°56.449	Box Core ↓	175	0	175	5	-8.5	1.1	1017.1	80	0/10
4b	634	CTD	12/Nov/2012	02h34	UTC-5	57°34.150	061°56.455	Box Core ↑	127	15	127	3	-8.9	1.1	1017.1	79	0/10
4b	634	CTD	12/Nov/2012	04h30	UTC-5	57°34.188	061°56.432	Piston Core ↓	170	14	170	3	-9.3	1.3	1016.7	84	0/10
4b	634	CTD	12/Nov/2012	04h33	UTC-5	57°34.183	061°56.440	Piston Core (bottom)	140	13	140	3	-9.7	1.3	1016.8	85	0/10
4b	634	CTD	12/Nov/2012	04h40	UTC-5	57°34.177	061°56.471	Piston Core ↑	140	16	140	3	-9.7	1.3	1016.8	85	0/10
4b	620	Basic	12/Nov/2012	15h43	UTC-5	56°23.830	061°12.980	CTD-Rosette ↓	163	95	163	6	-3.2	1.7	1012.0	89	0/10
4b	620	Basic	12/Nov/2012	16h00	UTC-5	56°23.830	061°13.010	CTD-Rosette ↑	156	20	156	3	-2.8	1.7	1011.9	90	0/10
4b	620	Basic	12/Nov/2012	16h15	UTC-5	56°23.854	061°12.964	IOPs ↓	233	350	233	2	-2.7	1.8	1011.9	89	0/10
4b	620	Basic	12/Nov/2012	16h23	UTC-5	56°23.849	061°12.902	IOPs ↑	195	320	195	1	-3.1	1.8	1012.0	90	0/10
4b	620	Basic	12/Nov/2012	16h43	UTC-5	56°23.800	061°13.120	Vertical Net Tow ↓	93	165	204	1	-3.1	1.8	1012.1	92	0/10
4b	620	Basic	12/Nov/2012	16h52	UTC-5	56°23.773	061°13.093	Vertical Net Tow ↑	95	226	140	5	-3.1	1.8	1012.1	93	0/10
4b	620	Basic	12/Nov/2012	17h08	UTC-5	56°23.822	061°13.040	Horizontal Net Tow ↓	94	280	130	6	-3.2	1.8	1012.0	93	0/10
4b	620	Basic	12/Nov/2012	17h20	UTC-5	56°23.639	061°13.572	Horizontal Net Tow ↑	92	190	150	7	-3.2	1.9	1012.0	93	0/10
4b	620	Basic	12/Nov/2012	17h38	UTC-5	56°23.601	061°13.751	RMT ↓	90	135	140	6	-3.0	1.9	1012.1	94	0/10
4b	620	Basic	12/Nov/2012	17h51	UTC-5	56°23.620	061°13.230	RMT ↑	90	340	140	7	-2.9	1.9	1012.0	93	0/10
4b	620	Basic	12/Nov/2012	18h24	UTC-5	56°23.825	061°12.960	Hydrobios ↓	94	339	130	5	-2.4	1.9	1012.2	91	0/10
4b	620	Basic	12/Nov/2012	18h32	UTC-5	56°23.840	061°12.941	Hydrobios ↑	94	293	140	6	-2.3	1.9	1012.3	91	0/10
4b	620	Basic	12/Nov/2012	18h47	UTC-5	56°23.816	061°12.927	Agassiz Trawl ↓	94	309	Calm	Calm	-2.9	1.9	1012.3	93	0/10
4b	620	Basic	12/Nov/2012	19h12	UTC-5	56°23.586	061°13.711	Agassiz Trawl ↑	90	147	90	5	-2.9	1.9	1012.5	94	0/10
4b	620	Basic	12/Nov/2012	19h50	UTC-5	56°23.795	061°12.992	Box Core ↓	94	338	120	3	-1.9	2.0	1012.7	93	0/10
4b	620	Basic	12/Nov/2012	19h53	UTC-5	56°23.795	061°13.001	Box Core ↑	94	347	120	2	-1.9	2.0	1012.7	93	0/10
4b	620	Basic	12/Nov/2012	20h02	UTC-5	56°23.802	061°13.041	Box Core ↓	93	10	Calm	Calm	-2.0	2.0	1012.8	94	0/10
4b	620	Basic	12/Nov/2012	20h07	UTC-5	56°23.805	061°13.051	Box Core ↑	93	13	Calm	Calm	-2.0	2.0	1012.8	94	0/10
4b	621	CTD	12/Nov/2012	22h17	UTC-5	56°24.901	061°31.073	CTD ↓	113	226	300	6	-2.5	2.0	1013.6	92	0/10
4b	621	CTD	12/Nov/2012	22h24	UTC-5	56°24.876	061°31.018	CTD ↑	110	176	300	3	-2.4	2.0	1013.9	92	0/10
4b	622	Nutrient	12/Nov/2012	23h10	UTC-5	56°24.973	061°43.938	CTD-Rosette ↓	85	255	315	3	-3.1	2.0	1014.7	90	0/10
4b	622	Nutrient	12/Nov/2012	23h27	UTC-5	56°24.880	061°43.943	CTD-Rosette ↑	83	210	300	2	-3.0	2.0	1014.9	89	0/10
4b	623	CTD	13/Nov/2012	00h25	UTC-5	56°26.839	061°56.442	CTD-Rosette ↓	118	215	245	9	-3.0	2.0	1015.2	86	0/10

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Leg	Station ID	Station Type	Local Date	Local Time	UTC to local	Latitude (N)	Longitude (W)	Activity	Depth (m)	Heading (°)	Wind		Air (ºC)	Water (ºC)	Pr Baro	Hum (%)	Ice
											Dir	Speed					
4b	623	CTD	13/Nov/2012	00h44	UTC-5	56°26.872	061°56.325	CTD-Rosette ↑	120	42	251	11	-2.2	2.1	1016.1	83	0/10
4b	624	Basic	13/Nov/2012	01h30	UTC-5	56°25.209	062°04.330	CTD-Rosette ↓	71	150	213	4	-3.7	2.1	1016.9	88	0/10
4b	624	Basic	13/Nov/2012	01h44	UTC-5	56°25.210	062°04.320	CTD-Rosette ↑	67	36	213	5	-3.8	2.0	1017.3	89	0/10
4b	624	Basic	13/Nov/2012	01h57	UTC-5	56°25.230	062°04.279	Vertical Net Tow ↓	68	36	211	2	-3.2	2.1	1017.5	87	0/10
4b	624	Basic	13/Nov/2012	01h59	UTC-5	56°25.236	062°04.253	Vertical Net Tow ↑	68	47	214	4	-3.9	2.1	1017.6	87	0/10
4b	624	Basic	13/Nov/2012	02h10	UTC-5	56°25.233	062°04.250	Horizontal Net Tow ↓	76	74	221	5	-3.9	2.1	1017.6	87	0/10
4b	624	Basic	13/Nov/2012	02h17	UTC-5	56°25.514	062°03.869	Horizontal Net Tow ↑	84	304	216	5	-3.0	2.2	1017.7	85	0/10
4b	624	Basic	13/Nov/2012	02h34	UTC-5	56°25.243	062°04.066	RMT ↓	68	78	214	3	-3.6	2.2	1018.0	87	0/10
4b	624	Basic	13/Nov/2012	02h41	UTC-5	56°25.407	062°04.066	RMT ↑	77	274	215	4	-3.5	2.2	1018.2	87	0/10
4b	624	Basic	13/Nov/2012	03h01	UTC-5	56°25.181	062°04.361	Hydrobios ↓	63	96	214	5	-3.7	2.2	1018.3	88	0/10
4b	624	Basic	13/Nov/2012	03h08	UTC-5	56°25.202	062°04.352	Hydrobios ↑	66	115	230	5	-3.4	2.2	1018.5	87	0/10
4b	624	Basic	13/Nov/2012	04h53	UTC-5	56°26.177	061°59.309	Box Core ↓	115	86	230	3	-2.5	2.1	1019.6	84	0/10
4b	624	Basic	13/Nov/2012	05h00	UTC-5	56°26.182	061°59.317	Box Core ↑	115	N/A	290	4	-2.3	2.1	1019.5	83	0/10
4b	624	Basic	13/Nov/2012	06h25	UTC-5	56°26.195	061°59.292	Piston Core ↓	115	140	N/A	0	-1.7	2.2	1020.7	84	0/10
4b	624	Basic	13/Nov/2012	06h28	UTC-5	56°26.172	061°59.291	Piston Core (bottom)	115	142	N/A	0	-1.7	2.2	1020.7	84	0/10
4b	624	Basic	13/Nov/2012	06h40	UTC-5	56°26.159	061°59.229	Piston Core ↑	115	142	N/A	0	-1.6	2.3	1020.9	82	0/10
4b	624	Basic	13/Nov/2012	07h26	UTC-5	56°26.149	061°59.075	Surface Skimmer ↓	115	195	N/A	0	-1.5	2.4	1021.1	83	0/10
4b	624	Basic	13/Nov/2012	08h02	UTC-5	56°26.153	061°59.118	Surface Skimmer ↑	115	268	N/A	2	-1.3	2.5	1021.5	82	0/10
4b	624	Basic	14/Nov/2012	12h02	UTC-5	54°07.070	055°34.870	24 bottles	N/A	269	200	17	3.3	1.7	1013.1	75	N/A
BaySys																	
BaySys	AN03 (702)	Mooring	27/Jul/2009	13h54		55°24.488	077°55.764	Mooring AN03-07 Released	138								
BaySys	AN03 (702)	Mooring	27/Jul/2009	14h36		55°24.558	077°55.308	Mooring AN03-07 Recovered	121								
BaySys	702	Full	27/Jul/2009	16h18		55°24 481	077°55.678	Horizontal Net Tow ↓	127								
BaySys	702	Full	27/Jul/2009	16h27		55°24.321	077°56.080	Horizontal Net Tow ↑	129								
BaySys	702	Full	27/Jul/2009	16h34		55°24.132	077°56.200	Horizontal Net Tow (end)	123								
BaySys	P8	Coring	27/Jul/2009	18h31		55°15.769	077°53.621	Gravity Core ↓	80.6								
BaySys	P8	Coring	27/Jul/2009	18h33		55°15.781	077°53.632	Gravity Core (bottom)	82.4								
BaySys	P8	Coring	27/Jul/2009	18h36		55°15.792	077°53.641	Gravity Core ↑	84								
BaySys	P9	Coring	28/Jul/2009	06h42		55°17.202	077°49.751	Gravity Core ↓	64.8								
BaySys	P9	Coring	28/Jul/2009	06h45		55°17.213	077°49.768	Gravity Core (bottom)	64.8								
BaySys	P9	Coring	28/Jul/2009	06h47		55°17.219	077°49.790	Gravity Core ↑	64.8								
BaySys	P9	Coring	28/Jul/2009	07h00		55°17.197	077°49.807	Gravity Core ↓	62.6								
BaySys	P9	Coring	28/Jul/2009	07h03		55°17.208	077°49.822	Gravity Core (bottom)	62.7								
BaySys	P9	Coring	28/Jul/2009	07h08		55°17.225	077°49.864	Gravity Core ↑	62.6								
BaySys	P6	Coring	28/Jul/2009	07h30		55°19.349	077°47.720	Gravity Core ↓	66.5								
BaySys	P6	Coring	28/Jul/2009	07h31		55°19.352	077°47.718	Gravity Core (bottom)	67								
BaySys	P6	Coring	28/Jul/2009	07h34		55°19.360	077°47.726	Gravity Core ↑	67.9								
BaySys	P3	Coring	28/Jul/2009	08h37		55°19.756	077°48.843	Gravity Core ↓	64.8								
BaySys	P3	Coring	28/Jul/2009	08h38		55°19.756	077°48.836	Gravity Core (bottom)	64.8								
BaySys	P3	Coring	28/Jul/2009	08h44		55°19.758	077°48.824	Gravity Core ↑	64.8								
BaySys	P2	Coring	28/Jul/2009	09h07		55°18.893	077°51.353	Gravity Core (bottom)	64.8								
BaySys	P2	Coring	28/Jul/2009	09h10		55°18.596	077°51.363	Gravity Core ↑	64.8								
BaySys	P4	Coring	28/Jul/2009	09h36		55°17.592	077°52.497	Gravity Core (bottom)	77								
BaySys	P4	Coring	28/Jul/2009	09h39		55°17.600	077°52.517	Gravity Core ↑	77								
BaySys	P10	Coring	28/Jul/2009	09h59		55°16.057	077°51.814	Gravity Core (bottom)	61.6								

