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2014 | Expedition Report

CCGS *Amundsen*

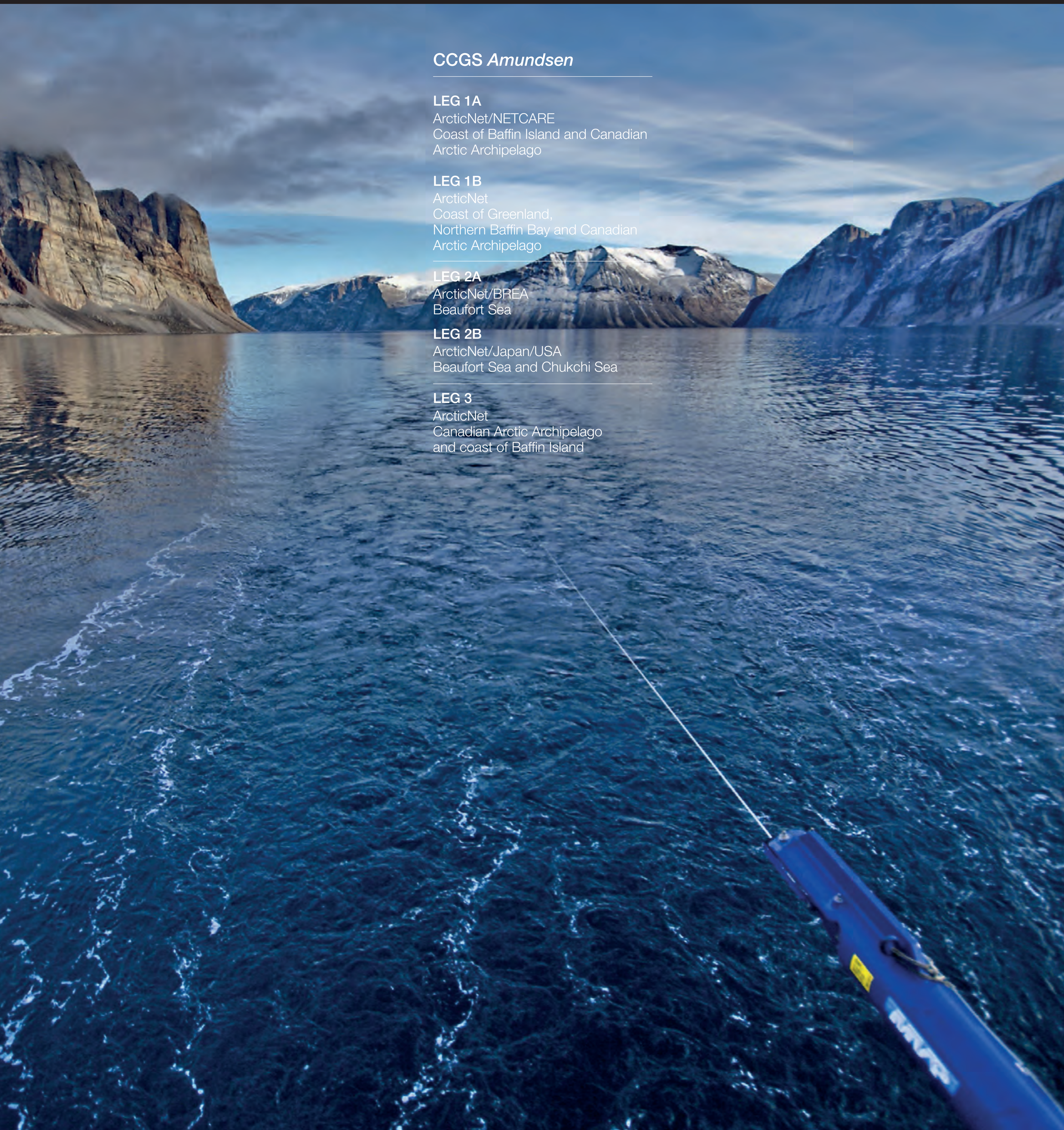
LEG 1A
ArcticNet/NETCARE
Coast of Baffin Island and Canadian Arctic Archipelago

LEG 1B
ArcticNet
Coast of Greenland, Northern Baffin Bay and Canadian Arctic Archipelago

LEG 2A
ArcticNet/BREA
Beaufort Sea

LEG 2B
ArcticNet/Japan/USA
Beaufort Sea and Chukchi Sea

LEG 3
ArcticNet
Canadian Arctic Archipelago and coast of Baffin Island



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NGCC • CCGS
AMUNDSEN
BRISE-GLACE DE RECHERCHE CANADIEN
CANADIAN RESEARCH ICEBREAKER

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2014 Expedition Report

The 2014 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 Legs 1, 2 and 3 of the ArcticNet Expedition onboard the CCGS *Amundsen*. The 2014 Expedition Report is divided into two parts:

Part I provides an overview of the expedition, the ship track and the stations visited, and a synopsis of operations conducted during each of the three legs.

Part II contains the reports submitted by 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 2014. The data presented in this 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.

The sections in Part II describing each project are organized with atmospheric, surface ocean and sea ice components first (Sections 1 to 6), followed by water column properties, which include mooring and remote sensing programs (Sections 7 to 10), CTD-Rosette operations and physical properties (Sections 11 and 12), as well as a suite of chemical and biological parameters (Sections 13 to 19, 21 and 22). Contaminants cycling in seawater and biota are treated in Section 20. Subsequent sections cover seabed mapping (Section 23), sediments and benthos sampling (Sections 24, 25 and 27 to 29), and ROV operations (Section 26). The ultimate Section 30 details the Schools on Board program.

The 2014 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 oceanographic data generated by the CTD-Rosette operations, as well as meteorological information (AAVOS) and data collected using the Moving Vessel Profiler (MVP), the ship-mounted current meter (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 2014 ArcticNet / *Amundsen* Expedition

1.1 Introduction

Recent warming trends in the Arctic over the last several decades suggest significant future impacts to northern coastal and marine environments, including to the peoples, communities and infrastructure of these areas. 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.

In the western Arctic, northern Baffin Bay and Hudson Bay, ArcticNet has established long-term oceanic observatories. Each observatory consists of a number of moorings equipped with instruments that gather continuous records of currents, temperature, conductivity, turbidity, dissolved oxygen and the vertical flux of carbon and contaminants. Some moorings are also equipped with autonomous hydrophones to record the acoustic background and the vocalizations of marine mammals.

On Tuesday 8 July 2014, the *Amundsen* left its homeport of Quebec City for a 96-day scientific expedition to the Canadian Arctic travelling a total of 20 094 nautical miles in support of several research programs, including: ArcticNet annual marine-based research program (see Phase 3 projects- http://www.arcticnet.ulaval.ca/research/phase3projects.php); GreenEdge, a project that aimed to understand the dynamics of the phytoplankton spring bloom and determine its role in the Arctic Ocean of tomorrow, including for human populations; NETCARE (Network on Climate and Aerosols: Addressing Key Uncertainties in Remote Canadian

Environments), a project configured around four research activities that address key uncertainties in the field, including carbonaceous aerosols, ice cloud formation and impacts, ocean-atmosphere interactions and implications of measurements on simulations of atmospheric processes and climate, and aimed to improve Canadian climate models as well as predictions of aerosols climate effects; BREA (Beaufort Regional Environmental Assessment), a multi-stakeholder initiative to prepare for oil and gas activity in the Beaufort Sea; and the Holocene Paleoceanography project. The Japan Agency for Marine-Earth Science and Technology (JAMSTEC), aiming at contributing to the advancement of academic research in addition to the improvement of marine science and technology, as well as the National Institute of Polar Research (NIPR), an inter-university research institute conducting comprehensive scientific research and observations in Polar regions, also took part of the expedition.

The main objective of the 2014 ArcticNet/*Amundsen* Expedition was to maintain ArcticNet's network of oceanic observatories by deploying 10 moorings and recovering 6 moorings in the Western Arctic. ArcticNet's ultimate goal is to redeploy 3 of the 6 moorings recovered in Barrow Canyon to establish long-term marine observatories for monitoring present variability and forecasting future change in Arctic ecosystems. In addition to work conducted at the mooring stations, shipboard sampling was carried out along the ship track and at designated sampling stations, including seafloor and ice island mapping, ROV diving, meteorological measurements and the sampling of seawater, sediment, plankton, juvenile fish and sea ice.

1.2 Regional settings

1.2.1 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 is far more restricted, consisting of three relatively narrow passages through the islands of the Canadian Arctic Archipelago (CAA). Melting ice sheets, changing sea ice conditions and changing weather also influence oceanographic conditions in Baffin Bay and Davis Strait.

Southern Baffin Bay supports concentrations of corals and sponges, inclusive of gorgonian and antipatharia species. A survey of the seafloor using the *Amundsen*'s remotely operated vehicle (ROV) will be conducted to explore the area, locate and sample hotspots of corals and sponges in this unique deep and cold Arctic environment.

Baffin Bay's connection to the Arctic Ocean is far more restricted, consisting of three relatively narrow passages through the islands of the Canadian Arctic Archipelago (CAA). One of these passages, Nares Strait, is located between Ellesmere Island and Greenland and includes from south to north: Smith Sound, Kane Basin, Kennedy Channel, Hall Basin and Robeson Channel. Each winter, there is a prolonged period during which land-fast ice arches span the strait at the entrance to Robeson Channel and south of Kennedy Channel. The ice in Nares Strait then becomes land-fast and shuts down southward ice motion. In the past decade, changes to this long-standing pattern of ice conditions have been observed with weaker or absent ice arches in Nares Strait resulting in increased ice flux from the Arctic and reduced amount of ice allowed to reside in the Arctic Ocean to thicken as multi-year ice.

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* extended their time series of atmosphere, ice and ocean data. This work is aimed at better understanding how the climate, ice conditions as well as ocean currents and biogeochemistry are changing under the effects of climate change and industrialization. With ice extent and volume shrinking in the Arctic, the Northwest Passage may be ice free and open to navigation during summer in the near future. Bathymetry 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 Beaufort Sea

The Canadian 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. 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.

Since 2002, extensive multidisciplinary research programs have been conducted in the Beaufort Sea area. Major oceanographic research activities were carried out as part of two major international overwintering research programs conducted onboard the CCGS

Amundsen in 2003-2004 (CASES program) and in 2007-2008 (CFL Study). Environmental and oceanographic research activities were also conducted in the offshore region of the Mackenzie Shelf, shelf slope and Beaufort Sea since 2009, in partnership with the Oil & Gas industry and within the framework of the Beaufort Regional Environmental Assessment (BREA, www.beaufortrea.ca) program. Overall since 2004, a marine observatory of a minimum of five oceanographic annual moorings (from 5 to 17 moorings) has been deployed and maintained annually in the area by ArcticNet researchers.

1.2.4 Chukchi Sea

Chukchi Sea is a unique marginal sea of the Arctic Ocean, strongly influenced by the northward transport of Pacific Ocean waters through Bering Strait. This inflow influences both the ice and ecosystem of the productive Chukchi shelf. Northeast Chukchi Sea and incised into the Arctic continental shelf off Alaska is found the Barrow Canyon, where a variety of water masses coexist and contribute to a dynamic physical environment.

Sampling operations in Barrow Canyon were conducted as part of collaborative initiatives between Canada, Japan and the US.

1.2.5 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, a high volume of freshwater inputs from numerous rivers that drain central North America, a winter season in which it is completely ice covered while summer is characterized by ice-free conditions. In Hudson Bay, operations were conducted within the framework of the BaySys/ArcticNet mooring program that aimed to understand the variability and change of freshwater-marine coupling in the Hudson Bay System.

1.3 2014 Expedition Plan

1.3.1 General schedule

Based on the scientific objectives, the expedition was divided into three separate legs: Leg 1, from 8 July to 14 August 2014, took the *Amundsen* into the Canadian High Arctic and included transit and sampling activities in Baffin Bay, Lancaster Sound and the Northwest Passage. Leg 2 took the ship to the Beaufort Sea/Amundsen Gulf, and involved activities in the Barrow Canyon, Chuckchi Sea as well as in the Northwind and Canada Abyssal Plaines, from 14 August to 25 September 2014. During Leg 3, the ship headed back towards Quebec City, between 25 September and 11 October 2014, while conducting activities in the Northwest Passage and Baffin Bay.

1.3.2 Leg 1a – ArcticNet/NETCARE - 8 to 24 July 2014 - Quebec City to Resolute

Leaving Quebec City on 8 July, the *Amundsen* sailed north to conduct bathymetric surveys and ROV dives off the coast of Baffin Island for the exploration of deep-sea corals. After dropping personnel off in Pond Inlet, the ship proceeded to Lancaster Sound to carry out sampling operations at designated stations and to study the sources and impacts of aerosols in the Arctic as part of the NETCARE program. As part of this program, the *Amundsen* also conducted coordinated sampling operations with the Alfred Wegener Institute's Polar 6 plane in Lancaster Sound. The ship reached Resolute on 23 July for a science rotation and the end of Leg 1a.

1.3.3 Leg 1b – ArcticNet - 24 July to 14 August 2014 - Resolute to Kugluktuk

Leaving Resolute on 24 July, the ship sailed east towards Greenland to deploy underwater gliders in Baffin Bay and conduct short bathymetric surveys, CASQ coring and oceanographic sampling operations off the coast of Greenland. From there, the ship continued north to carry out sampling operations between Ellesmere Island and Greenland, continuing as far north as Kennedy Channel. The *Amundsen* reached Kugluktuk on 14 August for a full crew change and the end of Leg 1.

1.3.4 Leg 2a – ArcticNet/BREA - 14 August to 9 September 2014 - Kugluktuk to Barrow, AK

The *Amundsen* spent approximately 4 weeks in the Beaufort Sea/Amundsen Gulf region to deploy six BREA moorings and three ArcticNet moorings, and conduct coring operations and SX90 sonar and multibeam surveys within the framework of ArcticNet's BREA funded projects. Oceanographic sampling and piston coring operations were also conducted along the ArcticNet designated transects. Sailing towards Barrow, the ship sampled at several stations and conducted cross-shelf MVP profiles. The ship reached Barrow, Alaska, on 9 September for a science rotation and the end of Leg 2a.