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Leg	Station ID	Station Type	Local Date	Local Time	UTC to local	Latitude (N)	Longitude (W)	Activity	Depth (m)	Heading (°)	Wind		Air (ºC)	Water (ºC)	Pr Baro	Hum (%)	Ice
											Dir	Speed					
BaySys	P10	Coring	28/Jul/2009	10h02		55°16.004	077°51.828	Gravity Core ↑	62.1								
BaySys	P5	Coring	28/Jul/2009	10h37		55°18.989	077°49.321	Gravity Core (bottom)	72.4								
BaySys	P5	Coring	28/Jul/2009	10h40		55°18.989	077°49.318	Gravity Core ↑	71.5								
BaySys	P1	Coring	28/Jul/2009	11h14		55°17.457	077°55.599	Gravity Core (bottom)	82.1								
BaySys	P1	Coring	28/Jul/2009	11h17		55°17.455	077°55.594	Gravity Core ↑	82.5								
BaySys	P7	Coring	28/Jul/2009	11h43		55°14.711	077°56.595	Gravity Core (bottom)	94.5								
BaySys	P7	Coring	28/Jul/2009	11h48		55°14.708	077°56.586	Gravity Core ↑	93.6								
BaySys	GW02	Net	28/Jul/2009	15h22		55°16.685	077°49.438	Zooplankton Ring Net ↓	40.7								
BaySys	GW02	Net	28/Jul/2009	15h35		55°16.050	077°49.869	Zooplankton Ring Net ↑	45.8								
BaySys	GW02	Net	28/Jul/2009	15h43		55°16.646	077°49.572	Zooplankton Ring Net ↓	40.9								
BaySys	GW02	Net	28/Jul/2009	15h51		55°16.670	077°49.932	Zooplankton Ring Net ↑	42.4								
BaySys	AN03 (702)	Mooring	28/Jul/2009	17h47		55°24.516	077°55.836	Mooring AN03-09 Deployed	137								
BaySys	AN03 (702)	Mooring	28/Jul/2009	18h07		55°24.534	077°55.890	Mooring AN03-09 in position	136								
BaySys	AN03 (702)	Mooring	28/Jul/2009	18h31		55°24.572	077°55.778	Mooring AN03-09 Triangulation 1 (162m)	136								
BaySys	AN03 (702)	Mooring	28/Jul/2009	18h38		55°24.563	077°55.968	Mooring AN03-09 Triangulation 2 (175m)	133								
BaySys	AN03 (702)	Mooring	28/Jul/2009	18h47		55°24.472	077°55.863	Mooring AN03-09 Triangulation 3 (170m)	137								
BaySys	702	Full	28/Jul/2009	18h50		55°24.442	077°55.783	CTD ↓	132								
BaySys	702	Full	28/Jul/2009	18h54		55°24.414	077°55.725	CTD (bottom)	129								
BaySys	702	Full	28/Jul/2009	18h56		55°24.395	077°55.692	CTD ↑	123								
BaySys	703	CTD	29/Jul/2009	06h35		54°40.694	079°57.450	CTD ↓	41								
BaySys	703	CTD	29/Jul/2009	06h37		54°40.716	079°57.492	CTD (bottom)	45.7								
BaySys	703	CTD	29/Jul/2009	06h38		54°40.732	079°57.518	CTD ↑	47.9								
BaySys	703	CTD	29/Jul/2009	06h38		54°40.732	079°57.518	Water sample	47.9								
BaySys	703	CTD	29/Jul/2009	06h54		54°40.730	079°57.642	Horizontal Net Tow↓	51.2								
BaySys	703	CTD	29/Jul/2009	07h01		54°40.808	079°58.258	Horizontal Net Tow (bottom)	58.8								
BaySys	703	CTD	29/Jul/2009	07h03		54°40.768	079°58.403	Horizontal Net Tow ↑	61.8								
BaySys	709	CTD	29/Jul/2009	10h01		54°42.705	080°46.703	CTD ↓	90.4								
BaySys	709	CTD	29/Jul/2009	10h05		54°42.695	080°46.717	CTD ↑, Water sample	90.8								
BaySys	704	CTD	29/Jul/2009	14h58		54°45.700	081°42.400	CTD ↓ (not good)	28.5								
BaySys	704	CTD	29/Jul/2009	15h00		54°45.600	081°42.400	CTD ↑ (not good)	28.5								
BaySys	704	CTD	29/Jul/2009	15h11		54°45.651	081°42.490	CTD ↓	28.3								
BaySys	704	CTD	29/Jul/2009	15h12		54°45.650	081°42.501	CTD ↑	28.6								
BaySys	704	CTD	29/Jul/2009	15h13		54°45.650	081°42.521	CTD (surface)	28.4								
BaySys	709	CTD	29/Jul/2009	19h47		54°42.739	080°46.773	CTD ↓ (not good)	90.3								
BaySys	709	CTD	29/Jul/2009	19h49		54°42.747	080°46.766	CTD ↑ (not good)	90.1								
BaySys	709	CTD	29/Jul/2009	19h51		54°42.764	080°46.752	CTD (surface)	90								
BaySys	709	CTD	29/Jul/2009	20h02		54°42.939	080°46.625	2 x CTDs ↓	89.8								
BaySys	709	CTD	29/Jul/2009	20h04		54°42.962	080°46.599	2 x CTDs ↑	90								
BaySys	709	CTD	29/Jul/2009	20h06		54°42.988	080°46.573	2 x CTDs (end)	89.9								
BaySys	HB01	Net	30/Jul/2009	13h03		57°05.039	081°55.233	Horizontal Net Tow Deployed	120								
BaySys	HB01	Net	30/Jul/2009	13h04		57°05.083	081°55.222	Horizontal Net Tow ↓	121								
BaySys	HB01	Net	30/Jul/2009	13h10		57°05.280	081°55.226	Horizontal Net Tow (bottom)	120								
BaySys	HB01	Net	30/Jul/2009	13h13		57°05.409	081°55.359	Horizontal Net Tow ↑	120								
BaySys	HB01	Net	30/Jul/2009	13h18		57°05.521	081°55.541	Horizontal Net Tow (surface)	119								
BaySys	HB02	Water	30/Jul/2009	18h38		57°55.286	082°17.309	Water sample	125								

Appendix 2 - Scientific log of activities conducted during the 2009 ArcticNet Expedition

Leg	Station ID	Station Type	Local Date	Local Time	UTC to local	Latitude (N)	Longitude (W)	Activity	Depth (m)	Heading (°)	Wind		Air (ºC)	Water (ºC)	Pr Baro	Hum (%)	Ice
											Dir	Speed					
BaySys	HB03	Water	31/Jul/2009	08h16		58°54.627	085°35.756	Water sample	74								
BaySys	HB04	Water	31/Jul/2009	18h43		59°24.250	089°15.360	Water sample	140								
BaySys	HB04	Water	31/Jul/2009	18h46		59°24.210	089°15.450	Water sample	138								
BaySys	AN01 (707)	Mooring	01/Aug/2009	06h20		59°58.440	091°56.650	Mooring AN01-07 Released	111								
BaySys	AN01 (707)	Mooring	01/Aug/2009	07h00		59°58.460	091°56.829	Mooring AN01-07 Recovered	102								
BaySys	707	Full	01/Aug/2009	07h10		59°58.441	091°56.564	CTD ↓	102								
BaySys	707	Full	01/Aug/2009	07h14		59°58.427	091°56.568	CTD (bottom)	104								
BaySys	707	Full	01/Aug/2009	07h16		59°58.421	091°56.571	CTD ↑	104								
BaySys	707	Full	01/Aug/2009	17h23		59°58.410	091°56.599	Water sample	104								
BaySys	707	Full	01/Aug/2009	08h08		59°58.348	091°56.843	Horizontal Net Tow ↓	103								
BaySys	707	Full	01/Aug/2009	08h16		59°58.143	091°56.708	Horizontal Net Tow (bottom)	105								
BaySys	707	Full	01/Aug/2009	08h17		59°58.115	091°56.609	Horizontal Net Tow ↑	105								
BaySys	707	Full	01/Aug/2009	08h23		59°58.125	091°56.253	Horizontal Net Tow (surface)	108								
BaySys	706	Full	01/Aug/2009	15h54		58°47.016	091°31.451	CTD (surface)	77.3								
BaySys	706	Full	01/Aug/2009	15h55		58°47.022	091°31.438	CTD ↑	77.2								
BaySys	706	Full	01/Aug/2009	15h56		58°47.027	091°31.420	CTD (end)	77.1								
BaySys	P15	Coring	02/Aug/2009	07h00		57°39.565	091°35.909	Gravity Core ↓	57.1								
BaySys	P15	Coring	02/Aug/2009	07h01		57°39.547	091°35.928	Gravity Core (bottom)	57.1								
BaySys	P15	Coring	02/Aug/2009	07h04		57°39.540	091°35.946	Gravity Core ↑	57								
BaySys	P15	Coring	02/Aug/2009	07h11		57°39.499	091°35.705	Gravity Core ↓	66.5								
BaySys	P15	Coring	02/Aug/2009	07h12		57°39.484	091°35.697	Gravity Core (bottom)	67.4								
BaySys	P15	Coring	02/Aug/2009	07h15		57°39.462	091°35.680	Gravity Core ↑	67.8								
BaySys	705	Full	02/Aug/2009	07h25		57°39.360	091°35.834	Probe?	64.9								
BaySys	AN04-A (705)	Mooring	02/Aug/2009	07h32		57°39.302	091°35.822	Mooring AN04-07A Released	64.1								
BaySys	AN04-A (705)	Mooring	02/Aug/2009	07h37		57°34.294	091°35.817	Mooring AN04-07A Recovered	63.4								
BaySys	705	Full	02/Aug/2009	07h44		57°39.402	091°35.784	Probe?	65.9								
BaySys	705	Full	02/Aug/2009	07h48		57°39.388	091°35.765	Mooring AN04-07B Released	66.3								
BaySys	AN04-B (705)	Mooring	02/Aug/2009	07h56		57°39.363	091°35.766	Mooring AN04-07B Recovered	65.9								
BaySys	AN04-B (705)	Mooring	02/Aug/2009	08h35		57°39.298	091°35.672	CTD ↓	64.4								
BaySys	705	Full	02/Aug/2009	08h37		57°39.299	091°35.664	CTD ↑	64.5								
BaySys	705	Full	02/Aug/2009	08h38		57°39.301	091°35.654	CTD (end)	64.5								
BaySys	705	Full	02/Aug/2009	08h54		57°39.277	091°35.495	Water sample	63								
BaySys	715	Basic	02/Aug/2009	11h03		57°26.418	091°54.519	CTD ↓	29.6								
BaySys	715	Basic	02/Aug/2009	11h04		57°26.421	091°54.520	CTD ↑	29.7								
BaySys	715	Basic	02/Aug/2009	11h04		57°26.424	091°54.520	CTD (end)	29.7								
BaySys	715	Basic	02/Aug/2009	11h10		57°26.501	091°54.550	Water sample	29.7								
BaySys	P17	Coring	02/Aug/2009	11h31		57°26.016	091°52.431	Gravity Core ↓	32.9								
BaySys	P17	Coring	02/Aug/2009	11h32		57°26.020	091°52.417	Gravity Core (bottom)	32.9								
BaySys	P17	Coring	02/Aug/2009	11h33		57°26.025	091°52.399	Gravity Core ↑	32.9								
BaySys	713	CTD	03/Aug/2009	08h09		57°42.382	090°46.421	CTD ↓	38.4								
BaySys	713	CTD	03/Aug/2009	08h10		57°42.377	090°46.407	CTD ↑	38.7								
BaySys	713	CTD	03/Aug/2009	08h12		57°42.361	090°46.363	CTD (end), Water sample	38.7								
BaySys	713 (3mn)	CTD	03/Aug/2009	13h26		57°42.147	090°52.475	Horizontal Net Tow ↓	35								
BaySys	713 (3mn)	CTD	03/Aug/2009	13h31		57°41.958	090°52.342	Horizontal Net Tow (bottom)	35.7								
BaySys	713 (3mn)	CTD	03/Aug/2009	13h35		57°41.871	090°52.155	Horizontal Net Tow ↑	35.6								

Appendix 2 - Scientific log of activities conducted during the 2009 ArcticNet Expedition

Leg	Station ID	Station Type	Local Date	Local Time	UTC to local	Latitude (N)	Longitude (W)	Activity	Depth (m)	Heading (°)	Wind		Air (ºC)	Water (ºC)	Pr Baro	Hum (%)	Ice
											Dir	Speed					
BaySys	AN04-A (705)	Mooring	03/Aug/2009	17h07		57°40.210	091°36.195	Mooring AN04-09A Deployed	54.1								
BaySys	705	Full	03/Aug/2009	17h20		57°40.074	091°36.178	CTD ↓	53.5								
BaySys	705	Full	03/Aug/2009	17h21		57°40.064	091°36.167	CTD (bottom)	53.6								
BaySys	705	Full	03/Aug/2009	17h22		57°40.060	091°36.166	CTD ↑	53.7								
BaySys	714	CTD	03/Aug/2009	18h56		57°34.638	091°20.465	CTD ↓	33.2								
BaySys	714	CTD	03/Aug/2009	18h57		57°34.622	091°20.456	CTD ↑	33.4								
BaySys	714	CTD	03/Aug/2009	18h58		57°34.608	091°20.448	CTD (end)	33.1								
BaySys	AN02 (706)	Mooring	04/Aug/2009	06h25		58°46.967	091°31.436	Mooring AN02-09 Deployed	76.3								
BaySys	AN02 (706)	Mooring	04/Aug/2009	06h44		58°46.721	091°32.035	Mooring AN02-09 in position	76								
BaySys	AN02 (706)	Mooring	04/Aug/2009	06h57		58°46.752	091°32.108	Mooring AN02-09 Triangulation 1 (162 m)	75.8								
BaySys	AN02 (706)	Mooring	04/Aug/2009	07h09		58°46.662	091°31.999	Mooring AN02-09 Triangulation 2 (152 m)	75.4								
BaySys	AN02 (706)	Mooring	04/Aug/2009	07h13		58°46.742	091°31.988	Mooring AN02-09 Triangulation 3 (143 m)	75.2								
BaySys	706	Full	04/Aug/2009	07h18		58°46.722	091°32.349	CTD ↓	75.7								
BaySys	706	Full	04/Aug/2009	07h20		58°46.717	091°32.397	CTD (bottom)	73								
BaySys	706	Full	04/Aug/2009	07h21		58°46.696	091°32.418	CTD ↑	71.8								
BaySys	706	Full	04/Aug/2009	08h10		58°46.732	091°31.205	Horizontal Net Tow ↓	77								
BaySys	706	Full	04/Aug/2009	08h16		58°46.888	091°31.966	Horizontal Net Tow (bottom)	29.7								
BaySys	706	Full	04/Aug/2009	08h17		58°46.903	091°32.006	Horizontal Net Tow ↑	29.1								
BaySys	706	Full	04/Aug/2009	08h22		58°47.013	091°31.901	Horizontal Net Tow (end)	28								
BaySys	AN01 (707)	Mooring	04/Aug/2009	15h28		59°58.137	091°56.135	Mooring AN01-09 Deployed	106								
BaySys	AN01 (707)	Mooring	04/Aug/2009	16h00		59°58.165	091°57.116	Mooring AN01-09 in position	104								
BaySys	AN01 (707)	Mooring	04/Aug/2009	16h17		59°58.212	091°57.199	Mooring AN01-09 Triangulation 1 (194 m)	102								
BaySys	AN01 (707)	Mooring	04/Aug/2009	16h26		59°58.192	091°57.011	Mooring AN01-09 Triangulation 2 (162 m)	102								
BaySys	AN01 (707)	Mooring	04/Aug/2009	16h30		59°58.082	091°57.111	Mooring AN01-09 Triangulation 3 (204 m)	106								
BaySys	707	Full	04/Aug/2009	16h33		59°58.032	091°57.072	CTD ↓	106								
BaySys	707	Full	04/Aug/2009	16h35		59°57.990	091°57.070	CTD (bottom)	105								
BaySys	707	Full	04/Aug/2009	16h37		59°57.956	091°57.071	CTD ↑	109								
BaySys	707	Full	04/Aug/2009	16h43		59°57.845	091°57.846	Horizontal Net Tow ↓	113								
BaySys	707	Full	04/Aug/2009	16h48		59°57.820	091°57.515	Horizontal Net Tow (bottom)	112								
BaySys	707	Full	04/Aug/2009	16h49		59°57.824	091°57.450	Horizontal Net Tow ↑	112								
BaySys	707	Full	04/Aug/2009	16h54		59°57.862	091°57.165	Horizontal Net Tow (surface)	109								
BaySys	707	Full	04/Aug/2009	16h55		59°57.871	091°57.130	Horizontal Net Tow (end)	110								