1.3.5 Leg 2b – ArcticNet/Japan - 9 to 25 September 2014 - Barrow, AK to Kugluktuk

After the science rotation in Barrow (AK) on 9 September, the ship spent approximately four days recovering six moorings and redeploying four, and conducting sampling operations in Barrow Canyon as part of collaborative initiatives between Canada, Japan and the US. The remainder of the leg was dedicated to mooring operations in the Chukchi Sea and sampling operations over the Northwind and Canada Abyssal Plains. The *Amundsen* was in Kugluktuk on 25 September for a full crew change and the end of Leg 2.

1.3.6 Leg 3 –ArcticNet - 25 September to 12 October 2014 - Kugluktuk to Quebec City

After the full crew change in Kugluktuk, the ship sailed back east through the Northwest Passage. A bathymetric survey, coring and sampling operations were conducted along the coast of Baffin Island. Coring operations to sample and date submerged shoreline features were also carried out in fjords of the Cumberland Peninsula. In addition to ArcticNet's sampling operations, the *Amundsen* supported the 2014 Schools on Board program from Kugluktuk to Iqaluit. A last stopover in Iqaluit on 6 October provided ArcticNet and Schools on Board participants the opportunity to disembark from the ship before the return to Quebec City. The ship reached Quebec City on 12 October.

1.3.7 BaySys program – 1 to 4 October 2014 - Hudson Bay

The main objective of the 2014 BaySys program was to service one mooring (AN01-13) that had been strategically positioned in southern Hudson Bay to monitor the W–SW area of the inter-annual water mass movements and to perform a CTD cast to determine the oceanographic properties of the water column at the mooring site. Operations were carried out from the CCGS *Henry Larsen*. Due to complications in communicating with the benthos mooring releases, the mooring could not be recovered during the expedition. Attempts were then made to recover moorings AN01-12 and AN01-11. Although mooring AN01-12 was released without any acknowledgement from the releases (communication problems due to a combination of sea state and malfunctioning releases), it was successfully recovered on 1 October 2014. AN01-11 did no release the mooring when commanded and could not be retrieved.

2 Leg 1a – 8 to 24 July 2014 – Baffin Bay and the Canadian Arctic Archipelago

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2.1 Introduction

Leg 1a took place from 8 to 24 July and focused on ArcticNet's marine-based research program in Baffin Bay and the Canadian Arctic Archipelago, starting in Quebec City and ending in Resolute (Figure 2.1). A contingent of the ROV and the NETCARE (Network on Climate and Aerosols: Addressing Key Uncertainties in Remote Canadian Environments) programs was also onboard during Leg 1a to conduct fieldwork in Baffin Bay and Parry Channel, respectively.

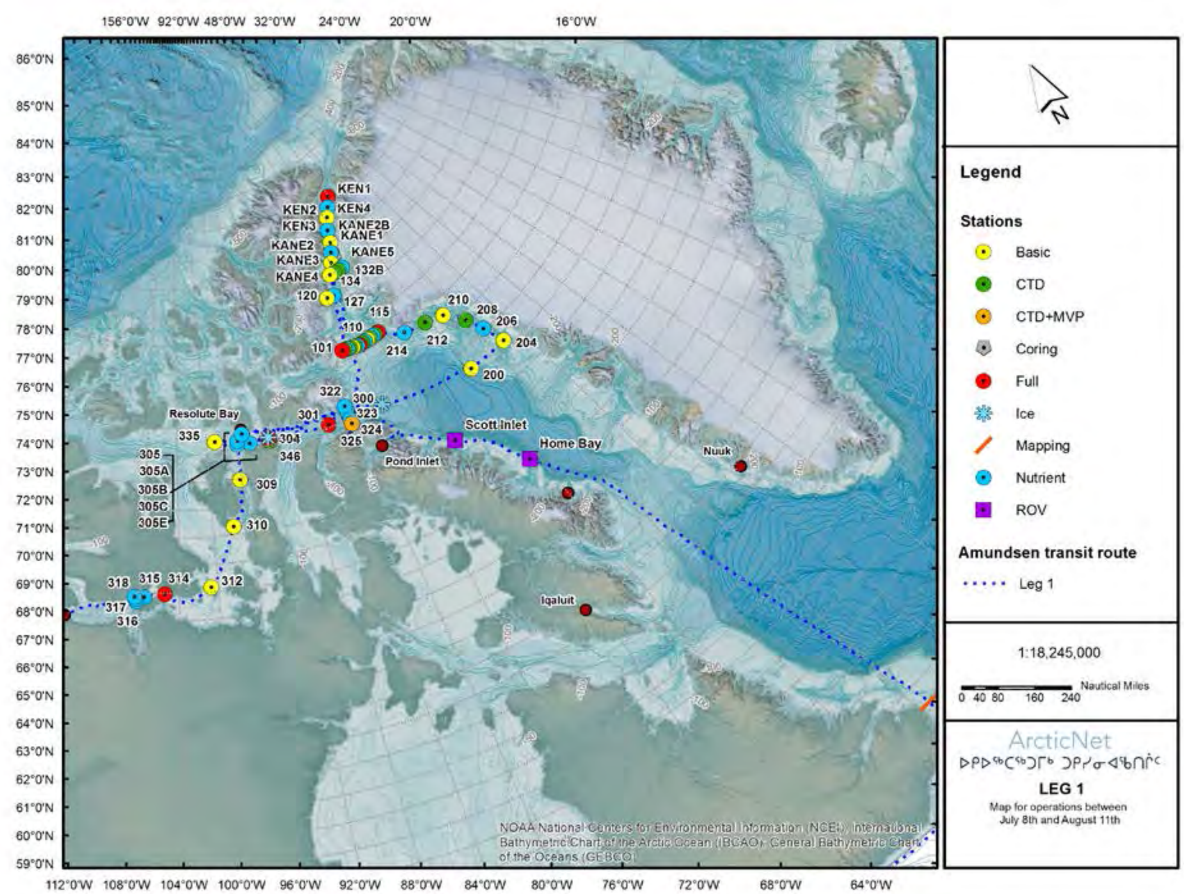

Figure 2.1. Ship track and the location of stations sampled in Baffin Bay and the Canadian Arctic Archipelago during Leg 1.

The specific objectives of the ArcticNet field program for Leg 1a were to:

- Conduct up to 3 ROV dives in Baffin Bay for deep-sea coral exploration;
- Conduct multibeam surveys at selected ROV dive sites;
- Sample 12 biophysical stations distributed in Parry Channel;
- Coordinate atmospheric sampling with the Alfred Wegener Institute Polar 6 plane in Lancaster Sound;
- Conduct MVP transect across the entrance of Lancaster Sound;
- Sample melt ponds in Lancaster Sound and Wellington Channel;
- On an opportunistic basis, deploy the Zodiac and/or Barge for sea-surface microlayer sampling and optical measurements;
- While in transit to Resolute, conduct a multibeam survey on the north side of Lancaster Sound, along the coast of Devon Island;
- Transport cargo to the sailboat Vagabond moored at Qikiqtarjuaq.

2.1.1 ROV program

The ROV dive program is funded by the International Governance Strategy program of DFO, by Memorial University and by ArcticNet. The major goal of the ROV project is to study coral and sponge habitats in the Canadian Arctic and specifically to identify and characterize corals and sponges in areas of the Arctic that have not previously been impacted by commercial fishing activities. Four dive targets were selected on the basis of their bathymetry, slope, and inferred surficial geology (Figure 2.2).

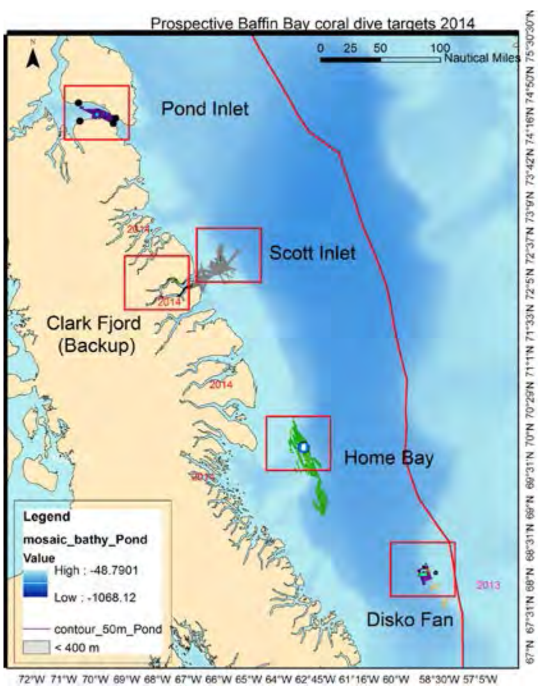

Figure 2.2. 2014 ROV dive targets offshore Baffin Island.

2.1.2 NETCARE (Network on Climate and Aerosols: Addressing Key Uncertainties in Remote Canadian Environments)

NETCARE is composed of roughly 50 Canadian and international scientists interested in aerosol-climate interactions, with a focus on the Arctic (see http://www.netcare-project.ca for more information). Within the framework of this program, sampling operations in Parry Channel took place from the *Amundsen* and from the research aircraft, POLAR6, operated by the Alfred Wegener Institute. The specific science objectives of the field program during Leg 1a were to:

- Characterize ship emissions and their impact on Arctic air quality and climate;
- Study the role of the ocean in driving atmospheric aerosol and climate.

2.2 Synopsis of operations

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

During this leg, the *Amundsen* traveled from Quebec City, QC (8 July) to Resolute (24 July) and 18 stations were visited with an overall tally of operations and activities as follows:

- 2 CTD casts;
- 17 CTD-Rosette casts;
- 1 MVP transect;
- 15 light and phytoplankton profiles, including Secchi disk and PNF;
- 10 plankton tows and trawls, including horizontal and vertical net tows, and Hydrobios;
- 7 box cores sampling of the sediments;
- 4 Agassiz trawls;
- 2 dedicated bathymetry / sub-bottom mapping surveys;
- 2 ROV dives in Home Bay and Scott Inlet;
- 2 weather balloons launches.

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

2.2.1 Timeline of operations

Leaving Quebec City at 10:15 AM on 8 July, the *Amundsen* sailed north towards Scott Inlet to conduct ROV dives and multibeam surveys at selected sites of interest. On the way to the Labrador Sea, the acquisition of atmospheric measurements began. On 14 July, the *Amundsen's* helicopter was used to resupply the *Vagabond* sailboat anchored near

Qikiqtarjuaq and to recover samples collected by the sailboat's crew during the winter and spring months.

Out of the four ROV dive targets initially selected on the basis of their bathymetry, slope and inferred surficial geology, only two were visited due to time constraints, ice conditions and weather (see Section 27 for more details). On 15 and 16 July, two 9-h dives were conducted in Home Bay and Scott Inlet, respectively, and one weather balloon was launched at each site. The ROV operations were particularly successful owing to the nice weather and calm sea conditions that prevailed, which also allowed conducting the first microlayer sampling with the Zodiac during the second ROV dive. The third optional short dive planned in Pond Inlet was cancelled due to time constraint and bad weather conditions. Dr. Edinger was satisfied with the work accomplished and agreed to cancel the Pond Inlet ROV station. The ROV team (2 pilots and 2 scientists) disembarked at Pond Inlet on 17 July.

After the rotation of personnel in Pond Inlet, the *Amundsen* continued north and carried out operations at designated Full Station 323, as well as Nutrient Stations 300 and 322, along two transects across Parry Channel (Figure 2.3). Weather conditions in the Sound then prevented any additional sampling operations on 18 July and the ship remained hidden in Navy Board Channel for half a day. A first ice/melt pond sampling was nonetheless performed using the ship's cage to carry personnel on the ice. Specific procedure for melt pond sampling is described in Section 8. In the evening, the transect sampling was completed with Nutrient Stations 324 and 325.

The Moving Vessel Profiler (MVP) was deployed at the entrance of Lancaster Sound and towed from south to north at a speed between 6 to 8 knots. The MVP deployment produced high-resolution profiles of the water column and complemented the CTD-Rosette deployments carried out at the 5 stations at the entrance of Lancaster Sound (Figure 2.3). A transect across Barrow Strait (Stations 343-346) was added to help resolve ocean circulation at this narrow and shallow area of the Parry Channel. However, severe ice conditions prevented the sampling and MVP profiling of the Barrow Strait transect. In future years and if ice conditions allow, a transect across McClure Strait at the western end of Parry Channel would be essential.

Figure 2.3. Leg 1a transit route and sampling stations across Parry Channel and Barrow Strait.

The ship reached Full Station 301 on 19 July, coinciding with the first encounter with Polar6 aircraft. For this first joint operation, the aircraft asked the ship to steam upwind for 2.5 hours (2 engines, full ahead) so they could monitor the fume plume of the ship.

A second encounter with the Polar6 took place the following day while Stations 346 (CTD) and 304 (Full) were sampled. Ice conditions prevented the sampling of the next three stations on the transect and after several hours lost (ca. 4 hours) and considerable fuel expended (6 engines running) with no notable progress towards the next station, it was decided to cancel these stations. Severe ice conditions (thickness and extent) continued to be a problem and the sampling schedule was modified accordingly. On a positive note, this provided a great opportunity to sample under ice blooms, melt ponds, leads and ice edges and to investigate the potential of these environments to act as sources of primary and secondary production and climate active gas (i.e. dimethylsulfide).

On 21 July, the final coordinated operation with Polar6 endeavoured to monitor the fume plume of the *Amundsen* while working in the ice. A pre-determined station was reached in the ice pack and the ship steamed upwind for 6 hours with 4 engines. The aircraft left at 12h00. A helicopter ice survey was conducted to find a route to Station 305 and Resolute and to assess the types and surface covered by melt ponds

Station 305 (Full) located in the giant lead was sampled before starting a south-north transect of five Nutrient stations (numbered 305a to 305e) following the ice edge on the western side of this large lead. Station 305e located offshore Resolute was completed early on July 23 and the rest of the day was devoted to a second microlayer sampling with the Zodiac and a fourth ice/melt ponds sampling. Scientific operations of Leg 1a concluded at 17h00 and the mid-leg rotation of scientists began at 8h30 on 24 July. The science rotation was carried out using the helicopter and all science participants were provided an immersion suit for the offshore transportation.

2.3 Chief Scientist's comments

Leg 1a was considered a great success. Despite some severe ice conditions, strong winds and bad weather, 18 science operations were successfully conducted on a daily basis. Moreover, the coordinated work with the AWI Polar6 aircraft as to monitor the fume plume was deemed a success.

The Chief Scientist and the science participants of Leg 1a express their gratitude to the Commanding Officer and the officers and crew of the CCGS *Amundsen* for their unrelenting support and comprehension throughout the cruise.