Appendix 3 - CTD logbook for the 2009 ArcticNet Expedition

Leg	Cast#	Station	Date Start UTC	Time Start UTC	Latitude N	Longitude W	Bottom depth (m)	Cast depth (m)	Comments	Rosette Type	Init.
Leg 2a											
2a	1	1 (B)	2009-07-18	11:50	70° 28.617	135° 06.674	62	51	test	CTD	YG
2a	2	1 (B)	2009-07-18	12:06	70° 28.814	135° 07.035	62	51	nutrients + contaminants	nut	YG
2a	3	2 (B)	2009-07-18	00:26	70° 38.354	135° 38.268	148	140	nutrients + N15	nut	YG
2a	4	11 (B)	2009-07-19	06:22	70° 44.150	135° 33.652	363	355	incomplete		YG
2a	5	11 (B)	2009-07-19	08:21	70° 44.272	135° 32.212	363	355	pump off between 0 and 50 m	nut	YG
2a	6	3 (B)	2009-07-19	13:07	70° 42.342	135° 48.125	404	395		nut	LP
2a	7	14 (B)	2009-07-20	00:26	70° 34.834	135° 57.252	94	85	nutrients + N15 + phyto	nut	YG
2a	8	15 (B)	2009-07-20	06:19	70° 39.265	135° 55.882	294	286	nutrients	nut	CM
2a	9	17 (B)	2009-07-20	12:51	70° 36.588	136° 28.446	730	720	bottles 2, 21 open	nut	LP
2a	10	4 (B)	2009-07-21	02:50	70° 45.757	136° 01.259	688	673	bottles 2, 21, 24 upen	nut	LP
2a	11	10 (B)	2009-07-21	12:39	70° 47.236	135° 31.720	432	421	bottles 2, 21 open	nut	LP
2a	12	I (09)	2009-07-21	21:47	70° 48.899	134° 32.990	73	65	mooring	mooring	YG
2a	13	23 (B)	2009-07-22	00:52	70° 53.815	134° 16.018	82	75	bottle 24 open	nut	LP
2a	14	22 (B)	2009-07-22	07:41	70° 49.098	134° 30.605	72	62.8	nutrients	nut	CM
2a	15	21 (B)	2009-07-22	16:29	71° 01.106	134° 37.945	337	331	mouse problems at 300 m	nut	CM
2a	16	18 (B)	2009-07-23	01:07	70° 52.504	135° 21.426	495	485	RAS	nut	LP
2a	17	08 (B)	2009-07-23	07:42	70° 55.219	135° 51.799	782	775	bottles 15 et 24 open	nut	YG
2a	18	20 (B)	2009-07-23	15:41	71° 00.938	135° 20.742	645	635	bottles 2, 15, 22, 23, 24!!!	nut	CM
2a	19	16 (B)	2009-07-24	14:09	70° 47.692	134° 39.451	1084	1000	21 open, 11 magically closed?	nut	YG
2a	20	6 (B)	2009-07-25	08:51	70° 56.156	136° 25.766	1024	1000	bottle 17 ou 18 closed at surface? See verbose	nut	YG
2a	21	7(B)	2009-07-25	14:19	70° 59.312	136° 07.705	1018	1000	bottle 16	nut	LP
2a	22	M (09)	2009-07-26	02:47	70° 44.228	135° 55.096	583	570	bottles all closed	nut	LP
2a	23	13 (B)	2009-07-27	03:55	70° 30.000	135° 40.000	66	60	all closed	nut	LP
2a	24	12 (B)	2009-07-27	14:11	70° 38.393	135° 06.006	61	50	all closed	nut	YG
Leg 2b											
2b	25	390	2009-07-31	21:03	70° 10.773	133° 34.114	40	45	touched the bottom	Chemistry	YG
2b	26	390	2009-07-31	23:06	70° 10.512	133° 34.006	43	38	ok	IOPs	LP
2b	27	390	2009-08-01	00:31	70° 06.990	133° 30.649	43	36	ras	biodiversite	CM
2b	28	689	2009-08-01	12:28	69° 29.270	137° 56.670	52	46	ras	box Core	LP
2b	29	690	2009-08-01	15:11	69° 29.050	137° 55.988	51	45.9	rinsing after degreasing	Chemistry	CM
2b	30	690	2009-08-01	16:44	69° 28.295	137° 57.263	53	48	ras	IOPs-PP	CM
2b	31	690	2009-08-01	20:21	69° 29.132	137° 56.330	55	46	ras	biodiversite	LP
2b	32	680	2009-08-02	16:46	69° 36.463	138° 12.472	120	115	ras	Chemistry	CM
2b	33	680	2009-08-02	19:14	69° 36.419	138° 13.316	122	115	ras	IOPs-PP	LP
2b	34	Cancelled									
2b	35	680	2009-08-02	20:54	69° 36.600	138° 13.709	124	115	skipped cast #34	Biodiv	LP
2b	36	680	2009-08-02	22:51	69° 36.570	138° 14.260	124	101	6 btls only	Xsie	LP
2b	37	394	2009-08-03	20:29	69° 50.826	133° 29.522	14	10	btl 20 not closed	Chemistry	YG
2b	38	394	2009-08-03	22:47	69° 50.905	133° 29.862	14	10	btl 20 not closed	combined	CM

Appendix 3 - CTD logbook for the 2009 ArcticNet Expedition

Leg	Cast#	Station	Date Start UTC	Time Start UTC	Latitude N	Longitude W	Bottom depth (m)	Cast depth (m)	Comments	Rosette Type	Init.
2b	39	290	2009-08-04	12:21	70° 40.337	130° 26.057	32	28	no bottle	CTD only	LP
2b	40	280	2009-08-04	14:56	70° 52.166	130° 30.410	38	33	btl 20 not closed	Chemistry	YG
2b	41	280	2009-08-04	16:28	70° 52.258	130° 30.415	42	38	20: open 04: leaked	IOPs	YG
2b	42	280	2009-08-04	18:13	70° 52.841	130° 31.710	42	37	20: open	Biodiversity	YG
2b	43	270	2009-08-04	19:51	71° 04.411	130° 32.851	50	43	btl all closed		
2b	44	260	2009-08-04	22:06	71° 16.002	130° 36.508	58	50	ras	basic IOP biodiv	LP
2b	45	260	2009-08-05	00:00	71° 16.000	130° 36.000	59	50	ras	basic Chemistry	LP
2b	46	250	2009-08-05	04:20	71° 28.312	130° 41.754	219	210	CDOM replaces pH	CTD	CM
2b	47	240	2009-08-05	06:20	71° 40.367	130° 44.465	460	450	ras	CTD	YG
2b	48	230	2009-08-05	08:03	71° 51.953	130° 50.267	702	692	ras	CTD	YG
2b	49	220	2009-08-05	10:15	72° 03.486	130° 53.532	890	880	ras	CTD	LP
2b	50	220	2009-08-05	14:11	72° 02.738	130° 49.512	834	400	ras	Biodiversity	CM
2b	51	220	2009-08-05	15:43	72° 03.221	130° 52.615	880	200	ras	IOP + PP	CM
2b	52	220	2009-08-05	17:28	72° 02.976	130° 56.687	911	225	ras	Chemistry	YG
2b	53	240	2009-08-05	22:17	71° 40.294	130° 43.674	465	200	btl 11 closed at 40 m instead of 30 m	IOP+PP+Bio	YG
2b	54	240	2009-08-06	00:31	71° 40.312	130° 44.192	459	400	ras	chemistry	LP
2b	55	110	2009-08-06	11:08	71° 42.062	126° 28.898	400	390	calibration O2 and Sal sampls + Heike	CTD only	LP
2b	56	110	2009-08-06	13:38	71° 41.838	126° 28.696	399	300	cable angle 20deg, wind getting colder	Biodiversity	LP
2b	57	110	2009-08-06	15:23	71° 42.048	126° 28.781	397	250	ras- descent rate 25m/minute	IOP + PP	CM
2b	58	110	2009-08-06	18:05	71° 41.827	126° 28.678	395	300	ras	Chemistry	YG
2b	59	120	2009-08-06	22:58	71° 33.877	126° 54.547	419	410	ras, seastate increasing	CTD only	LP
2b	60	130	2009-08-07	00:51	71° 25.630	127° 21.970	311	250		Basic IOP biodiv	LP
2b	61	130	2009-08-07	03:27	71° 25.439	127° 21.408	313	250	seastate increasing bottle 3 open	BasicChemistry	CM
2b	62	140	2009-08-07	09:05	71° 17.036	127° 47.418	148	140		Box core	YG
2b	63	150	2009-08-07	11:17	71° 09.660	128° 09.642	66	60	AC9 + LISSt CTD only	CTD only	LP
2b	64	160	2009-08-07	12:39	71° 03.026	128° 29.816	43	40	AC9 + LISSt CTD nutrients	nutrients	LP
2b	65	170	2009-08-07	14:35	70° 54.833	128° 55.091	35	30		Biodiversity	CM
2b	66	170	2009-08-07	16:07	70° 54.922	128° 55.432	35	30	AC9 + LISSt CTD nutrients	IOP + PP+nutrients	CM
2b	67	170	2009-08-07	17:38	70° 55.037	128° 55.142	35	30		Chemistry	CM
2b	68	150	2009-08-07	22:57	71° 09.737	128° 09.590	66	62		IOP+PP+Bio	LP
2b	69	150	2009-08-08	01:09	71° 09.659	128° 09.602	66	60	snow!	Chemistry	LP
2b	70	390	2009-08-08	11:37	70° 10.646	133° 33.593	44	40		ctd only	LP
2b	71	380	2009-08-08	13:10	70° 23.784	133° 36.552	63	57		Biodiversity	YG
2b	72	380	2009-08-08	14:48	70° 23.772	133° 35.982	63	55.7	AC9 + LISSt CTD nutrients	IOP + PP+nutrients	CM
2b	73	380	2009-08-08	16:07	70° 23.073	133° 35.558	62	55		Chemistry	CM
2b	74	370	2009-08-08	19:13	70° 35.921	133° 38.997	70	65		CTD-only	YG
2b	75	360	2009-08-08	21:28	70° 48.055	133° 43.830	75	70		basicIOP-biodiv	LP
2b	76	360	2009-08-08	23:36	70° 48.194	133° 43.940	74	70		chemistry	YG
2b	77	350	2009-08-09	04:18	70° 58.291	133° 44.036	90	85	with optics (Rick and Jens)	CTD-only	YG
2b	78	340	2009-08-09	06:22	71° 10.379	133° 50.044	575	570	no optics	CTD-only	YG

Appendix 3 - CTD logbook for the 2009 ArcticNet Expedition

Leg	Cast#	Station	Date Start UTC	Time Start UTC	Latitude N	Longitude W	Bottom depth (m)	Cast depth (m)	Comments	Rosette Type	Init.
2b	79	330	2009-08-09	08:05	71° 22.385	133° 53.503	1080	1000		CTD-only	YG
2b	80	320	2009-08-09	10:13	71° 34.304	133° 56.230	1159	1000		CTD only	LP
2b	81	310	2009-08-09	12:36	71° 44.528	133° 57.053	1614	1000		CTD only	LP
2b	82	320	2009-08-09	15:00	71° 34.225	133° 56.888	1160	300	pump kaput!	Biodiversity	CM
2b	83	320	2009-08-09	16:57	71° 33.832	133° 57.223	1141	300	pump ok: cleaned (CM&LP)	IOPs & PP	CM
2b	84	320	2009-08-09	19:03	71° 33.803	133° 57.241	1115	300		Chemistry	YG
2b	85	330	2009-08-09	21:31	71° 22.236	133° 53.228	1070	300		Optics	YG
2b	86	340	2009-08-09	23:45	71° 10.296	133° 49.570	562	300	btl 5 didn't close	basicIOP	LP
2b	87	340	2009-08-10	02:08	71° 10.056	133° 50.179	553	300	ok	basic chemistry	LP
2b	88	680	2009-08-10	16:44	69° 36.353	138° 14.095	125	120	bottle 5 didn't close	box core-chem	CM
2b	89	670	2009-08-10	19:22	68° 47.845	138° 26.243	174	167	Btls 6 and 13 didn't close	Biodiversity	YG
2b	90	670	2009-08-10	21:00	69° 47.984	138° 26.148	174	167	Btl 3 didn't close	IOP+PP+nut	YG
2b	91	670	2009-08-10	22:55	69° 47.825	138° 25.669	173	165	ok	Chemistry	LP
2b	92	660	2009-08-11	01:00	69° 59.081	138° 39.088	268	260	ok	Basic IOP	LP
2b	93	660	2009-08-11	03:14	69° 58.228	138° 38.244	260	250	ok without ISUS	Chemistry	CM
2b	94	650	2009-08-11	05:37	70° 10.115	138° 54.506	374	368	without ISUS	Nutrients	YG
2b	95	640	2009-08-11	07:35	70° 20.420	139° 08.778	564	564	7.4 m from bottom	CTD-only	YG
2b	96	630	2009-08-11	09:11	70° 32.012	139° 22.776	839	836	11.4 m from bottom	CTD-only	YG
2b	97	620	2009-08-11	11:08	70° 42.206	139° 36.523	1736	1708	19,66 m from bottom	Jeanthon	LP
2b	98	610	2009-08-11	14:27	70° 47.689	139° 36.178	1823	1805	btl 3 open	Chem (RON)	LP
2b	99	620	2009-08-11	18:43	70° 40.883	139° 37.288	1740	300	forgot to plug the UVP	Biodiversity	YG
2b	100	620	2009-08-11	20:56	70° 40.096	139° 39.431	1740	300	nitrates: dirty mirror?	IOP+PP	YG
2b	101	620	2009-08-11	22:49	70° 40.422	139° 37.956	1538	300		chemistry	LP
2b	102	630	2009-08-12	00:53	70° 31.883	139° 22.466	840	300	AC9 and LISS	CTD only	LP
2b	103	640	2009-08-12	02:50	70° 20.348	139° 08.231	573	300		Basic IOP	CM
2b	104	640	2009-08-12	05:05	70° 20.012	139° 05.945	550	3.3		Xie+Lansard	YG
2b	105	760	2009-08-12	13:44	70° 33.236	140° 47.899	579	571	ok	CTD-only	LP
2b	106	760	2009-08-12	15:21	70° 33.247	140° 47.784	560	300	btl 5 didn't close	Biodiversity	CM
2b	107	760	2009-08-12	16:50	70° 32.826	140° 47.616	566	300		IOP+PP+Nuts	CM
2b	108	760	2009-08-12	19:11	70° 32.383	140° 47.080	566	300	btl 14 and 24 didn't close	Chemistry	YG
2b	109	770	2009-08-12	23:03	70° 50.938	140° 48.400	223	215	AC9 + LISSP + BB9	ctd only	LP
2b	110	780	2009-08-13	01:58	70° 09.206	140° 48.348	49	45	AC9 + LISSP + BB9	basic Iop	LP
2b	111	780	2009-08-13	03:38	70° 09.217	140° 48.040	50	45	ok	basic chemistry	CM
2b	112	345	2009-08-14	16:26	71° 19.799	132° 34.796	479	460	1rst CTD of 1rst Cycle, Basic	Basic IoP	LP
2b	113	345	2009-08-14	18:19	71° 20.438	132° 35.530	502	500	8,3 m from bottom	Basic IOP	YG
2b	114	345	2009-08-14	20:27	71° 20.951	132° 36.394	517	500	24,8 m from bottom	Basic IOP+biodiv	CM
2b	115	345	2009-08-14	22:25	71° 21.262	132° 36.520	530	500	33,9 m from bottom	Basic+IOP	LP
2b	116	345	2009-08-15	00:23	71° 21.158	132° 37.286	519	500	28,9 m from bottom	Basic+IOP	LP
2b	117	345	2009-08-15	02:19	71° 21.276	132° 37.031	529	500	32,4 m from bottom	Basic+IOP	YG
2b	118	345	2009-08-15	04:20	71° 21.149	132° 36.612	524	500	30,6 m from bottom	Basic+IOP	YG

Appendix 3 - CTD logbook for the 2009 ArcticNet Expedition

Leg	Cast#	Station	Date Start UTC	Time Start UTC	Latitude N	Longitude W	Bottom depth (m)	Cast depth (m)	Comments	Rosette Type	Init.
2b	119	345	2009-08-15	06:21	71° 21.624	132° 36.641	536	500	45m ab bottom	rosette cycle	CM
2b	120	345	2009-08-15	08:17	71° 21.826	132° 36.455	539	500	47m ab bottom	rosette cycle	CM
2b	121	345	2009-08-15	10:23	71° 21.114	132° 35.122	519	500	26,3 above bottom	rosette cycle	LP
2b	122	345	2009-08-15	12:20	71° 21.387	132° 34.916	525	500	fog	rosette cycle	LP
2b	123	345	2009-08-15	14:24	71° 22.030	132° 41.242	559	500	btl 5 didn't close	rosette cycle	CM
2b	124	345	2009-08-15	16:23	71° 22.878	132° 43.484	612	300	25m/minute	IOP &PP	CM
2b	125	345	2009-08-15	18:19	71° 23.560	132° 39.796	602	500	btl 7 didn't close	cycle+ fullbiodiv	LP
2b	126	345	2009-08-15	20:18	71° 24.540	132° 38.322	580	500	ok	chemistry	CM
2b	127	345	2009-08-15	22:23	71° 25.330	132° 37.094	615	500	btl 7 didn't close	rosette cycle	LP
2b	128	345	2009-08-16	00:21	71° 25.150	132° 35.515	625	600	btl 7 didn't close; AC9 et BB9 removed; 26,21m alti	rosette cycle	LP
2b	129	345	2009-08-16	02:19	71° 24.756	132° 35.006	606	595	7 again! 13,2 m above bottom	rosette cycle	LP
2b	130	345	2009-08-16	04:26	71° 26.068	132° 36.308	564	648	7 again! 19,6 m above bottom	rosette cycle	LP
2b	131	570	2009-08-17	10:43	70° 12.318	137° 15.332	55	50	5,1 m from bottom	CTD-only	YG
2b	132	560	2009-08-17	12:13	70° 23.322	137° 28.414	400	395	6,0 m	CTD only	LP
2b	133	550	2009-08-17	14:07	70° 34.307	137° 42.632	1076	1077	9,38m ab bottom	CTD only	CM
2b	134	540	2009-08-17	17:18	70° 45.146	137° 53.644	1514	1532	1532 db: 10, 5 m from bottom	Biodiversity	YG
2b	135	540	2009-08-17	20:07	70° 45.302	137° 53.114	1514	300	bottle 16 didn't close	IOP + PP	YG
2b	136	540	2009-08-17	22:06	70° 45.373	137° 52.258	1522	300		biochemistry	LP
2b	137	530	2009-08-18	04:32	70° 56.419	138° 08.788	1602	1597	20 m from bottom	Oxygene	CM
2b	138	430	2009-08-18	15:00	71° 13.160	136° 42.764	1351	1357	17,6 m above bottom	Biodiversity	CM
2b	139	430	2009-08-18	17:27	71° 12.210	136° 44.200	1334	300	nitrates back on	IOPs & PP	YG
2b	140	430	2009-08-18	19:29	71° 11.028	136° 44.888	1300	300	ras	Chemistry	YG
2b	141	440	2009-08-19	00:11	71° 02.074	136° 27.670	1149	1000	CTD with Ron Demand	CTD Only	LP
2b	142	450	2009-08-19	02:29	70° 51.314	136° 14.159	840	834	18,32 m above bottom	CTD Only	CM
2b	143	470	2009-08-19	06:06	70° 28.319	135° 54.754	62	44	7,2 from bottom	CTD only	YG
2b	144	480	2009-08-19	07:29	70° 16.692	135° 45.097	56	50	6,1 from bottom	CTD only	YG
2b	145	460	2009-08-19	13:46	70° 40.624	136° 03.287	468	300	with optics a 25 m/minute	Biodiversity	CM
2b	146	460	2009-08-19	15:44	70° 41.029	135° 59.306	434	300	special nutrients- surf-56 m	nutrients	CM
2b	147	460	2009-08-19	16:15	70° 41.010	135° 58.063	420	300	ras	IOPs & PP	CM
2b	148	460	2009-08-19	18:26	70° 40.909	135° 58.063	362	355	8 m from bottom	Chemistry	YG
2b	149	135	2009-08-20	18:45	71° 18.620	127° 28.619	231	221.8	with optics	cycle	YG
2b	150	135	2009-08-20	20:24	71° 18.738	127° 29.340	230	222	10,7 m from bottom	cycle	CM
2b	151	135	2009-08-20	22:51	71° 18.629	127° 29.154	228	221	11,01 from bottom	cycle	LP
2b	152	135	2009-08-21	00:31	71° 18.556	127° 30.107	223	220.4	7,40 from bottom	cycle	LP
2b	153	135	2009-08-21	02:30	71° 18.680	127° 29.620	230	223	4,40 from bottom	cycle	LP
2b	154	135	2009-08-21	04:18	71° 18.785	127° 29.626	231	227	5,32 from bottom	cycle	LP
2b	155	135	2009-08-21	06:19	71° 18.709	127° 27.804	228	220.3	7,6 m from bottom	cycle	CM
2b	156	135	2009-08-21	08:19	71° 18.599	127° 29.536	227	220.7	7,3 m from bottom no prelevts	cycle	CM
2b	157	135	2009-08-21	10:19	71° 18.655	127° 29.507	230	227.5	3,96 m from bottom	cycle	LP
2b	158	135	2009-08-21	12:50	71° 18.455	127° 29.384	227	222	4,40 m from bottom	cycle	LP

Appendix 3 - CTD logbook for the 2009 ArcticNet Expedition

Leg	Cast#	Station	Date Start UTC	Time Start UTC	Latitude N	Longitude W	Bottom depth (m)	Cast depth (m)	Comments	Rosette Type	Init.
2b	159	135	2009-08-21	14:24	71° 18.412	127° 29.760	224	220.3	7,62 m from bottom	cycle	CM
2b	160	135	2009-08-21	16:20	71° 18.595	127° 30.292	222	215	9,62 m from bottom	cycle	CM
2b	161	135	2009-08-21	18:23	71° 18.690	127° 29.678	227	222	6,98 m from bottom	cycle	CM
2b	162	135	2009-08-21	20:31	71° 18.806	127° 29.929	227	225	6,79 m from bottom	IOP	YG
2b	163	135	2009-08-21	22:51	71° 18.544	127° 29.878	225	225	4,35 m from bottom	chemistry	YG
2b	164	235	2009-08-22	08:36	71° 45.869	130° 49.973	619	520		cycle 3	LP
2b	165	235	2009-08-22	10:41	71° 45.625	130° 45.625	567	522	47,5 m	cycle3	LP
2b	166	235	2009-08-22	12:18	71° 45.000	130° 48.376	599	520	with AC9	cycle3	LP
2b	167	235	2009-08-22	14:15	71° 45.944	130° 48.128	598	520	with AC9	cycle3	CM
2b	168	235	2009-08-22	16:25	71° 45.762	130° 50.090	617	520	with AC9	cycle3	CM
2b	169	235	2009-08-22	18:27	71° 46.114	130° 53.929	666	530	with AC9	cycle3	LP
2b	170	235	2009-08-22	20:24	71° 46.020	130° 56.380	681	684.8	9,6m ab bot without optics	cycle3	CM
2b	171	235	2009-08-22	22:31	71° 46.544	130° 51.293	637	634	8,72 m ab bottom	cycle3	LP
2b	172	235	2009-08-23	00:19	71° 46.627	130° 51.160	640	634.5	7,35 m ab bottom	cycle3	LP
2b	173	235	2009-08-23	02:26	71° 46.470	130° 50.236	626	620	9,79 m ab bottom	cycle3	LP
2b	174	235	2009-08-23	04:24	71° 45.983	130° 45.983	670	660	12,8 m from bottom	cycle 3	LP
2b	175	235	2009-08-23	06:20	71° 46.186	130° 56.808	686	387.7	9,7 m from bottom	cycle 3	CM
2b	176	235	2009-08-23	08:15	71° 46.476	130° 56.380	687	687.6	10 m from bottom	cycle 3	CM
2b	177	235	2009-08-23	10:23	71° 46.081	130° 51.072	626	625	5,52m ab bot	cycle 3	LP
2b	178	235	2009-08-23	12:18	71° 46.082	130° 51.080	629	625	5,15m ab bot	cycle 3	LP
2b	179	235	2009-08-23	14:15	71° 46.856	130° 51.172	634	629	9m ab bot	cycle 3	CM
2b	180	235	2009-08-23	16:22	71° 45.607	130° 53.802	657	654	6,5ab bot	cycle 3	CM
2b	181	235	2009-08-23	18:29	71° 45.226	130° 54.037	650	650.4	7,7 m ab bottom	cycle 3	CM
2b	182	235	2009-08-23	20:23	71° 45.290	130° 54.612	655	654.6	8,6 m ab bottom	cycle 3	CM
2b	183	235	2009-08-23	21:15	71° 45.029	130° 54.302	652	500		cycle 3	LP
2b	184	235	2009-08-24	00:21	71° 44.552	130° 54.433	633	500		cycle 3	LP
2b	185	235	2009-08-24	02:20	71° 44.798	130° 50.424	611	500		cycle 3	LP
2b	186	235	2009-08-24	04:43	71° 43.652	130° 50.512	576	500	problems	cycle 3	LP
2b	187	235	2009-08-24	06:32	71° 43.878	130° 52.132	597	500		cycle 3	YG
2b	188	235	2009-08-24	08:21	71° 43.932	130° 52.273	600	510		cycle 3	YG
2b	189	235	2009-08-24	10:40	71° 44.195	130° 45.047	547	520	25 m ab bottom	cycle 3	YG
2b	190	235	2009-08-24	12:29	71° 43.084	130° 49.970	560	300	AC9 LISSP	IOPs	LP
2b	191	235	2009-08-24	14:36	71° 42.734	130° 47.869	593	300	Last cast	biodiversity	LP
Leg 3a											
3a	1	S1	2009-08-30	00:09	69° 30.050	137° 59.786	60	54	First cast	Biology	DB
3a	2	S1	2009-08-30	05:34	69° 29.952	137° 59.702	59	54	Everything worked well !	Radium	DB
3a	3	S1	2009-08-30	07:08	69° 29.942	137° 59.484	58	56	Remake of cast 001	Biology	DB
3a	4	S1	2009-08-30	09:06	69° 29.980	137° 58.969	56	54	First cast by Veronique	Radium	VD
3a	5	S1.1	2009-08-30	10:40	69° 40.172	138° 09.168	126	120	No comments	Radium	DB
3a	6	S1.1	2009-08-30	11:57	69° 40.441	138° 09.720	128	123	Water mixed by ship	Radium	DB

Appendix 3 - CTD logbook for the 2009 ArcticNet Expedition

Leg	Cast#	Station	Date Start UTC	Time Start UTC	Latitude N	Longitude W	Bottom depth (m)	Cast depth (m)	Comments	Rosette Type	Init.
3a	7	S1.2	2009-08-30	13:25	69° 49.888	138° 19.628	189	181	Wrong station	Biogeochem	DB
3a	8	S1.2	2009-08-30	14:35	69° 50.058	138° 20.616	191	100	Profile incomplete. 24 didn't work	Radium	DB
3a	9	S1.2	2009-08-30	15:42	69° 50.312	138° 21.150	194	10	Profile incomplete. 24 didn't work	Radium	DB
3a	10	S2	2009-08-30	17:05	70° 00.077	138° 30.310	242	247	No comments	Biology	VD
3a	11	S2	2009-08-30	20:23	70° 00.520	138° 30.400	260	252	bottle 24 open	Biogeochem	VD
3a	12	S2	2009-08-31	00:13	69° 59.681	138° 29.533	256	248	bottle 24 open	Radium	VD
3a	13	S2	2009-08-31	06:48	69° 59.688	138° 32.870	271	261	bottle 24 closed	Radium	VD
3a	14	L1	2009-08-31	20:17	71° 05.531	139° 00.541	1914	1900	no nitrates. Altimeter not working. Engines running.	Biology	DB
3a	15	L1	2009-09-01	02:13	71° 06.352	139° 01.529	1913	1906	No nitrates. No PAR.	Biogeochem + O2 rea	DB
3a	16	L1	2009-09-01	15:26	71° 07.154	139° 11.898	1988	1978	No nitrates. No PAR.	Nd	VD
3a	17	L1	2009-09-01	21:03	71° 06.373	139° 18.250	2015	2066	Stopped for ice. Altimeter working.	Th Pa	VD
3a	18	L1	2009-09-02	01:08	71° 07.603	139° 19.723	2030	2077	No comments	Rivkin team	DB
3a	19	L1	2009-09-02	09:19	71° 06.268	139° 20.623	2045	2073	No comments	Ra 228	DB
3a	20	L1	2009-09-02	13:04	71° 06.802	139° 20.960	2049	2086	No comments	Cr & U	VD
3a	21	L1	2009-09-02	14:39	71° 06.218	139° 15.839	2034	2059	No comments	Ra 228-226	VD
3a	22	L2	2009-09-04	00:08	74° 38.740	137° 20.890	3000	3000	Stopped for cable problems	Th Pa	VD
3a	23	L2	2009-09-04	06:23	74° 38.670	137° 17.068	3000	1000	No comments	Ra 228-226	VD
3a	24	L2	2009-09-04	14:12	74° 35.620	137° 07.338	3000	500	No comments	Biology	DB
3a	25	L2	2009-09-04	18:31	74° 34.872	137° 03.553	3000	1000	No comments	Rivkin team	DB
3a	26	L2	2009-09-04	21:30	74° 34.174	136° 54.806	3000	3000	No comments	Nd & O2	DB
3a	27	L2	2009-09-05	03:35	74° 26.464	136° 28.141	3000	100	No comments	Pgnomics	VD
3a	28	L2	2009-09-05	04:37	74° 25.958	136° 28.804	3000	39	No comments	Pgnomics	VD
3a	29	L2	2009-09-05	05:36	74° 25.468	136° 29.587	3000	99	Rosette upcast and immediate downcast	Pgnomics	VD
3a	30	L2	2009-09-05	07:24	74° 25.057	136° 29.983	3000	59	See Operator verbo	Pgnomics	VD
3a	31	L2	2009-09-05	08:49	74° 25.924	136° 30.034	3000	3000	No comments	Biogeochem	VD
3a	32	L3	2009-09-07	14:02	75° 19.540	137° 39.638	3000	3000	Ship moving during upcast	Th Pa	DB
3a	33	L3	2009-09-07	21:26	75° 16.776	137° 33.851	3000	200	No comments	Biology	DB
3a	34	L3	2009-09-08	00:17	75° 16.892	137° 28.592	3000	3000	No comments	Biogeochem	VD
3a	35	L1.1	2009-09-09	01:00	72° 30.827	136° 35.912	2530	2534	Winch problems	Th Pa	VD
3a	36	L1.1	2009-09-09	10:22	72° 29.539	136° 43.603	2527	1000	Stop to cool winch	Ra	DB
3a	37	L1.1	2009-09-09	14:29	72° 30.950	136° 47.402	2533	200	No comments	Biology	DB
3a	38	L1.1	2009-09-10	02:48	72° 32.207	136° 56.005	2551	2556	Bottle 7 didn't close	Biogeochem	VD
3a	39	L1.1	2009-09-10	07:59	72° 32.594	136° 59.248	2554	600	No comments	Pgnomics	DB
3a	40	L1.1	2009-09-10	09:15	72° 32.552	136° 03.226	2558	600	Bottle 23 didn't close	Pgnomics	DB
3a	41	L1.1	2009-09-10	10:10	72° 32.920	136° 04.136	2560	10	No comments	Pgnomics	DB
3a	42	L1.1	2009-09-10	10:56	72° 33.266	137° 05.598	2560	10	No comments	Pgnomics	DB
3a	43	L1.1	2009-09-10	16:11	72° 35.268	136° 08.716	2590	2594	Bottle 7 didn't close	Nd	VD
3a	44	L1.1	2009-09-10	23:17	72° 37.316	137° 19.655	2626	100	No comments	Pgnomics	VD
3a	45	L1.1	2009-09-10	23:52	72° 37.646	137° 19.984	2630	80	Last Geotraces/3a	Pgnomics	DB