3 Leg 1b – 24 July to 14 August 2014 – Baffin Bay and the Canadian Arctic Archipelago

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3.1 Introduction

Leg 1b was carried out from 24 July to 14 August and was dedicated to operations in Baffin Bay and the Canadian Arctic Archipelago (Figure 3.1).

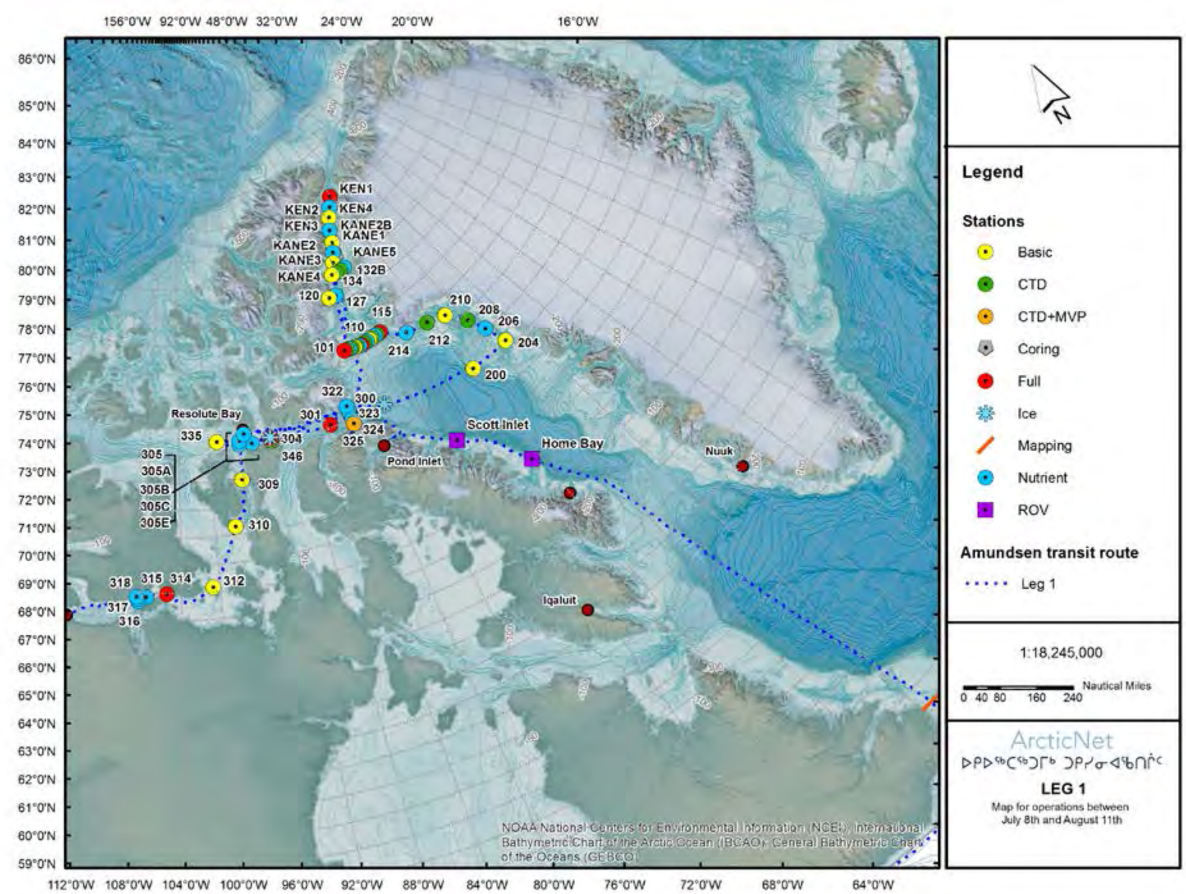

Figure 3.1. Ship track and the location of stations sampled in Baffin Bay and the Canadian Arctic Archipelago during Leg 1.

The specific objectives of the ArcticNet field program for Leg 1b were to:

- Sample 38 biophysical stations distributed in Baffin Bay and the Northwest Passage;
- Deploy the CASQ corer for sediment sampling at 4 designated sites in Baffin Bay;
- Conduct ~2 hours of multibeam surveys at selected CASQ coring sites;
- Conduct ice island sampling operations in Northern Baffin Bay (20 hours);

- Sample melt ponds along a longitudinal transect in Northern Baffin Bay;
- Conduct MVP transect during transit between Stations 200 and 204;
- On an opportunistic basis, deploy the Zodiac and/or Barge for sea-surface microlayer sampling and optical measurements;
- While in transit from Resolute to Baffin Bay, conduct a multibeam survey on the north side of Lancaster Sound, along the coast of Devon Island;
- Collect 200L of deep water at Stations 200 and 115 in Baffin Bay;
- If ice conditions allow, conduct a 20 nm MVP transect between Ellesmere Island and Greenland at 78°N (at Station 129).

3.2 Synopsis of Operations

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 Part II of this report.

During this leg, the *Amundsen* traveled from Resolute (24 July) to Kugluktuk (14 August) and 46 stations were visited with an overall tally of operations and activities as follows:

- 15 CTD casts
- 55 CTD-Rosette casts;
- 1 MVP transect;
- 51 light and phytoplankton profiles, including Secchi disk and PNF;
- 57 plankton tows and trawls, including horizontal and vertical net tows, and Hydrobios and IKMT;
- 21 box cores sampling of the sediment;
- 18 Agassiz trawls;
- 2 dedicated bathymetry / sub-bottom mapping surveys;
- 3 CASQ coring sampling.

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

3.2.1 Timeline of operations

The ship departed Resolute at 23h00 on 24 July after a 6-hour delay from the original timeline due to fog preventing helicopter flights. After leaving Resolute, the ship transited close to Devon Island, roughly along the 400-m isobath and according to the cruise plan. This multibeam line built on existing lines and aimed at acquiring data on the steep rock walls in the area (Figure 3.2). The multibeam survey aimed at identifying potential coral and sponge habitats and future ROV dive sites.

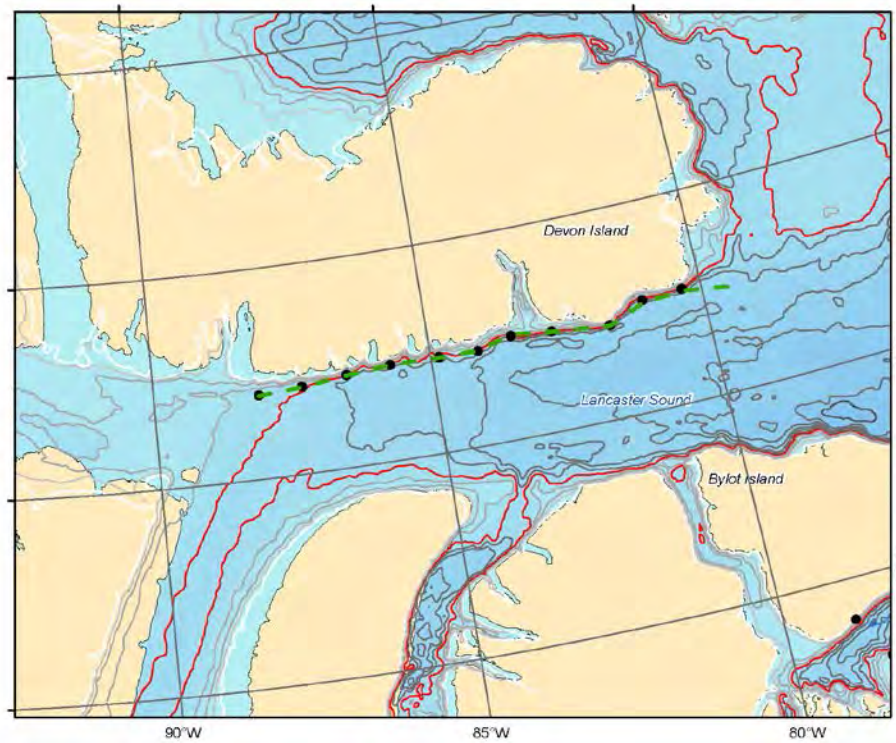

Figure 3.2. Suggested transit route along the 400 m isobath along the coast of Devon Island.

Ice island PII-A1F was located almost directly on the sailing path to Station 200; the weather was generally good, but the top of the island was foggy. The helicopter took off with the scientists but it was determined that it was not safe to leave the participants on the ice and that conditions should be re-assessed after the Zodiac was deployed for microlayer sampling. The ship began a circumnavigation of the ice island with the EM302. These operations were completed and the fog had not lifter, so the ship headed for Station 200.

Station 200 was reached during the night and a sub-bottom profiling survey was begun to select a site for the CASQ core and the Basic station. No obvious suitable site was found and the CASQ core was cancelled. All other operations were conducted and the ship sailed to Station 204 with the MVP in tow. The vertical extent of the MVP profiles began at 200 m, then was increased to 350 and finally to 500 m near the end of the 200-204 transect.

A suitable site for the CASQ was found at Station 204 and operations proceeded according to plan. Operations for the CASQ corer (9 m) went well and took a little over 2 hours including the installation and removal of the fork, which steps will be done during Rosette operations or transit for future stations.

Stations 206 (Nutrients) and 208 (CTD) were sampled on the way north to Station 210, where a multibeam survey, a Basic station, and a CASQ core (6-m) were completed on 29 July. After sampling Stations 212 (CTD) and 214 (Nutrient), the North Water transect began with Full Station 115 on 31 July. The North Water transect ended with Full Station 101 in the evening of 3 August, and the CASQ core at Station 137 was cancelled because strong winds were forecasted. The sampling transect spanning the widest distance between Ellesmere Island and Greenland and comprising Stations 101 to 115 has been sampled almost every year since 1997. Data collected at these stations has contributed to the understanding of the oceanographic fluxes passing through Nares Strait to Baffin Bay.

Sampling operations were conducted as far north as Kennedy Channel (80°N). According to the timeline, the ship sailed north to Full Station KEN1 immediately after completing operations at Station 101. Along the way, suitable ice features were looked for to conduct melt pond operations but none was found and the ceiling was too low for a helicopter survey. Stations KEN1, KEN2, KEN3, KEN4 and KANE1 were completed from north to south and the CASQ core site that had been identified while transiting north was re-visited (Figure 3.2). The possibility of melt pond operations was assessed while mapping for a potential CASQ core site. However, no suitable ponds or sediment was found in the immediate area.

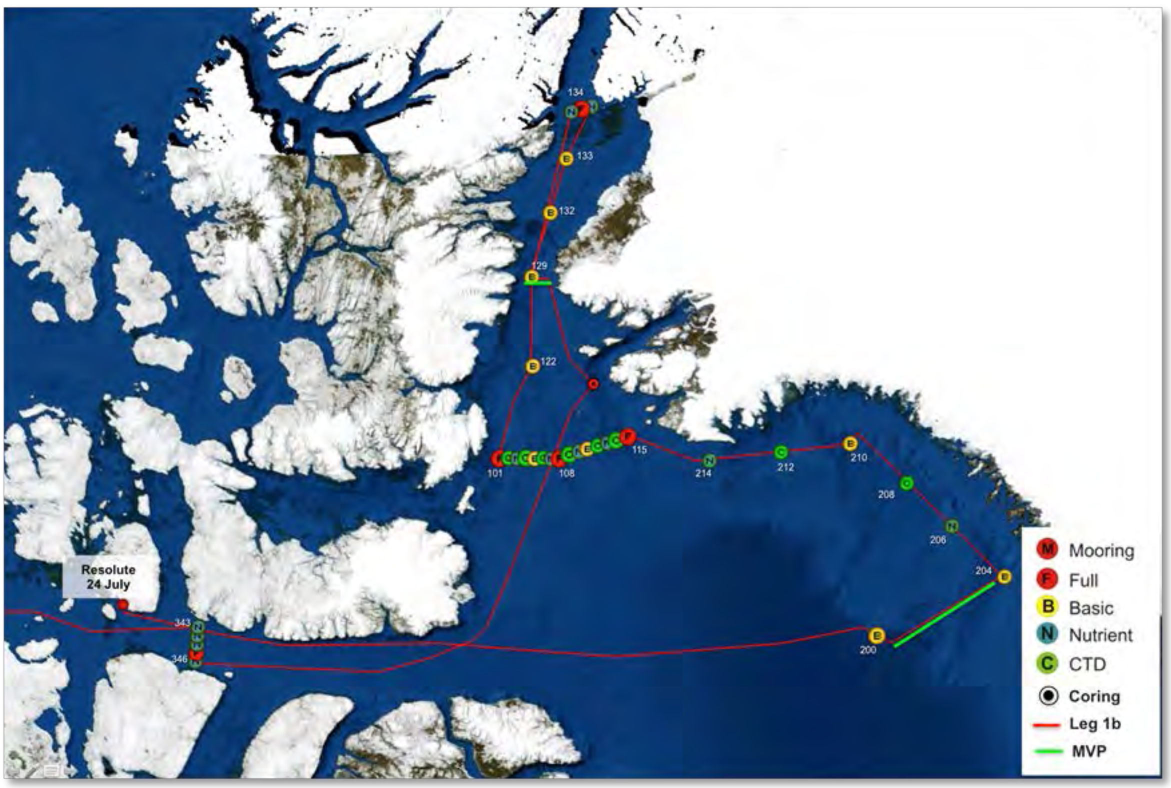

Figure 3.3. Leg 1b transit route and sampling stations in Baffin Bay.

A large ice island was observed near Station 134 and ice island operations started on the morning of 5 August under good weather conditions. While the ice team worked on the ice island, the ship performed two circumnavigations of the ice island, one with the EM302 only (to be able to ping at the highest possible rate) and another with both the EM302 and the EK60. Preliminary data indicate that the mapping was successful, but no fish aggregations were visible on the EK60. Two separate Zodiac operations were performed for 1) proximal CTD water column mapping and surface water sampling at 8 stations (identified z1 to z8 with samples divided between different teams) and 2) microlayer sampling. Operations around the ice island also included a helicopter flight to see the position of the main current relative to the ice, take the coordinates of ice island corners and determine the position of CTD sampling stations (ii1 through ii5) susceptible to detect upwelling down current. Finally, the ship performed 5 CTD-Rosette casts (ii1 to ii5) around the ice island and the ice team was recovered.