Appendix 3 - CTD logbook for the 2009 ArcticNet Expedition

Leg	Cast#	Station	Date Start UTC	Time Start UTC	Latitude N	Longitude W	Bottom depth (m)	Cast depth (m)	Comments	Rosette Type	Init.
Leg 3b											
3b	46	Area 1	2009-09-14	09:45	70° 49.033	136° 16.489	745	735	First IOL/3b	CTD	DB
3b	47	Area 2	2009-09-14	15:47	70° 50.149	136° 02.844	794	787	End of first line	CTD	VD
3b	48	Area 3	2009-09-15	00:08	70° 34.948	135° 38.825	69	61	End of second line	CTD	VD
3b	49	Area 4	2009-09-15	04:25	70° 48.773	136° 32.738	1000	982	Altimeter not working	CTD	DB
3b	50	Area 5	2009-09-15	15:46	70° 44.387	135° 26.834	269	262	Altimeter not working during upcast	CTD	DB
3b	51	USBL	2009-09-15	20:38	70° 44.560	136° 22.765	811	800	Altimeter not working. USBL Buoy Deployment.	CTD	VD
3b	52	Area 6	2009-09-16	13:20	70° 46.545	136° 06.866	727	717	Altimeter not working	CTD	VD
3b	53	Mooring B	2009-09-16	17:31	70° 39.319	135° 36.586	122	113	Altimeter working again	CTD	VD
3b	54	Area 7	2009-09-17	04:30	70° 44.540	136° 21.844	750	765	Altimeter stopped working around 350 m during downcast.	CTD	DB
3b	55	Area 8	2009-09-17	21:45	70° 44.588	135° 52.013	559	546	Altimeter still not working. Ship repositioned because of bad weather.	CTD	DB
3b	56	Area 9	2009-09-20	03:06	70° 47.987	136° 06.053	744	743	No comments	CTD	DB
3b	57	Area 10	2009-09-21	11:33	70° 43.793	136° 17.689	612	614	Ship repositioned at begginning of cast: weird profile	CTD	DB
3b	58	Area 11	2009-09-22	02:03	70° 35.557	136° 01.880	190	182	20 m missing from surface.	CTD	VD
3b	59	Area 12	2009-09-22	13:10	70° 33.431	135° 57.463	66	64	Altimeter unstable	CTD	VD
3b	60	Area 13	2009-09-23	03:02	70° 45.156	136° 38.978	1212	970	Altimeter not working between 300 and 600 m	CTD	DB
3b	61	Area 14	2009-09-24	01:50	70° 47.596	135° 33.934	418	413	Altimeter stopped working during upcast	CTD	DB
3b	62	Area15	2009-09-24	13:23	70° 35.639	136° 02.744	194	184	Altimeter not working	CTD	VD
3b	63	Area 16	2009-09-25	01:15	70° 38.954	135° 56.717	279	269	Altimeter not working. Calibration cast for MVP.	CTD	DB
3b	64	Area 17	2009-09-25	13:03	70° 38.803	136° 10.411	496	486	Altimeter not working	CTD	VD
3b	65	Area 18	2009-09-26	00:55	70° 41.269	136° 16.489	594	585	Altimeter working intermittently	CTD	DB
3b	66	Area 19	2009-09-26	13:01	70° 44.773	136° 11.795	611	600	Altimeter not working on the descent, and working intermittently on the ascent	CTD	VD
3b	67	Area 20	2009-09-27	01:11	70° 40.553	136° 02.500	457	457	Altimeter not working between 150 and 350 m	CTD	DB
3b	68	Area 21	2009-09-27	16:21	70° 35.412	135° 44.954	74	64	Altimeter working intermittently	CTD	VD
3b	69	Area 22	2009-09-27	21:44	70° 40.549	136° 05.880	462	453	Altimeter not working	CTD	DB
3b	70	Area 23	2009-09-28	13:04	70° 47.948	136° 11.722	749	752	Altimeter not working between 100 and 300 m	CTD	DB
3b	71	Area 24	2009-09-29	01:02	70° 45.458	135° 33.829	387	200	MVP calibration	CTD	VD
3b	72	Area 25	2009-09-29	13:05	70° 33.262	136° 28.792	484	481	Altimeter working again	CTD	VD
3b	73	Area 26	2009-10-01	14:28	70° 45.031	136° 38.426	1212	996	No nitrates during upcast.	CTD	DB
3b	74	Mooring A1	2009-10-01	16:24	70° 45.610	136° 00.595	668	668	No problems	CTD	DB
3b	75	Mooring C	2009-10-03	14:07	70° 35.136	136° 05.506	212	210	Stopped deck unit before the end of acquisition	CTD	DB
3b	76	Area 27	2009-10-04	21:32	70° 47.976	136° 18.768	687	688	Last IOL/3b !	CTD	VD
Leg 4a											
4a	1	408	2009-10-09	15:39	71° 18.728	127° 34.861	213	197	CA05-08 calibration. Bottle 18 didn't close.	CTD	DB
4a	2	408	2009-10-09	17:27	71° 24.655	127° 38.492	243	228	CA05MMP-08. No problems	CTD	DB
4a	3	437	2009-10-12	05:04	71° 47.070	126° 29.206	318	308	CA16-09. Bottle 18 didn't close.	Nutrients	DH
4a	4	437	2009-10-12	08:00	71° 47.719	126° 29.506	295	287	17 and 18 didn't close	Contaminants	DB
4a	5	437	2009-10-12	15:32	71° 46.938	126° 29.092	323	314	17 and 18 didn't close	CTD	DB

Appendix 3 - CTD logbook for the 2009 ArcticNet Expedition

Leg	Cast#	Station	Date Start UTC	Time Start UTC	Latitude N	Longitude W	Bottom depth (m)	Cast depth (m)	Comments	Rosette Type	Init.
4a	6	437	2009-10-12	21:53	71° 47.048	126° 29.796	319	309	17 and 18 didn't close	PP	DH
4a	7	408	2009-10-13	10:07	71° 18.437	127° 35.183	201	194	All bottles closed.	Nutrients	DB
4a	8	408	2009-10-13	12:39	71° 18.960	127° 35.473	205	198	No problems	Contaminants	DH
4a	9	408	2009-10-13	19:16	71° 18.677	127° 34.675	205	200	Bottle 18 didn't close.	PP	DH
4a	10	408	2009-10-14	01:50	71° 19.324	127° 35.400	208	200	CA05-09 calibration. No LADCP	CTD	DB
4a	11	416	2009-10-14	05:51	71° 18.112	127° 44.220	167	159	No LADCP. Bottle 18 didn't close	Nutrients	DB
4a	12	415	2009-10-14	07:00	71° 21.673	127° 33.223	243	231	No LADCP. Bottle 18 test worked. Altimeter not working after 200 m	CTD	DB
4a	13	414	2009-10-14	07:48	71° 25.303	127° 21.676	306	295	No LADCP. No altimeter. Bottle 18 leaked. Bottle 16 valve open.	Nutrients	DB
4a	14	413	2009-10-14	09:12	71° 29.864	127° 08.102	375	365	No LADCP. No altimeter. Test bottles 17 & 18 worked.	CTD	DB
4a	15	412	2009-10-14	10:11	71° 33.835	126° 55.498	418	408	No LADCP. Altimeter not working	Nuts + Chem	DB
4a	16	411	2009-10-14	11:52	71° 37.770	126° 42.509	436	427	No LADCP. Altimeter started working at 10m.	CTD	DH
4a	17	410	2009-10-14	12:57	71° 41.922	126° 29.384	408	399	No LADCP. Altimeter never started. Silicon band #15 broke. Replaced with rubber band.	Nuts	DH
4a	18	437	2009-10-14	18:48	71° 45.238	126° 30.319	367	357	Touched bottom at 15cm/s. CA16MMP-08. No apparent damage.	CTD	DH
4a	19	437	2009-10-14	21:10	71° 47.189	126° 29.117	311	303	No LADCP. Altimeter never worked.	PP	DH
4a	20	437	2009-10-15	03:08	71° 45.437	126° 31.163	355	351	No LADCP. Altimeter worked okay	CTD	DB
4a	21	405	2009-10-15	11:32	70° 39.871	122° 59.884	560	560	No LADCP. Altimeter worked.	Contaminants	DH
4a	22	405	2009-10-15	14:09	70° 39.845	122° 59.771	567	562	No LADCP. Altimeter worked.	B. core + DOM	DH
4a	23	405	2009-10-15	17:02	70° 39.769	123° 00.252	576	585	No LADCP	Nuts + PP+ Chem	DB
4a	24	405	2009-10-16	16:31	70° 39.811	123° 03.108	558	554	LADCP and new altimeter online.	DOM	DH
4a	25	446	2009-10-17	07:27	71° 39.028	119° 41.434	142	133	South of Prince of Wales Str.	CTD	DB
4a	26	450	2009-10-17	10:45	72° 05.567	119° 47.482	95	86	Prince of Wales Str.	Nuts+PP+Hg+Div	DB
4a	27	308	2009-10-19	23:17	74° 06.145	108° 49.718	587	541	Viscount Melville Sound	Nuts+PP+Chem+DOM	DB
4a	28	308	2009-10-20	02:48	74° 06.158	108° 49.954	544	541	Viscount Melville Sound	Box+Hg+Div	DB
4a	29	334	2009-10-22	17:00	74° 17.812	102° 44.940	225	217	Viscount Melville Sound	PP+Nuts+Chem+Div	DH
4a	30	304	2009-10-23	23:20	74° 18.727	091° 20.016	340	330	Lancaster Sound	Nuts+PP+Micro+Chem	DB
4a	31	304	2009-10-24	01:56	74° 18.893	091° 22.952	332	324	Lancaster Sound	Box+Hg+Div	DH
4a	32	330	2009-10-24	11:38	74° 08.384	087° 51.547	419	413	Lancaster Sound	Nutrients	DB
4a	33	325	2009-10-25	03:40	73° 49.105	080° 29.891	684	677	Lancaster Sound	Nutrients	DH
4a	34	324	2009-10-25	06:33	73° 58.846	080° 30.164	767	10	Com. Problem with CTD. Cast cancelled. Station cancelled.	Nutrients	DB
4a	35	323	2009-10-25	11:21	74° 09.701	080° 30.497	786	784	New CTD and new deck unit	Cont + Div	DB
4a	36	323	2009-10-25	14:08	74° 10.616	080° 31.882	778	90	Com. Problem with CTD. Cast cancelled. Will be remade.	Nuts + Chem	DB
4a	37	323	2009-10-25	21:30	74° 08.216	080° 38.960	801	800	Back to previous CTD. Works fine. Bottle 16 didn't close.	PP+DOM+Box/	DH
4a	38	323	2009-10-25	23:36	74° 06.978	080° 40.681	786	785	LADCP did not initialize.	Nuts+Chem	DH
4a	39	300	2009-10-26	02:08	74° 19.385	080° 31.134	703	695	LADCP worked.	Nuts	DH
4a	40	322	2009-10-26	05:24	74° 29.645	080° 36.187	660	630	Strong currents, great angle in the cable	Nuts	DB
4a	41	103	2009-10-27	00:44	76° 21.235	076° 32.227	155	149	LADCP did not initialize.	Nuts + PP + Div + DOM	DH

Appendix 3 - CTD logbook for the 2009 ArcticNet Expedition

Leg	Cast#	Station	Date Start UTC	Time Start UTC	Latitude N	Longitude W	Bottom depth (m)	Cast depth (m)	Comments	Rosette Type	Init.
4a	42	103	2009-10-27	06:03	76° 20.634	076° 35.272	161	157	No problems	Cont+Div+Box	DB
4a	43	105	2009-10-27	19:05	76° 14.830	075° 50.580	353	343	LADCP not working.	Nuts + PP + Div + DOM+	DH
4a	44	105	2009-10-27	00:35	76° 17.958	075° 44.906	313	310	LADCP not working.	Cont+Div	DH
4a	45	106	2009-10-28	02:37	76° 18.476	075° 21.264	380	375	LADCP not working.	CTD	DB
4a	46	107	2009-10-28	03:39	76° 16.855	074° 59.329	446	433	No problems	Nuts	DB
4a	47	108	2009-10-28	05:03	76° 13.776	074° 36.102	447	441	No problems	CTD	DB
4a	48	109	2009-10-28	10:18	76° 17.227	074° 06.940	447	444	Bottle #3 didn't close. 16 & 18 empty	Nuts+PP+Chem+DOM	DB
4a	49	109	2009-10-28	13:44	76° 17.212	074° 08.144	448	438	Bottle #3 didn't close	Cont+Div	DH
4a	50	110	2009-10-28	19:12	76° 17.716	073° 37.548	524	523	No problems.	Nuts	DH
4a	51	111	2009-10-28	21:14	76° 17.700	073° 12.628	559	553	All bottles closed.	Nuts+PP+DOM+Chem	DH
4a	52	111	2009-10-29	00:26	76° 17.308	073° 14.052	560	557	No problems.	Div+Cont	DH
4a	53	112	2009-10-29	03:44	76° 18.901	072° 42.346	567	558	Replaced missing o-ring on #16.	CTD	DH
4a	54	113	2009-10-29	04:57	76° 19.337	072° 13.716	550	551	No problems	Nutrients	DB
4a	55	114	2009-10-29	07:03	76° 19.439	071° 46.784	614	610	No problems	CTD	DB
4a	56	115	2009-10-29	16:01	76° 19.920	071° 11.726	672	672	Weird salinity and temperature profiles	PP + DOM	DB
4a	57	115	2009-10-29	19:04	76° 20.017	071° 11.738	654	654	No problem.	Nuts+chem	DH
4a	58	115	2009-10-29	22:48	76° 19.985	071° 14.420	667	668	No problem.	Cont+Div	DB
4a	59	136	2009-10-30	16:29	74° 45.833	073° 26.585	808	813	No problem.	PP+DOM	DH
4a	60	136	2009-10-30	19:21	74° 45.458	073° 33.466	779	783	Pump froze, cast had to be restarted. Nitrates probe not working for the first 70 m.	Nuts + Chem	DB
4a	61	136	2009-10-30	23:12	74° 42.458	073° 24.342	804	805	No problem	Cont + Div	DB
4a	62	141	2009-11-01	02:00	71° 27.917	070° 02.561	615	609	Downcast is noisy, upcast is fine.	CTD	DH
4a	63	141	2009-11-01	14:21	71° 24.870	070° 15.353	680	680	No problems	CTD	DB
4a	64	141	2009-11-01	21:14	71° 23.663	070° 08.766	423	417	Bottle #17 did not open.	Div+Cont+Box	DH
4a	65	141	2009-11-02	13:43	71° 23.950	070° 09.295	475	466	Really close to bottom, possibly stirred it.	Nuts+Chem+PP+DOM	DB
Leg 4b											
4b	66	352	2009-11-07	14:08	61° 15.868	064° 44.921	274	276	Remade the cast because of high currents. Still great angles in the cable.	Nutrients	DB
4b	67	354	2009-11-07	16:37	61° 00.504	064° 44.274	497	485	Cast cancelled due to faulty communication with the CTD during upcast.	Nutrients	DH
4b	68	600	2009-11-08	10:45	59° 05.208	063° 25.745	204	192	Mouth of Nachvak Fjord. Ship PAR sensor disabled, caused Deck Unit malfunction.	Nuts+PP+DOM+Hg	DH
4b	69	601	2009-11-08	14:28	59° 02.910	063° 36.209	166	157	Nachvak Fjord.	Nutrients	DH
4b	70	602	2009-11-09	00:09	59° 03.145	063° 52.312	151	142	No problem.	Nuts+PP+DOM+Hg	DH
4b	71	604	2009-11-09	03:41	58° 59.582	063° 53.701	62	53	No problem.	Nuts+PP+DOM	DB
4b	72	612	2009-11-09	11:33	58° 28.164	062° 59.060	44	36	Saglak Fjord. No problem.	CTD	DB
4b	73	613	2009-11-09	13:16	58° 28.985	063° 13.192	239	232	No problem.	Nutrients	DB
4b	74	613	2009-11-09	18:08	58° 29.081	063° 13.079	241	233	No problem.	CTD	DH
4b	75	614	2009-11-09	21:43	58° 24.125	063° 23.404	100	91	No problem.	CTD	DH
4b	76	615	2009-11-09	23:13	58° 19.376	063° 32.485	138	130	No problem.	Nuts+PP+DOM+Hg	DH

Appendix 3 - CTD logbook for the 2009 ArcticNet Expedition

Leg	Cast#	Station	Date Start UTC	Time Start UTC	Latitude N	Longitude W	Bottom depth (m)	Cast depth (m)	Comments	Rosette Type	Init.
4b	77	610	2009-11-10	07:21	58° 31.265	062° 50.413	127	119	No problem.	Nutrients	DB
4b	78	617	2009-11-10	12:14	58° 30.000	062° 41.212	135	127	No problem.	Nuts+PP+DOM+Hg	DH
4b	79	633	2009-11-11	04:57	57° 39.199	061° 53.490	165	160	Okak Fjord. No problem.	Nuts+PP+DOM+Hg	DB
4b	80	632	2009-11-11	10:12	57° 34.008	062° 03.398	83	80	No problem.	Nutrients	DB
4b	81	631	2009-11-11	19:42	57° 39.572	062° 11.635	91	83	Nooooooo problem	Nutrients	DH
4b	82	630	2009-11-11	23:09	57° 28.336	062° 26.521	51	42	No problem.	Nuts+PP+DOM+Hg	DH
4b	83	630	2009-11-12	02:10	57° 28.145	062° 26.381	51	43	No problem.	CTD	DB
4b	84	634	2009-11-12	06:50	57° 34.122	061° 56.412	102	92	No problem.	Contaminants + DO	DB
4b	85	620	2009-11-12	20:44	56° 23.807	061° 12.977	96	87	Anaktalak Fjord.	Nuts+PP+DOM+Hg	DH
4b	86	621	2009-11-13	03:14	56° 24.918	061° 31.078	113	102	No problem.	CTD	DB
4b	87	622	2009-11-13	04:10	56° 24.986	061° 43.924	85	77	No problem.	Nutrients	DB
4b	88	623	2009-11-13	05:26	56° 26.839	061° 56.413	119	110	No problem.	SonB	DB
4b	89	624	2009-11-13	06:29	56° 25.234	061° 04.360	71	55	Bottle 16 didn't close	Nuts+PP+DOM+Hg	DB

Appendix 4 - List of participants on Legs 1, 2, 3 and 4 of the ArcticNet Amundsen Expedition

Leg	Name	Position	Affiliation	Network Investigator/ Supervisor	Embark place	Embark date	Disembark place	Disembark date
Leg 1a Leg 1b	Latonas, Jeff	MSc student	University of Manitoba	Stern, Gary	Quebec City	4-Jun-09	Paulatuk	16-Jul-09
Leg 1b	Armstrong, Debbie	Research Associate	University of Manitoba	Stern, Gary	Victoria, B.C.	30-Jun-09	Paulatuk	16-Jul-09
Leg 1b	Babb, David	Technician	University of Manitoba	Barber, Dave	Victoria, B.C.	30-Jun-09	Paulatuk	16-Jul-09
Leg 1b	Baya, Anabelle	PhD student	Trent University	Hintelmann, Holger	Victoria, B.C.	30-Jun-09	Paulatuk	16-Jul-09
Leg 1b	Bricaud, Annick	Research Scientist	Laboratoire d'Océanographie de Villefranche	Babin, Marcel	Victoria, B.C.	30-Jun-09	Paulatuk	16-Jul-09
Leg 1b	Bruyant, Flavienne	PhD Student	Laboratoire d'Océanographie de Villefranche	Babin, Marcel	Victoria, B.C.	30-Jun-09	Paulatuk	16-Jul-09
Leg 1b	Candlish, Lauren	MSc Student	University of Manitoba	Barber, Dave	Victoria, B.C.	30-Jun-09	Paulatuk	16-Jul-09
Leg 1b	Cartwright, Doug	EM302 Operator	University of New-Brunswick	Hughes-Clark, John	Victoria, B.C.	30-Jun-09	Paulatuk	16-Jul-09
Leg 1b	Chami, Malik	Professor	Laboratoire d'Océanographie de Villefranche	Babin, Marcel	Victoria, B.C.	30-Jun-09	Paulatuk	16-Jul-09
Leg 1b	Church, Ian	EM-302 operator	University of New-Brunswick	Hughes-Clark, John	Victoria, B.C.	30-Jun-09	Paulatuk	16-Jul-09
Leg 1b	Colangelo-Lillis, Jesse	PhD student	University of of Washington	Deming, Jody	Victoria, B.C.	30-Jun-09	Paulatuk	16-Jul-09
Leg 1b	Coupel, Pierre	PhD student	Gascard, Jean-Claude	Babin, Marcel	Victoria, B.C.	30-Jun-09	Paulatuk	16-Jul-09
Leg 1b	Duplain, Alexandre	Research assistant	Laboratoire d'Océanographie de Villefranche	Babin, Marcel	Victoria, B.C.	30-Jun-09	Paulatuk	16-Jul-09
Leg 1b	Galindo, Virginie	Technician	Université Laval	Fortier, Louis	Victoria, B.C.	30-Jun-09	Paulatuk	16-Jul-09
Leg 1b	Hoccheim, Klaus	Research associate	University of Manitoba	Barber, Dave	Victoria, B.C.	30-Jun-09	Paulatuk	16-Jul-09
Leg 1b	Iacozza, John	PhD Student	University of Manitoba	Barber, Dave	Victoria, B.C.	30-Jun-09	Paulatuk	16-Jul-09
Leg 1b	Létourneau, Louis	Technician	Université Laval	Fortier, Louis	Victoria, B.C.	30-Jun-09	Paulatuk	16-Jul-09
Leg 1b	Levin, Jeremy	Media	Vancouver Aquarium	Fortier, Martin	Victoria, B.C.	30-Jun-09	Paulatuk	16-Jul-09
Leg 1b	Leymarie, Edouard	Engineer	Laboratoire d'Océanographie de Villefranche	Babin, Marcel	Victoria, B.C.	30-Jun-09	Paulatuk	16-Jul-09
Leg 1b	Marie, Dominique	Engineer	SBR	Babin, Marcel	Victoria, B.C.	30-Jun-09	Paulatuk	16-Jul-09
Leg 1b	Massot, Pascal	Technician	Université Laval	Michaud, Luc	Victoria, B.C.	30-Jun-09	Paulatuk	16-Jul-09
Leg 1b	Matsuoka, Atsushi	PDF	Laboratoire d'Océanographie de Villefranche	Babin, Marcel	Victoria, B.C.	30-Jun-09	Paulatuk	16-Jul-09
Leg 1b	McManus, Jordan	MSc student	UQAR	Bélanger, Simon	Victoria, B.C.	30-Jun-09	Paulatuk	16-Jul-09
Leg 1b	Michaud, Luc	Equipment manager	Université Laval	Michaud, Luc	Victoria, B.C.	30-Jun-09	Paulatuk	16-Jul-09
Leg 1b	Muggah, James	MVP operator	University of New-Brunswick	Hughes-Clark, John	Victoria, B.C.	30-Jun-09	Paulatuk	16-Jul-09
Leg 1b	Pind, Meredith	MSc student	University of Manitoba	Papakyriakou, Tim	Victoria, B.C.	30-Jun-09	Paulatuk	16-Jul-09
Leg 1b	Ras, Joséphine	Technician	Laboratoire d'Océanographie de Villefranche	Babin, Marcel	Victoria, B.C.	30-Jun-09	Paulatuk	16-Jul-09
Leg 1b	Stainton, Emmelia	MSc student	University of Manitoba	Papakyriakou, Tim	Victoria, B.C.	30-Jun-09	Paulatuk	16-Jul-09
Leg 1b	St-Germain, Frédéric	Technician	Université Laval	Michaud, Luc	Victoria, B.C.	30-Jun-09	Paulatuk	16-Jul-09
Leg 1b	Thirouard, Alexandre	Technician	Laboratoire d'Océanographie de Villefranche	Babin, Marcel	Victoria, B.C.	30-Jun-09	Paulatuk	16-Jul-09
Leg 1b	Tremblay, Jean-Éric	Chief scientist	Université Laval	Tremblay, Jean-Éric	Victoria, B.C.	30-Jun-09	Paulatuk	16-Jul-09
Leg 1b	Warner, Kerri-Ann	MSc student	University of Manitoba	Barber, Dave	Victoria, B.C.	30-Jun-09	Paulatuk	16-Jul-09
Leg 1b	Zheng, Guangming	PhD student	Scripps Institute of Oceanography	Reynolds, Rick	Victoria, B.C.	30-Jun-09	Paulatuk	16-Jul-09
Leg 1b Leg 2a	Else, Brent	PhD student	University of Manitoba	Papakyriakou, Tim	Victoria, B.C.	30-Jun-09	Paulatuk	30-Jul-09
Leg 2a	Asplin, Matthew	PhD Student	University of Manitoba	Barber, Dave	Paulatuk	16-Jul-09	Paulatuk	30-Jul-09
Leg 2a	Beaudoin, Jonathan	Technician	University of New-Brunswick	Hughes-Clark, John	Paulatuk	16-Jul-09	Paulatuk	30-Jul-09
Leg 2a	Bourgeois, Simon	MSc Student	UQAR	Archambault, Philippe	Paulatuk	16-Jul-09	Paulatuk	30-Jul-09
Leg 2a	Burt, Alexis	Technician	DFO	Stern, Gary	Paulatuk	16-Jul-09	Paulatuk	30-Jul-09
Leg 2a	Cadieux, Marc	PhD student	University of Manitoba	Stern, Gary	Paulatuk	16-Jul-09	Paulatuk	30-Jul-09
Leg 2a	Chaulk, Amanda	MSc student	University of Manitoba	Stern, Gary	Paulatuk	16-Jul-09	Paulatuk	30-Jul-09
Leg 2a	Fortier, Louis	Professor	Université Laval	Fortier, Louis	Paulatuk	16-Jul-09	Paulatuk	30-Jul-09
Leg 2a	Fortier, Martin	Chief scientist	ArcticNet	Fortier, Martin	Paulatuk	16-Jul-09	Paulatuk	30-Jul-09
Leg 2a	Galindo, Virginie	Technician	Université Laval	Fortier, Louis	Victoria, B.C.	17-Jul-09	Paulatuk	30-Jul-09
Leg 2a	Garcia, Nicole	Engineer	LMGEM	Raimbault, Patrick	Paulatuk	16-Jul-09	Paulatuk	30-Jul-09
Leg 2a	Gratton, Yves	Professor	Institut National de la Recherche Scientifique (INRS)	Gratton, Yves	Paulatuk	16-Jul-09	Paulatuk	30-Jul-09

Appendix 4 - List of participants on Legs 1, 2, 3 and 4 of the ArcticNet Amundsen Expedition