Stations 132b (CTD), KANE5 (Basic), 127 (Nutrient) and 120 (Basic) were completed. By then, moderate swell had set in with high winds forecasted for northern Baffin Bay (30-35 knots) and a Gale warning for the entrance to Lancaster Sound. CASQ core deployment at 71°09.200 W was cancelled to avoid transit delays to reach Lancaster Sound.

The ship sailed south and then west until the afternoon of 8 August, when heavy ice was reached and a helicopter ice patrol was sent out to assess melt pond sampling opportunities. A series of leads extended roughly 12 miles from the ship and beyond that, the way to Station 307 was covered with solid compacted ice, with large multi-year pieces and numerous pressure ridges. Similar ice conditions also prevailed to the south toward the entrance to McClintock (Figure 3.4).

Once operations in northern Baffin Bay were completed, the vessel returned west to conduct sampling operations at designated Basic Stations 335, 309, 310 and 312. The Full Station 314 in Dease Strait was completed on 12 August, in addition to Nutrient Stations 315, 318, 317 and 316.

The ship reached Kugluktuk on the evening of 13 August for the end of Leg 1b and for the scheduled full Coast Guard crew change on 14 August.

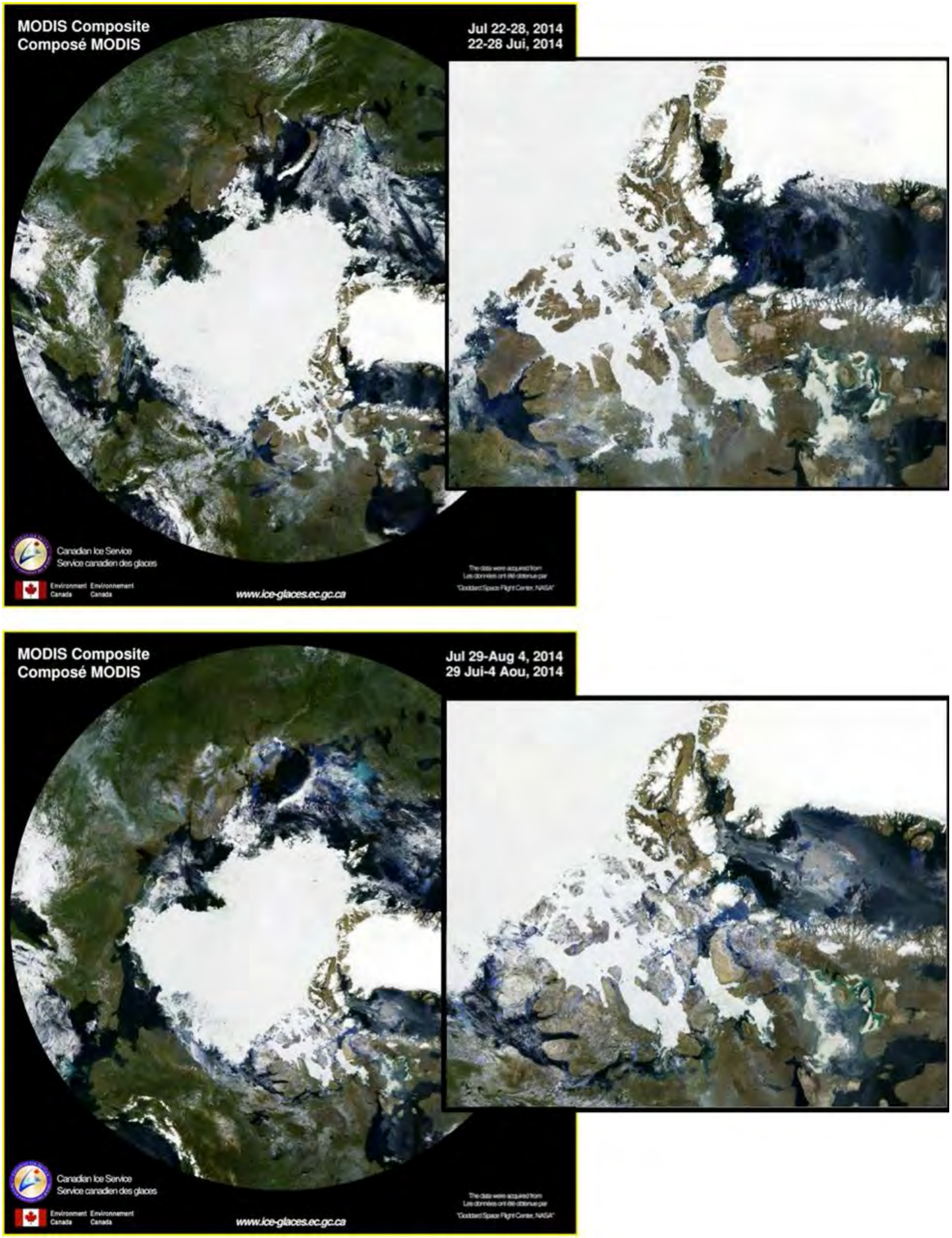

Figure 3.4. Ice conditions during Leg 1b, showing 1) a general lack of ice (fast or else) in Baffin Bay, Kane Basin and Kennedy Channel, 2) substantial ice cover in the Canadian Archipelago west of Somerset Island.

3.2.2 Operations in Dease Strait/Cambridge Bay

The scheduled Full station in Dease Strait near Cambridge Bay (Station 314, Figure 3.5) has been sampled as a Nutrient station almost every year since 2005 within the framework of the ArcticNet marine-based research program. This year, the Canadian High Arctic Research Station (CHARS) and Aboriginal Affairs and Northern Development Canada have requested a full suite of sampling operations to be conducted at Station 314 to gather baseline information on the environment and also contribute additional information to the time series already available (Table 3.1).

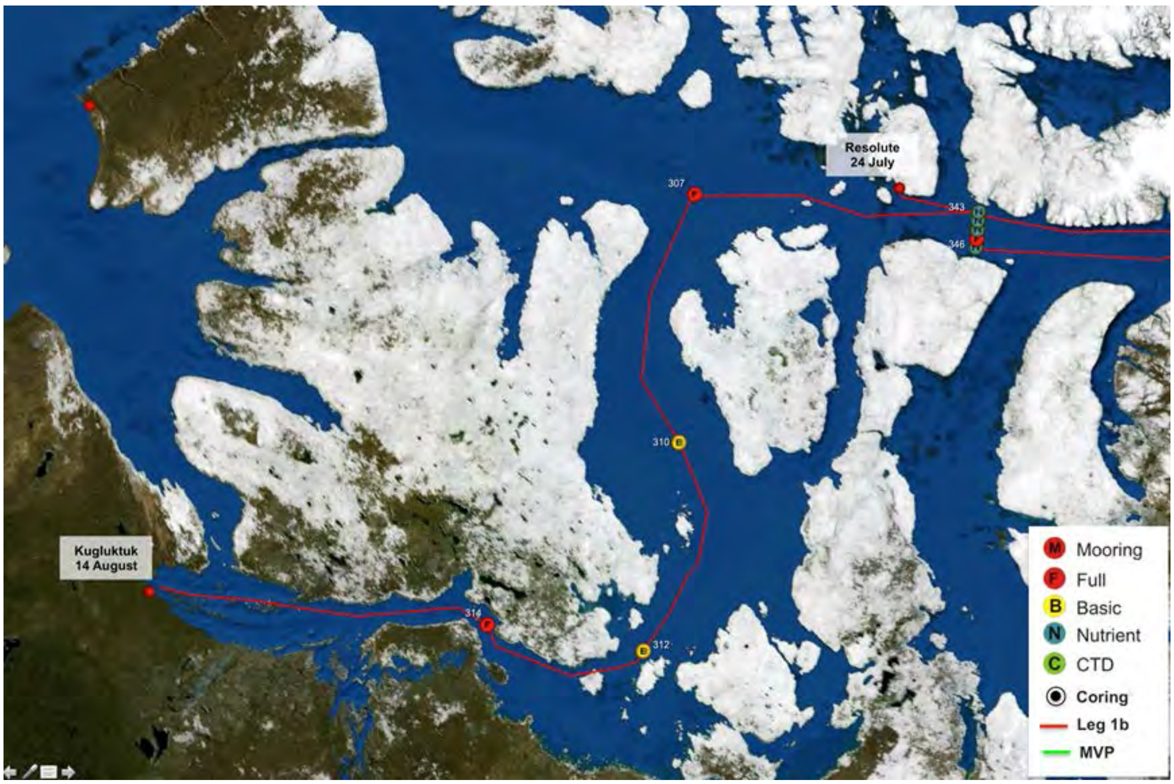

Figure 3.5. Leg 1b transit route and sampling stations in the NWP including Station 314 located in Dease Strait sampled as a Full station in Leg 1b.

Table 3.1. Scientific activities and measurements conducted at Station 314 in Dease Strait near Cambridge Bay. The list of activities follows the sequence in which operations were conducted (see Scientific Log in Appendix 2).

Leg	Local Date	Local Time	Latitude (N)	Longitude (W)	Depth (m)	Activity	Science team	Variables measured
1b	12/Aug/2014	08:00	68°58.270	105°27.904	76	DSN (Tucker)	Zooplankton/ Ichtyoplankton, Contaminants	Surface zooplankton and fish composition and abundance, Contaminants in pelagic invertebrates
1b	12/Aug/2014	08:32	68°58.059	105°28.179	76	Secchi, PNF	Phytoplankton	Optical properties, Phytoplankton fluorescence
1b	12/Aug/2014	08:32	68°58.059	105°28.179	76	Plankton net	Phytoplankton, Sediments	Phytoplankton composition

Leg	Local Date	Local Time	Latitude (N)	Longitude (W)	Depth (m)	Activity	Science team	Variables measured
1b	12/Aug/ 2014	09:09	68°58.221	105°28.281	80	CTD-Rosette Cast #85	CTD-Rosette, DMS(P), Microbes, Phytoplankton,	Sulfur compounds (DMS(P)), Chlorophyll a, Microbial abundance and genomics, Particulate C and N, Phytoplankton composition and abundance, Primary production
1b	12/Aug/ 2014	09:48	68°58.151	105°28.561	77	Hydrobios	Zooplankton/ Ichtyoplankton, Contaminants	Depth specific (top 80 m) zooplankton abundance and biomass
1b	12/Aug/ 2014	10:35	68°58.231	105°28.072	80	CTD-Rosette Cast #86	CTD-Rosette, TIC, Nutrients, Microbes	Total inorganic carbon (TIC) and O18, Nitrate (NO_3)/ Silicate (Si)/ Phosphate (PO_4) concentrations, Rates of N uptake/production
1b	12/Aug/ 2014	11:15	68°58.240	105°28.479	82	Bioness	Zooplankton/ Ichtyoplankton, Contaminants	Depth specific zooplankton abundance and biomass
1b	12/Aug/ 2014	12:45	68°58.202	105°28.160	80	5NVS (Monster)	Zooplankton/ Ichtyoplankton, Contaminants	Water column zooplankton abundance and biomass with images (LOKI)
1b	12/Aug/ 2014	13:10	68°58.177	105°28.039	75	Agassiz Trawl	Benthos, Contaminants	Benthic diversity and abundance, Contaminants in benthic invertebrates
1b	12/Aug/ 2014	15:25	68°58.234	105°28.286	84	Box Core	Benthos, Sediments, Contaminants	Sediment grain size and chemistry, Benthic diversity, Contaminants in sediments
1b	12/Aug/ 2014	15:25	68°58.234	105°28.286	Surf	ulayer Stn #10	Microlayer	DMS(P), TIC, Nutrients, Microbes, Phytoplankton
Continuously 7 July - 13 August (Cambridge Bay 12 August)					N/A	Atm	Aerosols and trace gases, Carbon fluxes, Methane fluxes	Composition and concentrations of aerosols/ trace gases, DMS, CO_2, Methane
Continuously 7 July - 13 August (Cambridge Bay 12 August)					Surf	Ocean surface	Carbon fluxes, Methane fluxes	pCO_2, Methane

3.3 Chief Scientist's comments

Overall, Leg 1b was highly successful with productive collaborations established between teams and with the *Amundsen*'s officers and crew. Preliminary data from the North-South transect anticipate interesting results and confirm the success of this endeavor. Those results (as well as a short presentation on optics) were presented at the final general meeting in the evening of 13 August, in front of the crew and the scientists. This was the opportunity to extend our gratitude to Captain Lacerte, the officers and the crew, who greatly contributed to make this scientific expedition a success.

4 Leg 2a - 14 August to 9 September 2014 – Amundsen Gulf, Beaufort Sea and Barrow Strait

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4.1 Introduction

Leg 2a of the 2014 Expedition took place from 14 August to 9 September and was centered on the ArcticNet-BREA Oceanographic Observatory project in the Western Arctic (Figure 4.1).

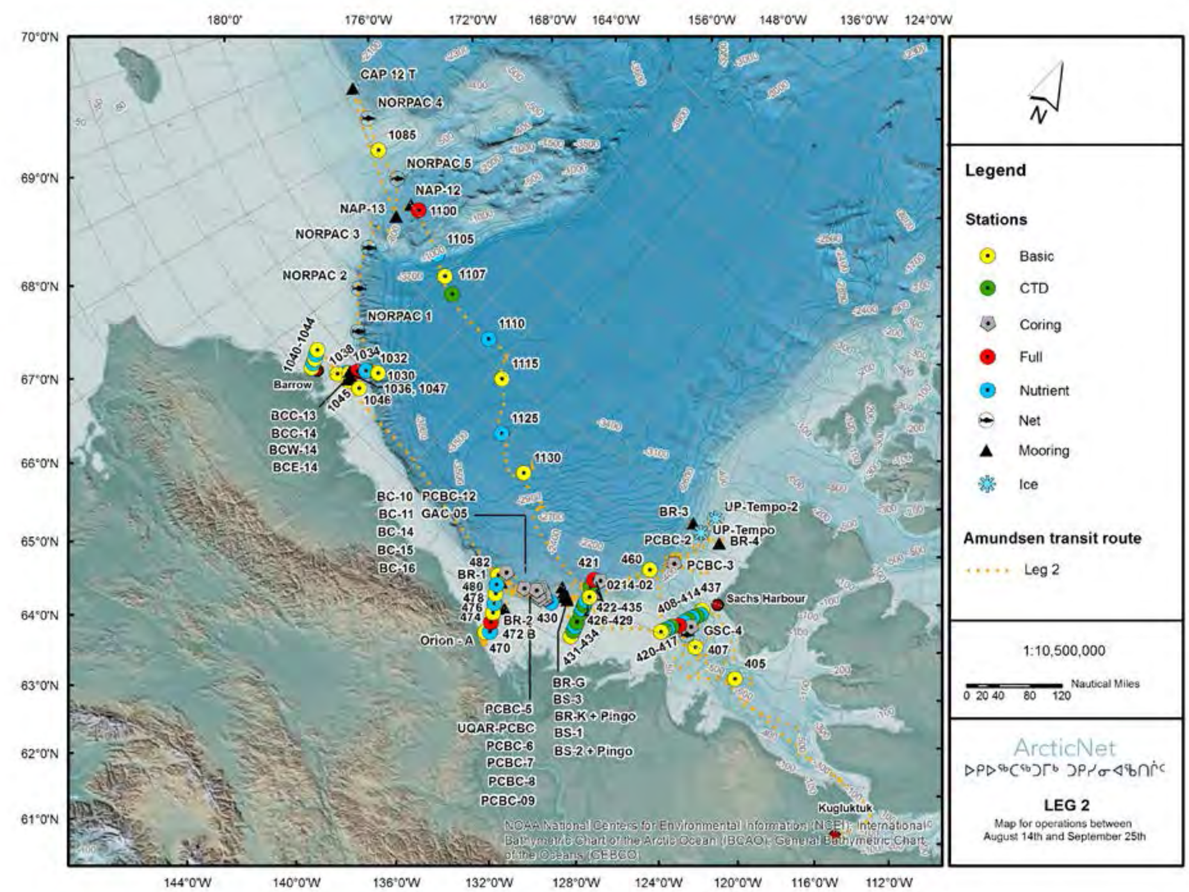

Figure 4.1. Ship track and the location of stations sampled in the Amundsen Gulf, Beaufort Sea and Barrow Strait during Leg 2.