Leg	Name	Position	Affiliation	Network Investigator/ Supervisor	Embark place	Embark date	Disembark place	Disembark date
Leg 2a	Hamilton, Travis	EM-302 operator	University of New-Brunswick	Hughes-Clark, John	Paulatuk	16-Jul-09	Paulatuk	30-Jul-09
Leg 2a	Iacozza, John	PhD Student	University of Manitoba	Barber, Dave	Victoria, B.C.	17-Jul-09	Paulatuk	30-Jul-09
Leg 2a	Lemes, Marcos	PhD student	University of Manitoba	Wang, Feiyue	Paulatuk	16-Jul-09	Paulatuk	30-Jul-09
Leg 2a	Létourneau, Louis	Technician	Université Laval	Fortier, Louis	Victoria, B.C.	17-Jul-09	Paulatuk	30-Jul-09
Leg 2a	Levesque, Mélanie	Technician	UQAR	Archambault, Philippe	Paulatuk	16-Jul-09	Paulatuk	30-Jul-09
Leg 2a	Li, Tao	PhD Student	University of Manitoba	Barber, Dave	Paulatuk	16-Jul-09	Paulatuk	30-Jul-09
Leg 2a	Marec, Claudie	Engineer	Institut National des Sciences de l'Univers (INSU)	Babin, Marcel	Paulatuk	16-Jul-09	Paulatuk	30-Jul-09
Leg 2a	Martin, Joannie	PhD student	Université Laval	Tremblay, Jean-Éric	Paulatuk	16-Jul-09	Paulatuk	30-Jul-09
Leg 2a	Massot, Pascal	Technician	Université Laval	Michaud, Luc	Victoria, B.C.	17-Jul-09	Paulatuk	30-Jul-09
Leg 2a	Michaud, Luc	Equipment manager	Université Laval	Michaud, Luc	Victoria, B.C.	17-Jul-09	Paulatuk	30-Jul-09
Leg 2a	Papakyriakou, Tim	Professor	University of Manitoba	Papakyriakou, Tim	Paulatuk	16-Jul-09	Paulatuk	30-Jul-09
Leg 2a	Petrosevich, Vlad	Technician	University of Manitoba	Papakyriakou, Tim	Paulatuk	16-Jul-09	Paulatuk	30-Jul-09
Leg 2a	Picheral, Marc	Engineer	Laboratoire d'Océanographie de Villefranche	Babin, Marcel	Paulatuk	16-Jul-09	Paulatuk	30-Jul-09
Leg 2a	Prieur, Louis	Professor	Laboratoire d'Océanographie de Villefranche	Babin, Marcel	Paulatuk	16-Jul-09	Paulatuk	30-Jul-09
Leg 2a	Stammers, Chris	Technician	University of Manitoba	Barber, Dave	Paulatuk	16-Jul-09	Paulatuk	30-Jul-09
Leg 2a	St-Germain, Frédéric	Technician	Université Laval	Michaud, Luc	Victoria, B.C.	17-Jul-09	Paulatuk	30-Jul-09
Leg 2b	Antoine, David	Research Scientist	Laboratoire d'Océanographie de Villefranche	Babin, Marcel	Paulatuk	30-Jul-09	Paulatuk	27-Aug-09
Leg 2b	Babin, Marcel	Research Scientist	Laboratoire d'Océanographie de Villefranche	Babin, Marcel	Paulatuk	30-Jul-09	Paulatuk	27-Aug-09
Leg 2b	Beaudoin, Jonathan	Technician	University of New-Brunswick	Hughes-Clark, John	Paulatuk	31-Jul-09	Paulatuk	27-Aug-09
Leg 2b	Bélanger, Simon	Professor	Université du Québec à Rimouski (UQAR)	Babin, Marcel	Paulatuk	30-Jul-09	Paulatuk	27-Aug-09
Leg 2b	Benner, Ron	Professor	University of South Carolina	Babin, Marcel	Paulatuk	30-Jul-09	Paulatuk	27-Aug-09
Leg 2b	Bruyant, Flavienne	Research Assistant	Université de Sherbrooke	Babin, Marcel	Paulatuk	30-Jul-09	Paulatuk	27-Aug-09
Leg 2b	Charrière, Bruno	Engineer	Laboratoire de Microbiologie, Géochimie et Ecologie Marine (LMGEM)	Sempéré, Richard	Paulatuk	30-Jul-09	Paulatuk	27-Aug-09
Leg 2b	Doxaran, David	Research Scientist	Laboratoire d'Océanographie de Villefranche	Babin, Marcel	Paulatuk	30-Jul-09	Paulatuk	27-Aug-09
Leg 2b	Ehn, Jens	PDF	Laboratoire d'Océanographie de Villefranche	Babin, Marcel	Paulatuk	30-Jul-09	Paulatuk	27-Aug-09
Leg 2b	Faubert, Etienne	Technician	Institut des Sciences de la Mer (ISMER)	Rochon, André				
Leg 2b	Gagnon, Jonathan	Technician	Université Laval	Tremblay, Jean-Eric	Paulatuk	30-Jul-09	Paulatuk	27-Aug-09
Leg 2b	Gasser, Beat	Engineer	International Atomic Energy Agency (IAEA)	Babin, Marcel	Paulatuk	30-Jul-09	Paulatuk	27-Aug-09
Leg 2b	Gratton, Yves	Professor	Institut National de la Recherche Scientifique (INRS)	Gratton, Yves	Paulatuk	31-Jul-09	Paulatuk	27-Aug-09
Leg 2b	Hamilton, Travis	EM-302 operator	University of New-Brunswick	Hughes-Clark, John	Paulatuk	31-Jul-09	Paulatuk	27-Aug-09
Leg 2b	Hooker, Stan	Research Scientist	Nasa	Hooker, Stan	Paulatuk	30-Jul-09	Paulatuk	27-Aug-09
Leg 2b	Huot, Yannick	Professor	Université de Sherbrooke	Babin, Marcel	Paulatuk	30-Jul-09	Paulatuk	27-Aug-09
Leg 2b	Jeanthon, Christian	Research Director CNRS	Station Biologique de Roscoff (SBR)	Vaulot, Daniel	Paulatuk	30-Jul-09	Paulatuk	27-Aug-09
Leg 2b	Jeffrey, Wade	Professor	Laboratoire d'Océanographie Biologique de Banyuls (LOBB)	Babin, Marcel	Paulatuk	30-Jul-09	Paulatuk	27-Aug-09
Leg 2b	Jerome, Daphne	Wildlife Monitor	ArcticNet	Inuvialuit Game Council	Paulatuk	30-Jul-09	Paulatuk	27-Aug-09
Leg 2b	Joux, Fabien	Research Scientist	Laboratoire d'Océanographie Biologique de Banyuls (LOBB)	Babin, Marcel	Paulatuk	30-Jul-09	Paulatuk	27-Aug-09
Leg 2b	Lansard, Bruno	PDF	McGill University	Mucci, Alfonso	Paulatuk	30-Jul-09	Paulatuk	27-Aug-09
Leg 2b	Levesque, Keith	ArcticNet coordinator	Université Laval	Fortier, Louis	Paulatuk	30-Jul-09	Paulatuk	27-Aug-09
Leg 2b	Leymarie, Edouard	Engineer	Laboratoire d'Océanographie de Villefranche	Babin, Marcel	Paulatuk	30-Jul-09	Paulatuk	27-Aug-09
Leg 2b	Link, Heike	PhD student	Institut des Sciences de la Mer (ISMER)	Archambault, Philippe	Paulatuk	30-Jul-09	Paulatuk	27-Aug-09
Leg 2b	Lovejoy, Connie	Professor	Université Laval	Lovejoy, Connie	Paulatuk	30-Jul-09	Paulatuk	27-Aug-09
Leg 2b	Marec, Claudie	Engineer	Institut National des Sciences de l'Univers (INSU)	Gratton, Yves	Paulatuk	31-Jul-09	Paulatuk	27-Aug-09

Appendix 4 - List of participants on Legs 1, 2, 3 and 4 of the ArcticNet Amundsen Expedition

Leg	Name	Position	Affiliation	Network Investigator/ Supervisor	Embark place	Embark date	Disembark place	Disembark date
Leg 2b	Marie, Dominique	Engineer	Station Biologique de Roscoff (SBR)	Babin, Marcel	Paulatuk	30-Jul-09	Paulatuk	27-Aug-09
Leg 2b	Martin, Jacobo	PhD Student	International Atomic Energy Agency (IAEA)	Babin, Marcel	Paulatuk	30-Jul-09	Paulatuk	27-Aug-09
Leg 2b	Martin, Joannie	PhD student	Université Laval	Tremblay, Jean-Éric	Paulatuk	31-Jul-09	Paulatuk	27-Aug-09
Leg 2b	Massé, Guillaume	Research Scientist	LOCEAN	Babin, Marcel				
Leg 2b	Massot, Pascal	Technician	Université Laval	Michaud, Luc	Victoria, B.C.	31-Jul-09	Paulatuk	27-Aug-09
Leg 2b	Matsuoka, Atsushi	PDF	Laboratoire d'Océanographie de Villefranche	Babin, Marcel	Paulatuk	30-Jul-09	Paulatuk	27-Aug-09
Leg 2b	Mignot, Alexandre	PhD Student	Laboratoire d'Océanographie de Villefranche	Ras, Joséphine	Paulatuk	30-Jul-09	Paulatuk	27-Aug-09
Leg 2b	Ortega, Eva	PDF	Laboratoire d'Océanographie Biologique de Banyuls (LOBB)	Babin, Marcel	Paulatuk	30-Jul-09	Paulatuk	27-Aug-09
Leg 2b	Para, Julien	PhD student	Laboratoire de Microbiologie, Géochimie et Ecologie Marine (LMGEM)	Sempéré, Richard	Paulatuk	30-Jul-09	Paulatuk	27-Aug-09
Leg 2b	Pind, Meredith	PhD student	University of Manitoba	Papakyriakou, Tim	Paulatuk	30-Jul-09	Paulatuk	27-Aug-09
Leg 2b	Prieur, Louis	Professor	Laboratoire d'Océanographie de Villefranche	Gratton, Yves	Paulatuk	31-Jul-09	Paulatuk	27-Aug-09
Leg 2b	Raimbault, Patrick	Research scientist	Laboratoire de Microbiologie, Géochimie et Ecologie Marine (LMGEM)	Raimbault, Patrick	Paulatuk	30-Jul-09	Paulatuk	27-Aug-09
Leg 2b	Reynolds, Rick	Research Scientist	Scripps Institution of Oceanography	Reynolds, Rick	Paulatuk	30-Jul-09	Paulatuk	27-Aug-09
Leg 2b	Rochon, André	Research Scientist	Institut des Sciences de la Mer (ISMER)	Rochon, André				
Leg 2b	Song, Guisheng	PhD student	Institut des Sciences de la Mer (ISMER)	Babin, Marcel	Paulatuk	30-Jul-09	Paulatuk	27-Aug-09
Leg 2b	St-Germain, Frédéric	Technician	Université Laval	Michaud, Luc	Victoria, B.C.	31-Jul-09	Paulatuk	27-Aug-09
Leg 2b	Thirouard, Alexandre	Technician	Laboratoire d'Océanographie de Villefranche	Babin, Marcel	Paulatuk	30-Jul-09	Paulatuk	27-Aug-09
Leg 2b	Vaulot, Daniel	Research Scientist	Station Biologique de Roscoff (SBR)	Babin, Marcel	Paulatuk	30-Jul-09	Paulatuk	27-Aug-09
Leg 2b	Wright, Vanessa	Research Scientist	Nasa	Hooker, Stan	Paulatuk	30-Jul-09	Paulatuk	27-Aug-09
Leg 2b	Xie, Huixiang	Professor	Institut des Sciences de la Mer (ISMER)	Babin, Marcel	Paulatuk	30-Jul-09	Paulatuk	27-Aug-09
Leg 3a	Amini, Marghaleray	Postdoctoral Fellow	University of Saskatchewan	Francois, Roger/Holmden, Chris	Paulatuk	27-Aug-09	Paulatuk	12-Sep-09
Leg 3a	Asher, Elizabeth	PhD Student	University of British Columbia	Francois, Roger/Tortell, Philippe	Paulatuk	27-Aug-09	Paulatuk	12-Sep-09
Leg 3a	Asplin, Matthew	PhD Student	University of Manitoba	Barber, Dave	Paulatuk	27-Aug-09	Paulatuk	12-Sep-09
Leg 3a	Barber, Dave	Professor	University of Manitoba	Barber, Dave	Paulatuk	27-Aug-09	Paulatuk	12-Sep-09
Leg 3a	Bart De, Baere	PhD student	University of British Columbia	Francois, Roger	Paulatuk	27-Aug-09	Paulatuk	12-Sep-09
Leg 3a	Beverage, Ian	Research Scientist	University of Victoria	Francois, Roger/Cullen, Jay	Paulatuk	27-Aug-09	Paulatuk	12-Sep-09
Leg 3a	Blondeau, Sylvain	Technician	Université Laval	Michaud, Luc	Paulatuk	27-Aug-09	Paulatuk	12-Sep-09
Leg 3a	Boisvert, Dominique	Technician	INRS	Gratton, Yves	Paulatuk	27-Aug-09	Quebec City	12-Sep-09
Leg 3a	Brown, Kristina	PhD Student	University of British Columbia	Francois, Roger/Tortell, Philippe	Paulatuk	27-Aug-09	Paulatuk	12-Sep-09
Leg 3a	Carpenter, Jason	Senior Instructor	Nunavut Arctic College	Inuvialuit Game Council	Paulatuk	27-Aug-09	Paulatuk	12-Sep-09
Leg 3a	Cullen, Jay	Research scientist	University of Victoria	Francois, Roger	Paulatuk	27-Aug-09	Paulatuk	12-Sep-09
Leg 3a	Francois, Roger	Research scientist	University of British Columbia	Francois, Roger	Paulatuk	27-Aug-09	Paulatuk	12-Sep-09
Leg 3a	Gagnon, Jonathan	Technician	Université Laval	Tremblay, Jean-Eric	Paulatuk	28-Aug-09	Paulatuk	12-Sep-09
Leg 3a	Galley, Ryan	Research associate	University of Manitoba	Barber, Dave	Paulatuk	27-Aug-09	Paulatuk	12-Sep-09
Leg 3a	Guignard, Constance	Research Associate	McGill University	Mucci, Alfonso	Paulatuk	27-Aug-09	Paulatuk	12-Sep-09
Leg 3a	Gupta, Mukesh	PhD student	University of Manitoba	Barber, Dave	Paulatuk	27-Aug-09	Paulatuk	12-Sep-09
Leg 3a	Hale, Michelle	Research scientist	Memorial University	Francois, Roger/Rivkin, Richard	Paulatuk	27-Aug-09	Paulatuk	12-Sep-09
Leg 3a	Hamilton, Adam	Research scientist	Memorial University	Francois, Roger/Rivkin, Richard	Paulatuk	27-Aug-09	Paulatuk	12-Sep-09
Leg 3a	Hernandez, Maria	PhD Student	University of Victoria	Francois, Roger/Varela, Diana	Paulatuk	27-Aug-09	Paulatuk	12-Sep-09
Leg 3a	Kobryn, Arielle	PhD Student	University of Victoria	Francois, Roger/Varela, Diana	Paulatuk	27-Aug-09	Paulatuk	12-Sep-09
Leg 3a	Lucas, Trevor	Wildlife monitor	ArcticNet	Inuvialuit Game Council	Paulatuk	27-Aug-09	Paulatuk	12-Sep-09
Leg 3a	Maldonado, Maite	Research scientist	University of British Columbia	Francois, Roger	Paulatuk	27-Aug-09	Paulatuk	12-Sep-09

Appendix 4 - List of participants on Legs 1, 2, 3 and 4 of the ArcticNet Amundsen Expedition