The specific objectives of Leg 2a were to:

- Deploy 6 BREA moorings;
- Conduct 48hrs of SX90 acoustic survey (including the deployment of fishing gear during the survey);

- Conduct approximately 100hrs of bathymetric survey in designated areas of the Beaufort Sea and Mackenzie Shelf;
- Deploy the piston corer at 9 designated GSC sites;
- Deploy the box corer at 16 designated GSC sites;
- Conduct science operations at 4 designated sites within the framework of the Holocene Paleoceanography project (UQAR);
- Deploy 3 ArcticNet moorings;
- Sample 41 biophysical stations distributed in the Beaufort Sea and Mackenzie Shelf area;
- Deploy 5 On Ice Met towers;
- Deploy 5 Ice Beacons next to the On Ice Met towers;
- Deploy 3 ice-tethered moorings in the vicinity of Station BR-3 with each mooring being near an On Ice Met tower;
- Conduct 1 dedicated CTD-Rosette casts at 4 mooring stations for the contaminant group;
- Deploy one ice tethered ADCP next to an On Ice Met tower;
- Deploy 1 UpTempO buoys in open water near Stations BR-3, BR-4 and Basic 460 (3 UpTempO buoys total);
- Deploy a chaetognath sampling device at up to 5 station;
- Deploy 1 POPS mooring near Station BR-3;
- Deploy up to 3 Polar SVP buoys on multiyear ice;
- Conduct 3 cross-shelf MVP transects on the Mackenzie Shelf;
- Conduct science operations at 1 additional station within the framework of the Holocene Paleoceanography project (UQAR).

4.1.1 BREA (Beaufort Regional Environmental Assessment)

This multi-stakeholder initiative sponsors regional environmental and socio-economic research that makes historical information available and gathers new information vital to the future management of oil and gas in the Beaufort Sea (see http://www.beaufortrea.ca/about/ for more information).

BREA participants were onboard the *Amundsen* during Leg 2a to conduct operations as a part of the Southern and Northeastern Beaufort Sea Marine Observatories project (2011-2014). The project's goal is to establish three oceanographic observatories, each composed of two moorings, to collect year-round marine observations of the Beaufort Sea using state-of-the-art instruments. This four-year project, led by ArcticNet and IMG-Golder, an Inuit-owned environmental and engineering company, aims to collect data to gauge the physical conditions and variability of the Canadian Beaufort Sea year over year. This information will provide previously unavailable scientific evidence of oceanic and sea ice conditions, enabling regulators to make informed decisions about potential environmental effects of exploitation drilling in the Beaufort Sea.

4.2 Synopsis of Operations

This section provides a general synopsis and timeline of operations during Leg 2a. Detailed cruise reports provided by onboard participants and including specific objectives, methodology and preliminary results for projects conducted during this leg are available in Part II of this report.

During this leg, the *Amundsen* traveled from Kugluktuk (14 August) to Barrow, AK (9 September) and 37 stations were visited with an overall tally of operations and activities as follows:

- 10 CTD casts;
- 48 CTD-Rosette casts;
- 22 light and phytoplankton profiles, including Secchi disk and PNF;
- 34 plankton tows and trawls, including horizontal and vertical net tows, and Hydrobios;
- 12 Piston coring stations;
- 29 Box coring stations;
- 11 Agassiz trawls;
- 6 Beam trawls;
- 2 Ice stations;
- 6 BREA mooring deployments;
- 3 ArcticNet mooring deployments;
- 4 SX90 surveys.

4.2.1 Timeline of operations

Science participants were transported onboard the ship using the helicopter after the boarding of the Coast Guard crew on 14 August. Following the crew change, the *Amundsen* remained at anchor overnight offshore Kugluktuk to allow everyone to rest a while before starting Leg 2a. The ship left anchor and started sailing north the morning of 15 August.

Science operations started with a Basic station (405) in the Amundsen Gulf on 16 August. From then on, Basic, Nutrient and CTD stations succeeded each other until 20 August. Throughout these 5 days, a total of 3 Basic (405, 407 and 437), 3 Nutrient (410, 412 and 414) and 2 CTD stations (411 and 413) were completed. Alongside, the SX90 was operated during a dedicated acoustic survey from 17 to 19 August between Banks Island and Cape Bathurst. This operation was incorporated within the framework of the BREA hydroacoustic-mapping project.

On 20 August, piston core and box core were deployed at the first designated GSC site (GSC-4) in the Beaufort Sea. Then, operations were conducted at 8 biophysical stations positioned along the Banks Island-Cape Bathurst transect (starting north at Station 408 and ending at Station 420) and southwest on the Mackenzie shelf (Stations 422 to 435). A list of all sampling operations conducted at each type of biophysical station (CTD, Nutrient, Basic and Full) is displayed in the Appendix 2. While transiting between transects, the ship proceeded with an opportunistic SX90 12h-survey.

From 22 to 23 August, a total of 5 moorings were deployed within the framework of the BREA Oceanographic Observatory project and the ArcticNet mooring project. Two windows of 10-12 hours on two separate days allowed the deployment of 3 short moorings (i.e. BS-1 (80 m), BR-K (152 m) and BS-2 (300 m)) the first day and 2 longer ones (i.e. BS-3 (500 m) and BR-G (700 m)) the day after. The mooring operations started with the deployment of the shortest one as to allow the crew and science team to get confortable and coordinated on the foredeck before moving on to the deeper and longer moorings. Once a mooring was deployed, the ship conducted a multibeam line over the site, using the EM302 water column software, to confirm the geographic and vertical positions of the mooring.

The two windows of time dedicated to mooring deployments were interspersed with a Basic station (434) and a line of Nutrient and CTD stations along the Mackenzie shelf (starting southwest at Station 433 and ending at Station 426).

The day of 24 August started off with a Full station (421), followed by a UQAR coring station. Due to sea-ice conditions, the planned Station AMDO214-02 was repositioned. The ship then transited northeast towards Basic Station 460.

Between 26 August and September 1st, operations were conducted on the west coast of Banks Island. These operations included deploying 3 BREA moorings (BR-3, BR-4 and BR-1) and conducting coring sampling at 5 GSC stations (PCBC-3, PCBC-2, PCBC-8, PCBC-12 and PCBC-5) and 1 UQAR station (UQAR-PCBC). Deployment of the box core was attempted at Station GAC-05 without success, as it did not trigger. A total of 24h, spread over two different operational day and according to 2 sites, was also allotted to sea-ice operations. Alongside, the SX90 was opportunistically operated in the marginal ice zone of the Beaufort Sea during transit.

From September 1st to 4 September, operations were conducted on the Mackenzie Shelf and Mackenzie Trough. Operations included piston and box corer deployments at selected sites (PCBC-6, BC-10, BC-11, BC-14, BC-15, PCBC-7 and BC-16) and a BREA mooring deployment (BR-2). Basic Stations 482 and Orion-A were also sampled. Once again, the SX90 was opportunistically operated on the Mackenzie Shelf while the ship transited south. A total of 5 biophysical stations were then sampled along a south to north transect in the Mackenzie Trough on 6 September.

The GSC coring Station PCBC-9 constituted the last station to be sampled in Canadian Waters before the ship headed towards Barrow, Alaska. Due to a lack of time, operations that were planned along the way were cancelled, including MVP cross-shelf trasects. The ship arrived offshore Barrow on 9 September for a science rotation. A total of 19 Leg 2a participants got off the ship while 20 participants boarded for Leg 2b.

4.3 Chief Scientist's comments

Overall Leg 2a was successful: 37 biophysical stations were sampled out of the 41 initially planned and all of the BREA and ArcticNet mooring operations were successfully conducted. Moreover, most of the GSC stations were sampled and over 90h of SX90 survey were completed. 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.

5 Leg 2b – 9 to 25 September 2014 - Amundsen Gulf, Beaufort Sea and Barrow Strait

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5.1 Introduction

Starting on 9 September in Barrow, Alaska, and ending on 25 September in Kugluktuk, NWT, Leg 2b was a joint Canada-Japan-USA mission. For the first time since its inauguration in 2003, the *Amundsen* operated for science in American waters west of the Beaufort Sea (Figure 5.1). Before this mission, operations in non-Canadian waters were limited to short forays into Greenland waters during the annual survey of the North Water polynya.

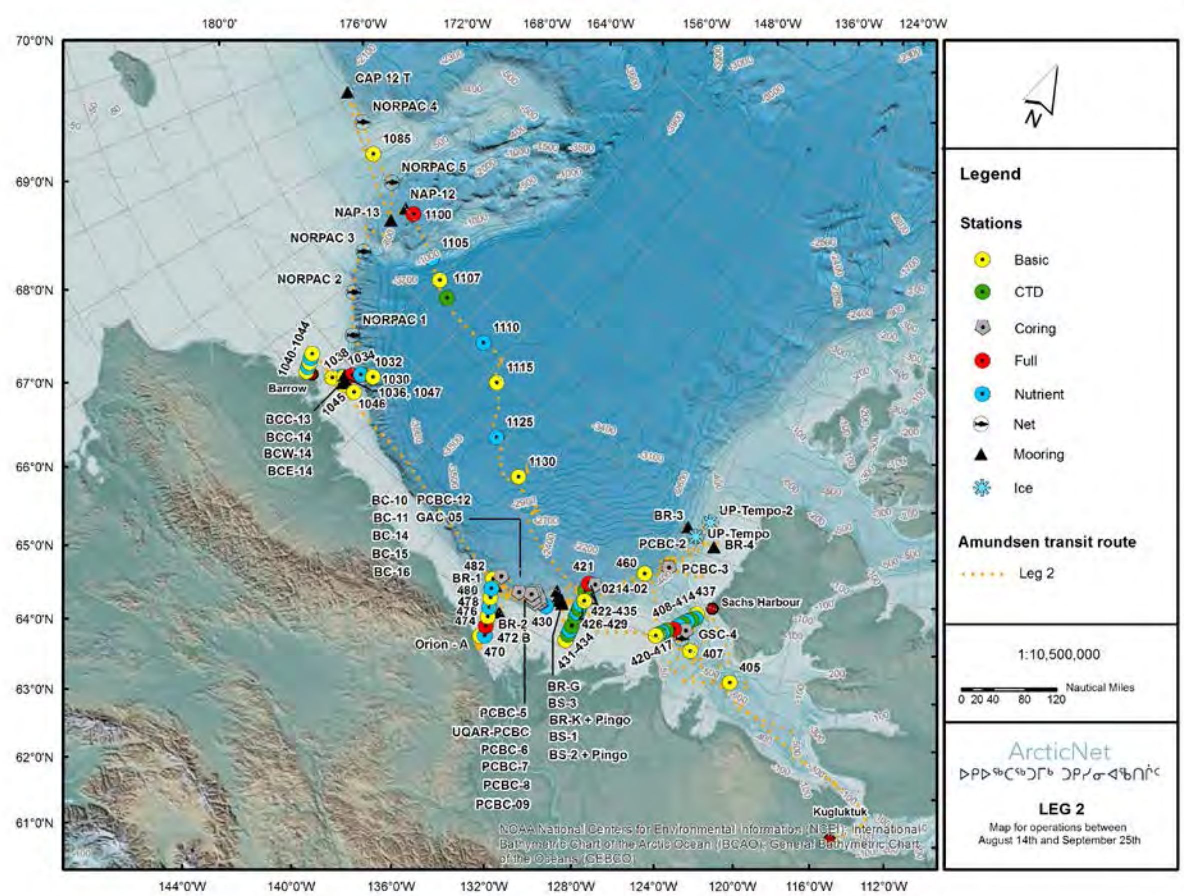

Figure 5.1. Ship track and the location of stations sampled in the Amundsen Gulf, Beaufort Sea and Barrow Strait during Leg 2.

The specific objectives of the mission were to:

- Recover and redeploy 3 moorings in Barrow Canyon (BCE, BCC and BCW);
- Recover 2 moorings on Northwind Abyssal Plain (mooring NAP-12 and NAP-13);
- Recover 1 mooring on Chukchi Abyssal Plain (mooring CAP-12);
- Deploy 1 mooring on Northwind Abyssal Plain (mooring NAP-14);
- Sample 5 Basic stations across Barrow Canyon (DBO-5 transect);
- Conduct one MVP transect across Barrow Canyon near JAMSTEC moorings;
- Sample 9 biophysical stations distributed in the Chukchi Sea and Beaufort Sea;
- Deploy 4 on-ice met towers;
- Deploy 4 ice beacons next to on-ice met towers and additional beacons on interesting ice floes;
- Deploy one ice-tethered ADCP next to on-ice met tower;
- Deploy a chaetognath sampling device at up to 3 stations;
- Deploy NORPAC net at 9 designated stations (some NORPAC stations also include gravity coring operations);
- Deploy one or two UpTempO buoys if deployments were impossible on Leg 2a;
- Deploy 2 POPS buoys in open water;
- Deploy Polar SVP beacons on MYI if deployments were impossible on Leg 2a.

5.2 Synopsis of Operations

This section provides a general synopsis and timeline of operations during Leg 2b. Detailed cruise reports provided by onboard participants and including specific objectives, methodology and preliminary results for projects conducted during this leg are available in Part II of this report.

During this leg, the ship traveled from Barrow, AK (9 September) to Kugluktuk (25 September) with 38 stations visited and an overall tally of operations and activities as follows:

- 32 CTD-Rosette casts;
- 22 XCTD casts;
- 3 MVP transect;
- 53 plankton tows and trawls, including horizontal and vertical net tows, and Hydrobios and IKMT;
- 6 Beam trawls;
- 6 Box coring stations;
- 9 Van Veen Grabs;
- 6 Agassiz trawls;
- 10 Gravity cores;
- 2 Ice stations;
- 7 moorings recovery;
- 3 moorings deployment.

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

5.2.1 Timeline of operations

Seventeen participants including the Chief Scientist were transferred from Barrow onboard the *Amundsen* in the afternoon of 9 September. Shore to ship transfer was conducted using the ship's helicopter. Despite the usual recommendations, three scientists arrived late in Barrow and were transferred to the ship on 10 September briefly interrupting science operations offshore.

New coming scientists reviewed the operational procedures and safety protocols pertaining to their scientific operations. In particular, first-time participants (e.g. Japanese and American teams) reviewed in detail the procedures and safety protocols developed for operations onboard the *Amundsen* before carrying out a deployment for the first time.

The ship left Barrow to start science operations on the DBO-5 transect off Barrow (Distributed Biological Observatory program) in the early morning of 10 September, successfully completing the 5 planned shallow Basic stations of the transect by early morning of the 11th. The DBO-5 transect is normally composed of 10 stations separated by 2 nautical miles. Because of the limited time available during Leg 2b (huge distances to be covered and several priority operations to be carried out), only 5 stations separated by 6 nautical miles were planned and sampled. Three of the Basic stations (1040, 1042 and 1044) along this transect were complete Basic stations, where the ship spent approximately 6 hours on station. Station 1042 was the Hot Spot of the DBO-5 transect. Stations 1041 and 1043 were considered mini-Basic stations, where only a subset of the sampling operations was conducted (only 3 hours on station). Operations conducted at these mini-Basic stations included a CTD-Rosette, a NORPAC plankton net deployment and a sediment grab. These mini-Basic stations were included in the plan to accommodate requests from the Japanese and American teams.

Once operations on the DBO-5 transect were completed, the ship steamed northeast towards the Barrow Canyon moorings. Moorings BCE-13 and BCC-13 were schedule to be recovered on 11 September, and mooring BCW-13 was schedule to be recovered in the morning of 12 September. Mooring operations could not have taken place prior to 11 September, as this would leave insufficient time after the science rotation for the JAMSTEC team to prepare. After recovering all moorings, the ship conducted an MVP transect across Barrow Canyon and parallel to the mooring line. It was recommended that the MVP be towed at a speed between 6 to 8 knots over the 12 nm transect.

Three out of four planned mooring deployments (BCW, BCC, BCE) were successfully conducted at their planned locations very near their proposed depths. It was not possible to deploy Mooring NAP-14 due to persistent adverse weather conditions (3-4m swell, 30-

40 knots Easterly winds). For a full record of the mooring deployment plans, see Appendix 2. Moorings BCW and BCE were deployed using the Zodiac, whereas the deployment of mooring BCC was done without the Zodiac due to adverse weather. Rough weather throughout the Barrow Canyon and Abyssal Plains (Chukchi and Northwind) made it very difficult for mooring operations. Mooring operations were further made difficult due to short inter-instrument spacing (for the *Amundsen* A-frame) of the JAMSTEC mooring designs, which made tacking very hard and resulted in high line tensions and sensitive (potentially dangerous) handling maneuvers. With that being said, mooring operations were successful due to effective planning, information dissemination, organization and experience.

After completing stations in Barrow Canyon, the ship transited northwest and conducted operations at several stations along the way. Stations NORPAC-1 to NORPAC-3 were located on the Chukchi borderlands and operations at these stations included the deployment of a NORPAC net and a sediment grab.

From 14 to 17 September, the ship conducted operations on the Northwind Abyssal Plain and Ridge and on the Chukchi Abyssal Plain. Priority operations included recovering 3 moorings and deploying 1 mooring. Mooring NAP-14 was redeployed at 75°00.170 N and 162°00.180 W.

Once mooring operations were completed, the ship sailed towards Kugluktuk, conducting sampling operations at designated stations along the way (Full 1100, Nutrient 1105, Basic 1107, Nutrient 1110, Basic 1115, Nutrient 1125, Basic 1130 and Basic 435). In addition to station sampling, a total of 15 hours were allotted to sea ice sampling operations. For a summary of the ice operations conducted, please refer Section 5. Sea ice operations took place in Canadian waters around Full Station 490 located just north of the Beaufort Sea Oil and Gas Exploration Leases. Imperial Oil Limited has contributed $48K of shiptime for sea-ice sampling operations. This $48K has been spread between operations on Leg 2a and 2b.

The ship arrived in Kugluktuk on the evening of 24 September for the end of Leg 2b and the full Coast Guard crew change on 25 September. The crew change was carried out using the helicopter and all science participants were provided an immersion suit for the offshore transportation. The charter plane left Kugluktuk at 2:05 PM on 25 September.

5.3 Chief Scientist's comments

Despite the difficult meteorological conditions that prevailed during the second half of Leg 2b, the objectives of the ambitious scientific program were in large part (90%) completed. 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.

6 Leg 3 – 25 September to 11 October 2014 – The Canadian Arctic Archipelago and Baffin Bay

Chief Scientist: Donald Forbes[1] (donaldl.forbes@nrcan-rncan.gc.ca)
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6.1 Introduction

Leg 3 took place from 25 September to 11 October and focused on ArcticNet's marine-based research program in the Canadian Arctic Archipelago and Baffin Bay, starting in Kugluktuk and reaching Quebec City (Figure 6.1).

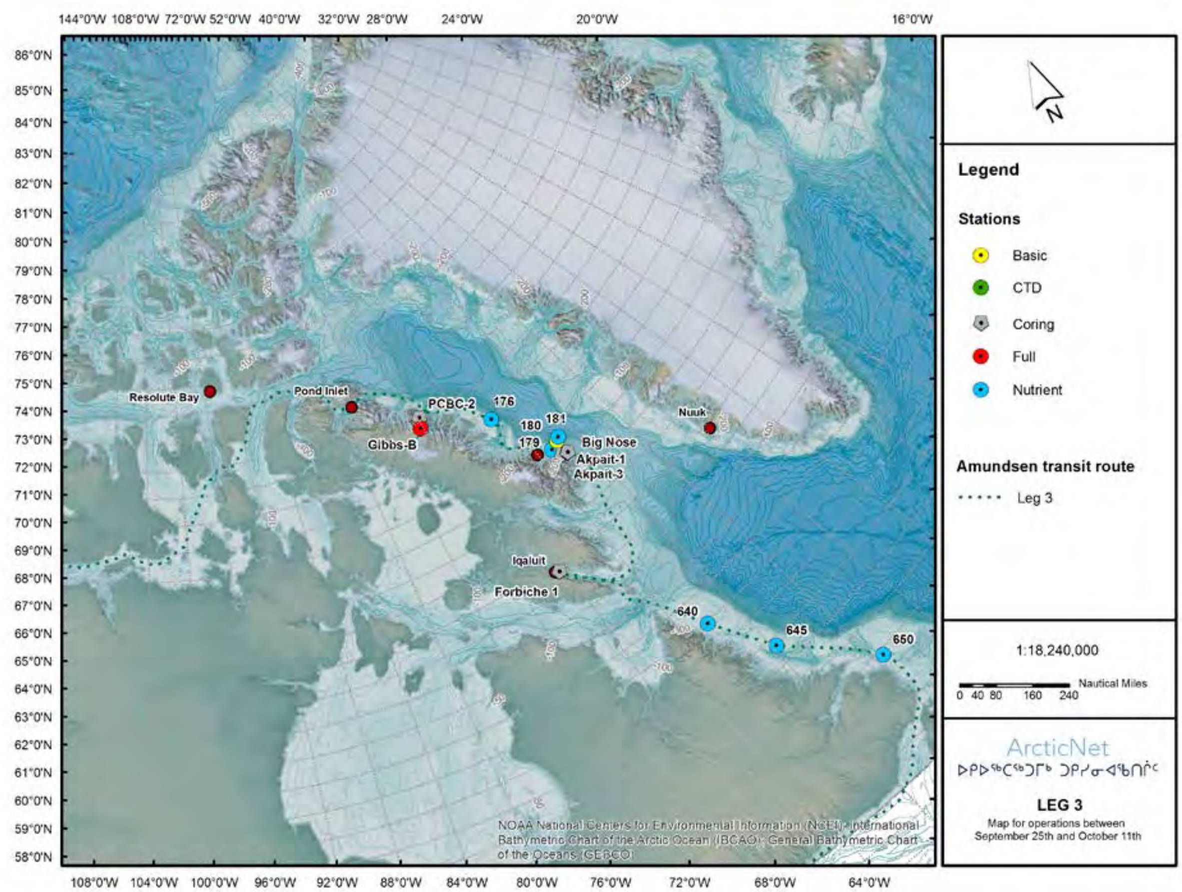

Figure 6.1. Ship track and the location of stations sampled in the Canadian Arctic Archipelago and Baffin Bay during Leg 3.

The specific objectives and priorities of Leg 3 were to:

- Meet with the CCGS *DesGroseilliers* for refuelling (12hrs);
- Conduct 12 hours of multibeam survey in and around Scott Inlet;
- Conduct box and piston coring operations at 1 selected site in Scott Inlet;
- Conduct box and piston coring operations at 1 selected site offshore Scott Inlet;

- Conduct sampling operations at 12 biophysical stations located off the coast of Baffin Island;
- Conduct coring operations at selected sites in 3 fjords of Baffin Island (Giffs Cove, Big Nose and Akpait);
- Conduct coring operations at selected site near Hill Island in Frobisher Bay;
- Conduct sampling operations at 6 biophysical stations in the Labrador Sea;
- Gather multibeam data in a large area of deep water in Frobisher Bay on the way in and out of Falk-Fletcher Passage;
- Historical visit of Beechey Island;
- Multibeam survey over seep anomalies on the Labrador Coast.

6.2 Synopsis of Operations

This section provides a general synopsis and timeline of operations during Leg 3. Detailed cruise reports provided by onboard participants and including specific objectives, methodology and preliminary results for projects conducted during Leg 3 are available in Part II of this report.

During this leg, 13 stations were visited with an overall tally of operations and activities as follows:

- 11 CTD-Rosette casts;
- 9 plankton tows and trawls, including horizontal and vertical net tows, and Hydrobios;
- 4 Box coring stations;
- 2 Agassiz trawls;
- 6 Piston cores.

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

6.2.1 Timeline of operations

Science participants were transported onboard the ship using the helicopter after the boarding of the Coast Guard crew on 25 September. Following the crew change, the *Amundsen* left anchor and started sailing east.

The ship reached a designated GSC site in Scott Inlet on 30 September (PCBC-2), where box and piston coring operations were conducted. On October 1st, one Full and one Nutrient station (respectively Gibbs-B and Gibbs-N) were completed. The ship also conducted box and piston coring operations at a selected site offshore Scott inlet (PCBC-3). Initially, 7 hours were dedicated to multibeam mapping of Scott Inlet and Clarke fjord to build on existing data. However, since sea conditions did not permit the mapping of Scott Through, both Clarke and Gibbs fjords were mapped instead (Figure 6.2). Mapping was completed between the two coring stations and resulted in an extension of an already mapped area in Clarke fjord and of the head of Gibbs fjord.

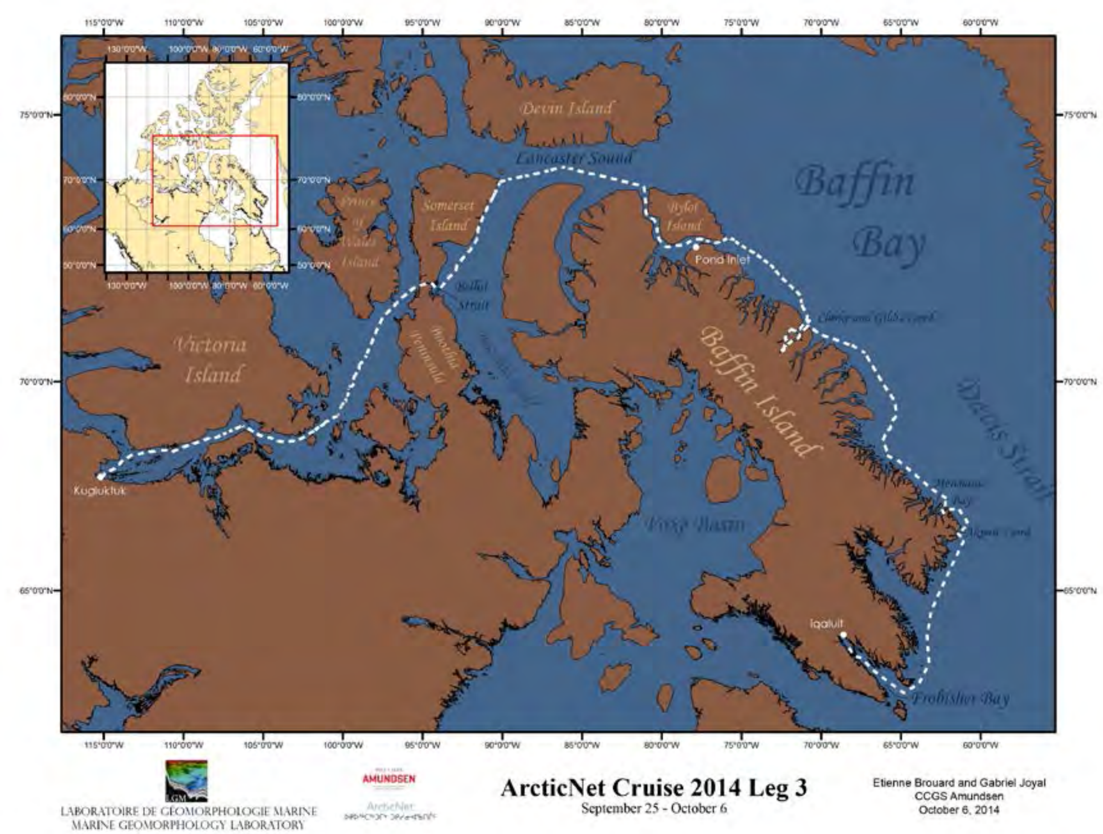

Figure 6.2 Ship tracking during Leg 3.