Leg	Name	Position	Affiliation	Network Investigator/ Supervisor	Embark place	Embark date	Disembark place	Disembark date
Leg 3a	McAlister, Jason	PhD Student	University of British Columbia	Francois, Roger/Orians, Kristin	Paulatuk	27-Aug-09	Paulatuk	12-Sep-09
Leg 3a	Orians, Kristin	Research scientist	University of British Columbia	Francois, Roger	Paulatuk	27-Aug-09	Paulatuk	12-Sep-09
Leg 3a	Ouellet, Jean	Technician	Université Laval	Michaud, Luc	Paulatuk	27-Aug-09	Paulatuk	12-Sep-09
Leg 3a	Payne, Chris	Research scientist	University of British Columbia	Francois, Roger/Maldonado, Maria	Paulatuk	27-Aug-09	Paulatuk	12-Sep-09
Leg 3a	Prinsenberg, Simon	Research scientist	DFO	Barber, Dave	Paulatuk	27-Aug-09	Paulatuk	12-Sep-09
Leg 3a	Pucko, Monika	PhD student	University of Manitoba	Stern, Gary	Paulatuk	27-Aug-09	Paulatuk	12-Sep-09
Leg 3a	Ramirez, Elena	PhD Student	University of Victoria	Francois, Roger/Cullen, Jay	Paulatuk	27-Aug-09	Paulatuk	12-Sep-09
Leg 3a	Rivkin, Richard	Professor	Memorial University	Francois, Roger	Paulatuk	27-Aug-09	Paulatuk	12-Sep-09
Leg 3a	Semeniuk, Dave	PhD Student	University of British Columbia	Francois, Roger/Maldonado, Maria	Paulatuk	27-Aug-09	Paulatuk	12-Sep-09
Leg 3a	Soon, Maureen	Research scientist	University of British Columbia	Francois, Roger	Paulatuk	27-Aug-09	Paulatuk	12-Sep-09
Leg 3a	Sternberg, Erika	PDF	Dalhousie University	Francois, Roger/Thomas, Helmuth	Paulatuk	27-Aug-09	Paulatuk	12-Sep-09
Leg 3a	Sutherland, Ness	Research scientist	IOS	Francois, Roger/Miller, Lisa	Paulatuk	27-Aug-09	Paulatuk	12-Sep-09
Leg 3a	Swystun, Kyle	PhD student	University of Manitoba	Papakyriakou, Tim	Paulatuk	27-Aug-09	Paulatuk	12-Sep-09
Leg 3a	Taylor, Rebecca	PhD Student	University of British Columbia	Francois, Roger/Maldonado, Maria	Paulatuk	27-Aug-09	Paulatuk	12-Sep-09
Leg 3a	Tucker, Jane	Research scientist	Memorial University	Francois, Roger/Rivkin, Richard	Paulatuk	27-Aug-09	Paulatuk	12-Sep-09
Leg 3a	Varela, Diana	Research scientist	University of Victoria	Francois, Roger	Paulatuk	27-Aug-09	Paulatuk	12-Sep-09
Leg 3a	Warner, Kerri-Ann	MSc student	University of Manitoba	Barber, Dave	Paulatuk	27-Aug-09	Paulatuk	12-Sep-09
Leg 3a Leg 3b	Church, Ian	EM302 operator	University of New-Brunswick	Hughes-Clark, John	Paulatuk	27-Aug-09	Paulatuk	8-Oct-09
Leg 3a Leg 3b	Dansereau, Véronique	Technician	INRS	Gratton, Yves	Paulatuk	27-Aug-09	Paulatuk	8-Oct-09
Leg 3b	Auger, Vincent	Professional	ROPOS	Michaud, Luc	Paulatuk	12-Sep-09	Paulatuk	8-Oct-09
Leg 3b	Blasco, Katie	Research Assistant	Geological Survey of Canada	Blasco, Steve	Paulatuk	12-Sep-09	Iqaluit	8-Oct-09
Leg 3b	Blasco, Steve	Research Scientist	Geological Survey of Canada	Blasco, Steve	Paulatuk	12-Sep-09	Paulatuk	8-Oct-09
Leg 3b	Blondeau, Sylvain	Technician	Université Laval	Michaud, Luc	Paulatuk	13-Sep-09	Paulatuk	8-Oct-09
Leg 3b	Boisvert, Dominique	Technician	INRS	Gratton, Yves	Paulatuk	13-Sep-09	Quebec City	8-Oct-09
Leg 3b	Candlish, Lauren	MSc Student	University of Manitoba	Barber, Dave	Paulatuk	12-Sep-09	Paulatuk	8-Oct-09
Leg 3b	Gupta, Mukesh	PhD Student	University of Manitoba	Barber, Dave	Paulatuk	13-Sep-09	Paulatuk	8-Oct-09
Leg 3b	Hoccheim, Klaus	Research Associate	University of Manitoba	Barber, Dave	Paulatuk	12-Sep-09	Paulatuk	8-Oct-09
Leg 3b	Hughes-Clark, John	Professor	University of New-Brunswick	Hughes-Clark, John	Paulatuk	12-Sep-09	Paulatuk	8-Oct-09
Leg 3b	Jarrett, Kate	Coring Technician	Geological Survey of Canada	Blasco, Steve	Paulatuk	12-Sep-09	Paulatuk	8-Oct-09
Leg 3b	Li, Tao	PhD Student	University of Manitoba	Barber, Dave	Paulatuk	12-Sep-09	Paulatuk	8-Oct-09
Leg 3b	MacKillop, Kevin	Coring Technician	Geological Survey of Canada	Blasco, Steve	Paulatuk	12-Sep-09	Paulatuk	8-Oct-09
Leg 3b	Muggah, James	EM302 Operator	University of New-Brunswick	Hughes-Clark, John	Paulatuk	12-Sep-09	Paulatuk	8-Oct-09
Leg 3b	Murphy, Bob	Coring Technician	Geological Survey of Canada	Blasco, Steve	Paulatuk	12-Sep-09	Paulatuk	8-Oct-09
Leg 3b	Ouellet, Jean	Technician	Université Laval	Michaud, Luc	Paulatuk	13-Sep-09	Paulatuk	8-Oct-09
Leg 3b	Papakyriakou, Tim	Chief scientist	University of Manitoba	Papakyriakou, Tim	Paulatuk	12-Sep-09	Paulatuk	8-Oct-09
Leg 3b	Pienkowski-Furze, Anna	PhD / Coring Tech	University of Alberta	Blasco, Steve	Paulatuk	12-Sep-09	Paulatuk	8-Oct-09
Leg 3b	Smith, Roy	Wildlife monitor	ArcticNet	Fortier, Martin	Paulatuk	12-Sep-09	Paulatuk	8-Oct-09
Leg 3b	Stainton, Emmelia	MSc student	University of Manitoba	Papakyriakou, Tim	Paulatuk	12-Sep-09	Paulatuk	8-Oct-09
Leg 3b	Toodesh, Reenu	MSc student	University of New-Brunswick	Hughes-Clark, John	Paulatuk	12-Sep-09	Paulatuk	8-Oct-09
Leg 4a	Aubry, Cyril	PhD Student	Université Laval	Fortier, Louis	Paulatuk	8-Oct-09	Iqaluit	6-Nov-09
Leg 4a	Bailey, Joscelyn	MSc Student	University of Manitoba	Stern, Gary	Paulatuk	8-Oct-09	Iqaluit	6-Nov-09
Leg 4a	Bergeron, Myriame	MSc Student	Université Laval	Tremblay, Jean-Éric	Paulatuk	8-Oct-09	Iqaluit	6-Nov-09
Leg 4a	Blasco, Katie	Research Assistant	Geological Survey of Canada	Blasco, Steve	Paulatuk	9-Oct-09	Iqaluit	6-Nov-09
Leg 4a	Bourseillier, Philippe	Media	Figaro Magazine	Fortier, Martin	Paulatuk	8-Oct-09	Iqaluit	6-Nov-09
Leg 4a	Delaronde, Joanne	Technician	DFO	Stern, Gary	Paulatuk	8-Oct-09	Iqaluit	6-Nov-09

Appendix 4 - List of participants on Legs 1, 2, 3 and 4 of the ArcticNet Amundsen Expedition

Leg	Name	Position	Affiliation	Network Investigator/ Supervisor	Embark place	Embark date	Disembark place	Disembark date
Leg 4a	Gagné, Steeve	Technician	Université Laval	Michaud, Luc	Paulatuk	8-Oct-09	Iqaluit	6-Nov-09
Leg 4a	Galley, Ryan	Research Associate	University of Manitoba	Barber, Dave	Paulatuk	8-Oct-09	Iqaluit	6-Nov-09
Leg 4a	Lansard, Bruno	PDF	U. McGill	Mucci, Alfonso	Paulatuk	8-Oct-09	Iqaluit	6-Nov-09
Leg 4a	Levesque, Keith	Chief scientist	ArcticNet	Fortier, Martin	Paulatuk	8-Oct-09	Iqaluit	6-Nov-09
Leg 4a	Levesque, Mélanie	Technician	UQAR	Archambault, Philippe	Paulatuk	8-Oct-09	Iquluit	6-Nov-09
Leg 4a	Link, Heike	PhD student	UQAR	Archambault, Philippe	Paulatuk	8-Oct-09	Iqaluit	6-Nov-09
Leg 4a	Michaud, Luc	Equipment manager	Université Laval	Michaud, Luc	Paulatuk	8-Oct-09	Iqaluit	6-Nov-09
Leg 4a	Pangrazi, Jean-Jacques	Technician	Laboratoire d'Océanographie de Villefranche	Babin, Marcel	Paulatuk	8-Oct-09	Iqaluit	6-Nov-09
Leg 4a	Pineault, Simon	MSc student	Université Laval	Tremblay, Jean-Éric	Paulatuk	8-Oct-09	Iqaluit	6-Nov-09
Leg 4a	Robertson, Angus	Engineer	Geological Survey of Canada	Blasco, Steve	Paulatuk	8-Oct-09	Iqaluit	6-Nov-09
Leg 4a	Stainton, Emmelia	MSc student	University of Manitoba	Papakyriakou, Tim	Paulatuk	9-Oct-09	Iqaluit	6-Nov-09
Leg 4a	Thaler, Mary	PhD student	Université Laval	Lovejoy, Connie	Paulatuk	8-Oct-09	Iqaluit	6-Nov-09
Leg 4a	Toujani, Ahmed	MSc student	UQAR	Gosselin, Michel	Paulatuk	8-Oct-09	Iqaluit	6-Nov-09
Leg 4a	Warner, Kerri-Ann	MSc student	University of Manitoba	Barber, Dave	Paulatuk	8-Oct-09	Iqaluit	6-Nov-09
Leg 4a Leg 4b	Ardyna, Mathieu	MSc Student	UQAR	Gosselin, Michel	Paulatuk	8-Oct-09	Quebec City	18-Nov-09
Leg 4a Leg 4b	Baya, Anabelle	PhD student	Trent University	Hintelmann, Holger	Paulatuk	8-Oct-09	Quebec City	18-Nov-09
Leg 4a Leg 4b	Bois, Jérôme	PhD student	Laboratoire d'Océanographie de Villefranche	Babin, Marcel	Paulatuk	8-Oct-09	Quebec City	18-Nov-09
Leg 4a Leg 4b	Boisvert, Dominique	Technician	INRS	Gratton, Yves	Paulatuk	9-Oct-09	Quebec City	18-Nov-09
Leg 4a Leg 4b	Cartwright, Doug	EM302 Operator	University of New-Brunswick	Hughes-Clark, John	Paulatuk	8-Oct-09	Quebec City	18-Nov-09
Leg 4a Leg 4b	Cloutier, Hélen	Technician	Université Laval	Fortier, Louis	Paulatuk	8-Oct-09	Quebec City	18-Nov-09
Leg 4a Leg 4b	Dupuis, Vincent	Technician	Université Laval	Michaud, Luc	Paulatuk	8-Oct-09	Quebec City	18-Nov-09
Leg 4a Leg 4b	Ferland, Joannie	Technician	UQAR	Gosselin, Michel	Paulatuk	8-Oct-09	Quebec City	18-Nov-09
Leg 4a Leg 4b	Gauthier, Maéva	MSc student	University of Victoria	Juniper, Kim	Paulatuk	8-Oct-09	Quebec City	18-Nov-09
Leg 4a Leg 4b	Geoffroy, Maxime	MSc Student	Université Laval	Fortier, Louis	Paulatuk	8-Oct-09	Quebec City	18-Nov-09
Leg 4a Leg 4b	Huard, David	PDF	INRS	Gratton, Yves	Paulatuk	8-Oct-09	Quebec City	18-Nov-09
Leg 4a Leg 4b	Legere, Christine	EM302 Operator	University of New-Brunswick	Hughes-Clark, John	Paulatuk	8-Oct-09	Quebec City	18-Nov-09
Leg 4a Leg 4b	Massot, Pascal	Technician	Université Laval	Michaud, Luc	Paulatuk	8-Oct-09	Quebec City	18-Nov-09
Leg 4a Leg 4b	Obolenski, Grigor	Technician	Laboratoire d'Océanographie de Villefranche	Babin, Marcel	Paulatuk	8-Oct-09	Quebec City	18-Nov-09
Leg 4a Leg 4b	Stolze, Lina	PhD student	Memorial University	Bentley, Sam	Paulatuk	8-Oct-09	Quebec City	18-Nov-09
Leg 4a Leg 4b	Tong, Eunice	Technician	IOS	Miller, Lisa	TBD	8-Oct-09	Iqaluit	18-Nov-09
Leg 4a Leg 4b	Wurl, Oliver	PDF	IOS	Miller, Lisa	Paulatuk	8-Oct-09	Iqaluit	18-Nov-09
Leg 4b	Angnatok, Joey	Professional	ArcticNet	Fortier, Martin	Iqaluit	6-Nov-09	Nain	12-Nov-09
Leg 4b	Arnold, Mandy	Professional	Schools on Board	Barber, Lucette	Iqaluit	6-Nov-09	Quebec City	18-Nov-09
Leg 4b	Baikie, Caitlyn	Student	SoB Nunatsiavut participant	Sheldon, Tom	Iqaluit	6-Nov-09	Quebec City	18-Nov-09
Leg 4b	Bajer-Koulack, Ameena	Student	Schools on Board	Barber, Lucette	Iqaluit	6-Nov-09	Quebec City	18-Nov-09
Leg 4b	Barber, Lucette	Professional	Schools on Board	Barber, Lucette	Iqaluit	6-Nov-09	Quebec City	18-Nov-09
Leg 4b	Bentley, Sam	Professor	Memorial University	Bentley, Sam	Iqaluit	6-Nov-09	Quebec City	18-Nov-09
Leg 4b	Berben, Alysha	Student	Schools on Board	Barber, Lucette	Iqaluit	6-Nov-09	Quebec City	18-Nov-09
Leg 4b	Braisdell, Rory	Student	Schools on Board	Barber, Lucette	Iqaluit	6-Nov-09	Quebec City	18-Nov-09
Leg 4b	Brochu, Rosalie	Student	Schools on Board	Barber, Lucette	Iqaluit	6-Nov-09	Quebec City	18-Nov-09
Leg 4b	Brown, Tanya	Research Assistant	Royal Military College	Reimer, Ken	Iqaluit	6-Nov-09	Quebec City	18-Nov-09
Leg 4b	Denniston, Mary	Nunatsiavut student	ESG	Reimer, Ken	Iqaluit	6-Nov-09	Quebec City	18-Nov-09
Leg 4b	Estrada, Esteban	Research assistant	Royal Military College	Reimer, Ken	Iqaluit	6-Nov-09	Quebec City	18-Nov-09
Leg 4b	Gauci, Danielle	Teacher	Schools on Board	Barber, Lucette	Iqaluit	6-Nov-09	Quebec City	18-Nov-09
Leg 4b	Hegel, Max	Professional	Schools on Board	Barber, Lucette	Iqaluit	6-Nov-09	Quebec City	18-Nov-09

Appendix 4 - List of participants on Legs 1, 2, 3 and 4 of the ArcticNet Amundsen Expedition

Leg	Name	Position	Affiliation	Network Investigator/ Supervisor	Embark place	Embark date	Disembark place	Disembark date
Leg 4b	Hollet, Rebecca	SoB Student	Schools on Board	Barber, Lucette	Iqaluit	6-Nov-09	Quebec City	18-Nov-09
Leg 4b	Huelse, Peter	PhD Student	Memorial University	Bentley, Sam	Iqaluit	6-Nov-09	Quebec City	18-Nov-09
Leg 4b	LeBlanc, Bonita	SoB Student	Schools on Board	Barber, Lucette	Iqaluit	6-Nov-09	Quebec City	18-Nov-09
Leg 4b	Murdock, Ian	Professional	CSSF	Juniper, Kim	Iqaluit	6-Nov-09	Quebec City	18-Nov-09
Leg 4b	Onalik, Germaine	SoB Student	SoB Nunatsiavut participant	Sheldon, Tom	Iqaluit	6-Nov-09	Quebec City	18-Nov-09
Leg 4b	Pienitz, Reinhard	Professor	Université Laval	Pienitz, Reinhard	Iqaluit	6-Nov-09	Quebec City	18-Nov-09
Leg 4b	Richerol, Thomas	PhD student	Université Laval	Pienitz, Reinhard	Iqaluit	6-Nov-09	Quebec City	18-Nov-09
Leg 4b	Sandrelli-Hotte, Rebeccah	SoB Student	Schools on Board	Barber, Lucette	Iqaluit	6-Nov-09	Quebec City	18-Nov-09
Leg 4b	Wolfrey, Jobie	SoB Student	SoB Nunatsiavut participant	Sheldon, Tom	Iqaluit	6-Nov-09	Quebec City	18-Nov-09