On 2 October, the *Amundsen* entered Baffin Bay with the objective of collecting seawater to estimate the size and evaluate the fate (bio-oxidation vs. outgassing) of the methane-enriched layer that was identified during the 2013 ArcticNet expedition. To do so, 4 biophysical stations out of the 12 initially planned were sampled along the 350 m isobath off the coast of Baffin Island (Nutrient Station 176 and Basic Station 180) and along an inshore-offshore transect in Baffin Bay (Nutrient Stations 179 and 181). The ship then headed south to the Cumberland Peninsula.

On 4 October, coring operations were conducted at 3 selected sites within 2 fjords of Baffin Island, namely Big Nose and Akpait (Stations Akpait-3 and Akpait-1), as to sample and date submerged shoreline features (deltas) identified through multibeam sonar onboard the MV *Nuliajuk*. Samples and the resulting chronology from the Cumberland Peninsula constitute the first data of its kind collected from these submerged shorelines in the eastern Canadian Arctic on top of providing some sense of the rate of sea-level rise in this region over past millennia. Multibeam mapping was performed to determine route planning and stations accessibility within the fjords (Figure 6.3).

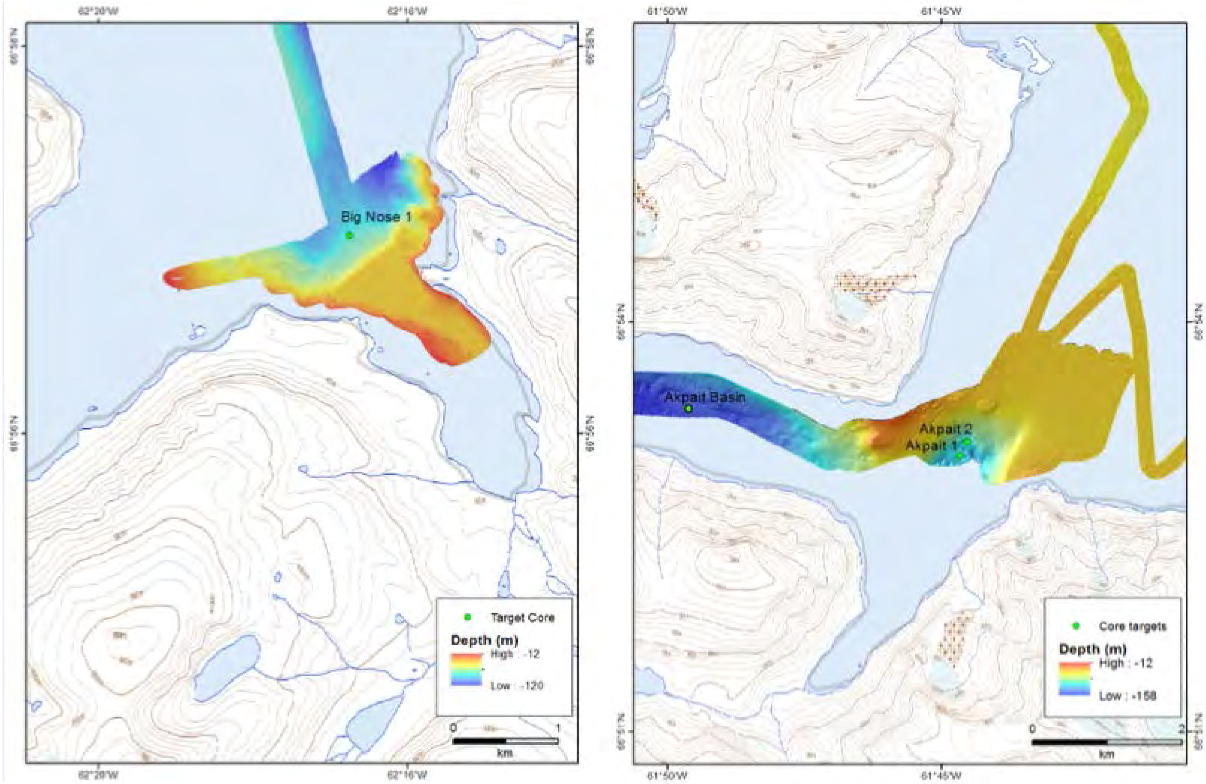

Figure 6.3 Existing multibeam data and coring target in Big Nose Inlet (left) and Akpait (right).

After completing operations in the fjords of the eastern Cumberland Peninsula, the ship continued transiting towards Iqaluit. Entering Frobisher Bay, the *Amundsen* transited through the Falk-Fletcher Passage as to add one line of multibeam data in a large area of deep water (Figure 6.4).

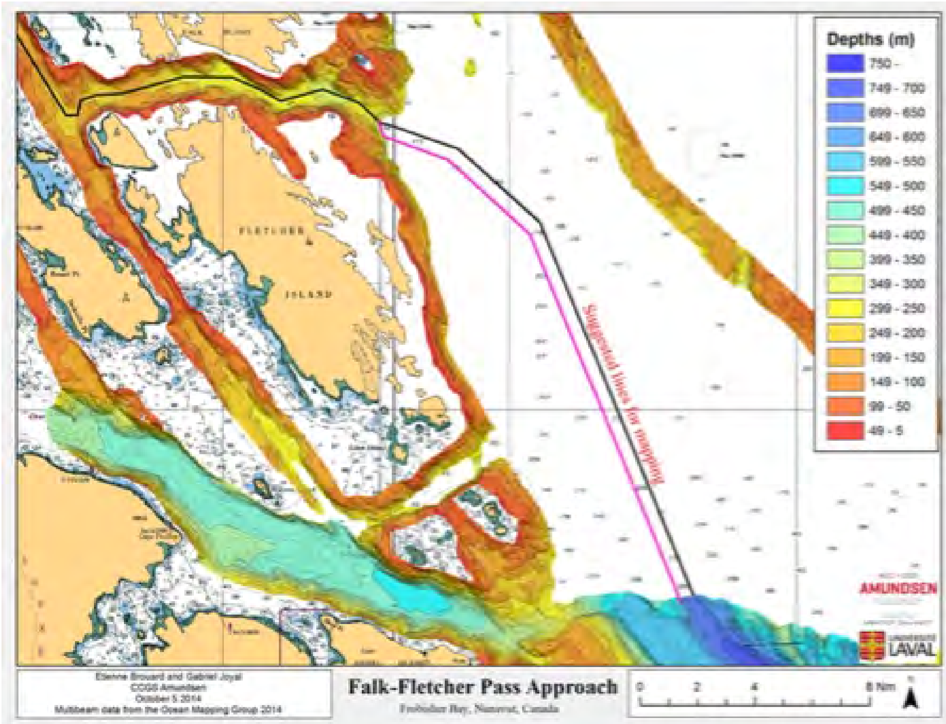

Figure 6.4 Falk-Fletcher Passage and multibeam data.

On 6 October, the ship carried on with coring operations in the vicinity of Hill Island, inner Frobisher Bay (Station Forbiche-1). The target location stood as a proof-of-concept site where relatively youthful submarine slides can be successfully cored and aged.

The science rotation in Iqaluit was done in late afternoon on 6 October. All Schools on Board personnel and two media participants got off the ship.

Between 7 and 11 October, the *Amundsen* transited from Iqaluit to Quebec City, through the Labrador Sea. During its transit, the ship conducted operations at 3 designated Nutrient stations along the coast of Labrador (640, 645 and 650). The objective of these sampling stations was to collect seawater to estimate the size and evaluate the fate (bio-oxidation vs. outgassing) of the methane-enriched layer that was identified in the Labrador Current during the 2013 ArcticNet expedition. The ship docked in Quebec City on 11 October.

6.3 Chief Scientist's comments

Leg 3 went smoothly with 13 stations visited and successful Schools on Board session. 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.

Part II – Project reports

1 Atmospheric measurements of aerosol particles and trace gases (NETCARE) – Leg 1

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1.1 Introduction

Atmospheric measurements in the Arctic are sparse. This lack of key measurements leads to atmospheric and climate models that fail to reproduce observations (Browse et al. 2012). In particular, the number, distribution, composition and controls on particulate matter are poorly understood. Particulate matter plays an important role in the climate system, as it is necessary to form both liquid water clouds (via cloud condensation nuclei, or CCN) and ice clouds (via ice nuclei, or IN). Thus an understanding of the current distribution of aerosol particles in the Arctic, the controls on that distribution, and the ability of those particles to act as IN or CCN is necessary to understanding the present and future climate of the region. To this end, direct measurements of CCN and IN were made as well as particle number and size distribution. Water-soluble components of fine particulate matter were analyzed by ion chromatography along with water-soluble gases to gain insight into the composition of the aerosols. Dimethyl sulfide (DMS), suggested as an important gas-phase precursor to aerosol particle formation and growth in the Arctic (Levasseur 2013), was measured by two different methods. Other trace gases, which could be important for particle growth, such as organic acids and unsaturated hydrocarbons, were measured. Particulate matter was collected on filters to allow analysis of sulfur isotope ratios as a clue to the contribution of biogenic sulfur (derived from DMS) to the particles.

The overall goal was to characterize the concentrations, spatial distribution, and chemical composition of particulate matter and its potential precursor gases in the Arctic.

1.2 Methodology

1.2.1 Trace Gas Measurements

Two chemical ionization mass spectrometers (CIMS) were deployed. One was located in the starboard foredeck container and used benzene as the reagent ion in order to measure DMS and potentially unsaturated hydrocarbons (such as isoprene) at 10 Hz. These measurements were made 24 hours a day for the period of 15 July – 7 August. The second mass spectrometer was located in the OASIS container, with the inlet on the top of the container, and used acetate as the reagent ion in order to measure organic acids at 1 Hz. These measurements were made 24 hours a day for the period 7 July – 12 August. (Benzene CIMS operated by Emma Mungall, Acetate CIMS operated by Jeremy Wentzell on Leg 1a and Alex Lee on Leg 1b)

An ambient ion monitor ion chromatograph system (AIM-IC) was deployed in order to simultaneously measure the water-soluble fraction of fine particulate matter and soluble atmospheric gases. The instrument was located in the forward filtration lab and the inlet on the starboard side of the foredeck, beside the starboard foredeck container. The instrument sampled with 1-hour time resolution 24 hours a day from 13 July to 9 August, with only occasional daylong gaps in the data for maintenance and calibrations. (AIM-IC operated by Greg Wentworth)

A gas chromatograph was used to analyze gas samples for DMS. These samples included ambient samples, samples taken above melt ponds and samples taken from the POLAR6 aircraft. (The GC was operated by Roghayeh Ghahremaninezhad on Leg 1a and Greg Wentworth on Leg 1b)

1.2.2 Aerosol Particle Measurements

A single stage impactor (SSI) and micro-orifice uniform deposition impactor (MOUDI) were used to collect particles on the monkey's island of the ship. One SSI sample was taken a day (Table 1.1). Two MOUDI samples were taken a week. Scanning electron microscopy (SEM) samples were taken alongside every SSI and MOUDI sample. (The SSI and MOUDI were operated by Vickie Irish)

Table 1.1. MOUDI and SSI Sampling Times (EDT).

DATE	SSI		SSI SEM		MOUDI & SEM	
	Start	Finish	Start	Finish	Start	Finish
8th July	15:31	16:01				
9th July	09:24	09:39				
10th July	13:25	13:40				
11th July	08:24	09:19			09:32	15:45
12th July	09:25	10:10				
13th July	16:06	16:31				

DATE	SSI		SSI SEM		MOUDI & SEM	
	Start	Finish	Start	Finish	Start	Finish
14th July	08:41	09:01			09:43	16:04
15th July	13:10	13:55				
16th July	17:42	18:02				
17th July	15:24	15:34	15:44	16:04	16:20	22:26
18th July	16:29	16:44	16:56	17:26		
19th July	12:08	12:28	13:30	13:50		
20th July					12:33	22:20
21st July	10:11	10:31	10:42	11:12		
22nd July	08:13	08:33	08:40	09:00		
23rd July	10:34	10:47	10:50	11:10	15:17	21:17
24th July	17:40	17:55	18:00	18:20		
25th July	15:40	16:00	16:43	17:29	08:32	15:32
26th July	13:03	13:23	13:32	14:46		
27th July	13:37	01:57	14:05	14:35		
28th July	17:58	18:18	18:24	19:14	19:20	01:20
29th July	09:30	09:50	10:14	11:04		
30th July	15:49	16:09	16:14	16:54	09:18	15:19
31st July	13:04	13:26	13:32	14:29		
1st August	12:34	12:54	13:26	13:52		
2nd August	15:53	16:13	16:20	16:50	08:04	14:34
3rd August	08:31	08:51	08:57	09:40	21:51	10:42
4th August	10:47	11:07	11:15	11:40		
5th August	18:37	18:57	19:16	19:45		
7th August	08:40	09:00	09:05	09:45		
8th August	10:12	10:32	10:38	11:08	11:14	18:14
9th August	10:00	10:20	10:26	11:14		
10th August	12:17	12:37	12:51	13:31	13:41	21:10
11th August	09:57	10:17	10:24	11:14		
12th August	09:58	10:24	10:33	11:04		

An aerodynamic particle sizer (APS) provided particle size distributions for particles larger than 500 nm every second. The APS was operated continuously for the period 10 July – 12 August. (APS operated by Vickie Irish)

The AIM-IC mentioned above measured the water-soluble components of fine particulate matter with hourly time resolution. It sampled 24 hours a day for the period 13 July to 9 August, with occasional gaps for maintenance and calibrations (AIM-IC operated by Greg Wentworth)

Two scanning mobility particle sizers (SMPS) were deployed, one on the foredeck and one behind the bridge. These were operated continuously (except for 13, 14, and 15 July, when the foredeck SMPS was not working) and provided particle size distributions from 10-500 nm every few minutes. (Foredeck SMPS operated by Emma Mungall, OASIS container SMPS operated by Jeremy Wentzell)

A condensation particle counter (CPC) in the starboard foredeck container provided particle number concentration from 4 nm to <1 µm every second. The CPC was operated continuously for the period 7 July – 13 August. (Operated by Emma Mungall)

A cloud condensation nucleus counter (CCNC) was deployed in the starboard foredeck container. The CCNC, together with the CPC, can be used to determine the fraction of aerosol particles that will activate to form cloud droplets (i.e. that will allow a cloud droplet to form around them) at a given supersaturation with respect to liquid water. This gave an estimate of the population of CCN in the atmosphere. The CCNC scanned five supersaturations every hour and was operated continuously for the period 7 July – 1 August. (CCNC operated by Emma Mungall)

Aerosols in different sizes were measured using a high volume sampler with a cascade impactor to collect and determine the amount of sulfur. The high volume sampler collected aerosols as a vacuum pump pulled air through the filters. Samples collected at the filters were extracted in solution, which was then used for ion chromatography and stable isotope analysis. In addition, aerosol sulfate concentrations were measured at the same time as precipitation and fogs to compare with the characteristics of aerosols in each size fraction with the characteristics of the sulfate in each medium. (Sampling carried out by Roghayeh Ghahremaninezhad)

1.3 Preliminary results

Many of the instruments that acquire continuously generate so much data that they take a very long time to process, and so have not yet generated preliminary results. Conversely, many of the discrete samples that were collected can only be analyzed back in the lab. A couple of exceptions to this were the SMPS and CPC, which sampled continuously but were simple to analyze. Below are the plots of the particle number concentration and the size distribution over most of Leg 1. The large spikes represent times when we were sampling the ship's smokestack.

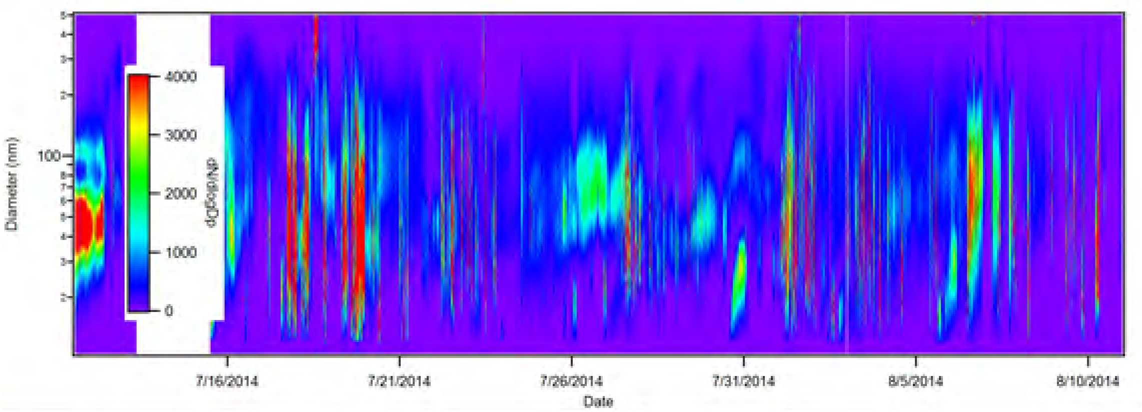

Figure 1.1. Particle diameter over time, colored by the bin-weighted number concentration.

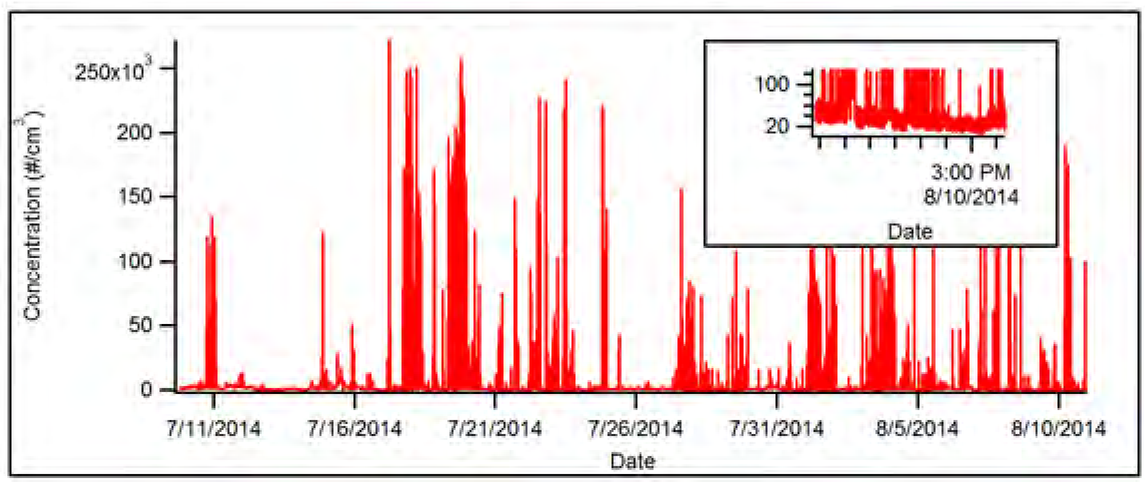

Figure 1.2. Particle number concentration over time. Insert shows the difference (up to four orders of magnitude) between background number concentrations and number concentrations when the smokestack influences measurements.

1.4 Comments and recommendations

As can be intimated from Figure 1.1 and 1.2, the smokestack presented the largest difficulty to making atmospheric measurements from a ship. We found that inlets on the foredeck were less affected than inlets on the OASIS container or on the monkey's island, with the monkey's island inlets less affected than inlets on the OASIS container. The conclusion drawn from this is that the further forward the inlets are the better. Recommendation for future atmospheric sampling on the *Amundsen* would be to endeavour to have inlets as far forward as possible and to attempt to have the wind coming over the bow as much as possible. It was not possible to make good measurements when the wind was from the stern.

A less important issue that came up was the sensitivity of the instruments, particularly those on the foredeck and in the forward filtration lab, to vibrations caused both by the ship's engines and the motion of the ship when breaking ice. A recommendation for future measurements would be to have some form of shock protection for the most sensitive instruments.

References

Browse, J., Carslaw, K. S., Arnold, S. R., Pringle, K. & Boucher, O. The scavenging processes controlling the seasonal cycle in Arctic sulphate and black carbon aerosol. *Atmos. Chem. Phys.* 12, 6775–6798 (2012).

Levasseur, M. Impact of Arctic meltdown on the microbial cycling of sulphur. *Nature Geosci* 6, 691–700 (2013).

2 Biogeochemistry of the inorganic carbon cycle, surface climate, air-surface fluxes and carbon exchange dynamics - Legs 1 and 2

ArcticNet Phase 3 – Carbon Exchange Dynamics in Coastal and Marine Ecosystems. http://www.arcticnet.ulaval.ca/pdf/phase3/carbon-dynamics.pdf

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2.1 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) and total alkalinity (TA) in the surface waters. Out of the four measurable carbon system parameters (DIC, TA, pH and pCO_2), a minimum of two is needed to calculate the others and fully describe the inorganic carbon chemistry, over-determination of the system being beneficial.

Biological activity alters the chemical signatures of the water, affecting both the isotopic carbon ratio (∂13C) and dissolved inorganic carbon (DIC) concentrations. Phytoplankton incorporates carbon into their organic matter and preferentially selects light carbon (12C) over the heavier carbon isotope (13C). This biological fraction leads to isotopically heavy productive surface waters exhibiting low concentrations of DIC. At depth, particularly below the pycnocline, the organic carbon from sinking particulate matter is reminizeralized into DIC and the waters become istotopically light due to the release of 12C. These signals can provide powerful insight into the biological processes occurring in the water column. Further processes altering the C-isotopic signature of DIC are the uptake of isotopically lighter anthropogenic CO_2 from the atmosphere, and from terrestrial sources (runoff) revealing individual DI13C characteristics. Together with further oceanographic tracers, DI13C data were used to unravel processes controlling the observed DIC distributions in the investigation area. O18 samples were taken in conjunction with TIC/A_T samples. O18 is important to track as it gives a signature for where the water mass has come from, be it from glacial or seawater origin.

The surface meteorology and flux program of 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 to the direct measurement of heat, CO_2 and momentum. Eddy covariance represents the lone local scale (100s m to km) direct measurement of the respective fluxes using micrometeorological approaches.

The specific objectives of this sampling program were:

- Develop a process-level understanding of the exchange dynamics of heat, CO_2, and momentum;
- Develop tools (observations, models, remote sensing) to assist with regional budeting of the above variables;
- Forecast how the ocean's response to climate change and variability will affect the atmosphere-ocean cycling of CO_2.

2.2 Methodology

2.2.1 Total Inorganic Carbon Sampling

During Leg 1, a total of 300 x 500mL and 18 x 250mL samples were collected for analysis of TIC and A_T. A further 30 samples (triplicates at 10 different stations) were collected from the bulk water at all microlayer stations. O18 samples were taken at all the same stations and mostly at surface depths (surface, 10 m, 30 m and 50 m). All samples were collected in parallel with the Nutrient Rosette. TIC and A_T samples were collected in 500 mL bottles (and later in 250 mL bottles) and O18 samples were collected in 2 mL vials. No TIC or A_T samples were analyzed on board during Leg 1. All the bottles were spiked with $HgCl_2$ and stored in the refrigerated container at 4°C. All of the O18 vials were stored at room temperature.

The following is a list of stations sampled for TIC/ A_T and O18 during Leg 1. Sampling at Full, Basic and Nutrient stations went as follows (as much as was possible):

- Full stations – full depth profiles;
- Basic stations – surface or full profiles;
- Nutrient stations – surface profiles (top two depths).

Table 2.1. Stations sampled for TIC during Leg 1 (ML = microlayer).

Station	Type of Station	Cast #	Date	Samples Taken	Additional notes
ROV1	BASIC	001	15 July 2014	TIC/A_T/O18	
ML 1			16 July 2014	TIC/A_T	See ML report in Section 9
323	FULL	004	17 July 2014	TIC/A_T/O18	Rough sea
300	NUTS	005	18 July 2014	TIC/A_T/O18	V rough sea
322	NUTS	006	18 July 2014	TIC/A_T/O18	35kt wind, mixed surface depths
324	NUTS	007	18 July 2014	TIC/A_T/O18	

Station	Type of Station	Cast #	Date	Samples Taken	Additional notes
325	NUTS	008	18 July 2014	TIC/A_T/O18	
301	BASIC	010	19 July 2014	TIC/A_T/O18	
346	NUTS	011	20 July 2014	TIC/A_T/O18	Propellors mixed up surface
304	FULL	013	20 July 2014	TIC/A_T/O18	
305	FULL	015	22 July 2014	TIC/A_T/O18	
305A	NUTS	016	22 July 2014	TIC/A_T/O18	
305B	NUTS	017	22 July 2014	TIC/A_T/O18	
305C	NUTS	018	23 July 2014	TIC/A_T/O18	
305D	NUTS	019	23 July 2014	TIC/A_T/O18	
305E	NUTS	020	23 July 2014	TIC/A_T/O18	
ML2			23 July 2014	TIC/A_T/O18	See ML report in Section 9
ML3				TIC/A_T/O18	See ML report in Section 9
200	BASIC	022	27 July 2014	TIC/A_T/O18	Surface water may be contaminated by wash off from overheating rosette
204	BASIC	025	28 July 2014	TIC/A_T/O18	
206	NUTS	026	29 July 2014	TIC/A_T/O18	
210	BASIC	029	29 July 2014	TIC/A_T/O18	
214	NUTS	031	30 July 2014	TIC/A_T/O18	
115	FULL	033	30 July 2014	TIC/A_T/O18	
ML4 – 115	FULL		30 July 2014	TIC/A_T/O18	See ML report
111	BASIC	039	31 July 2014	TIC/A_T/O18	
108	FULL	042	31 July 2014	TIC/A_T/O18	
ML5 – 108	FULL		31 July 2014	TIC/A_T/O18	See ML report in Section 9
105	BASIC	046	1 August 2014	TIC/A_T/O18	
101	FULL	051	1 August 2014	TIC/A_T/O18	
KEN1	FULL	054	3 August 2014	TIC/A_T/O18	
ML6 – KEN1	FULL		3 August 2014	TIC/A_T/O18	See ML report in Section 9
KEN2	NUTS	055	3 August 2014	TIC/A_T/O18	
KEN3	BASIC	057	4 August 2014	TIC/A_T/O18	
KEN4	NUTS	058	4 August 2014	TIC/A_T/O18	
KANE1	BASIC	060	4 August 2014	TIC/A_T/O18	
ML7 – KANE1	BASIC		4 August 2014	TIC/A_T/O18	See ML report in Section 9
KANE2	NUTS	061	5 August 2014	TIC/A_T/O18	
KANE3	BASIC	063	5 August 2014	TIC/A_T/O18	
KANE4	NUTS	064	5 August 2014	TIC/A_T/O18	
ML8 – PII-K	Ice island		5 August 2014	TIC/A_T/O18	See ML report in Section 9
KANE5	BASIC	073	6 August 2014	TIC/A_T/O18	
127	NUTS	074	6 August 2014	TIC/A_T/O18	
120	BASIC	076	6 August 2014	TIC/A_T/O18	
309	BASIC	080	10 August 2014	TIC/A_T/O18	Top five surface depths taken in 500ml bottles. Last 6 depths taken in 250ml bottles.
310	BASIC	082	11 August 2014	TIC/A_T/O18	All samples taken in 250ml bottles.
312	BASIC	084	11 August 2014	TIC/A_T/O18	All samples taken in 250ml bottles.
ML9 – 312	BASIC		11 August 2014	TIC/A_T/O18	See ML report in Section 9
314	BASIC	086	12 August 2014	TIC/A_T/O18	All samples taken in 250ml bottles.
ML10 – 314	BASIC		12 August 2014	TIC/A_T/O18	See ML report in Section 9

During Leg 2, a total of 38 stations were sampled for DIC, TA, 13C and 18O analysis (Table 2.2).

Table 2.2. Stations sampled for DIC, TA, 13C and 18O during Leg 2.

Station	Latitude (N)	Longitude (W)	Cast #	Date
405	70°38.330	123°01.940	1406003	17 Aug 2014
407	71°00.210	126°04.660	1406005	18 Aug 2014
437	71°47.170	126°30.010	1406007	19 Aug 2014
412	71°33.720	126°55.500	1406010	20 Aug 2014
408	71°18.700	127°34.840	1406014	20 Aug 2014
418	71°09.760	128°10.410	1406016	21 Aug 2014
420	71°03.040	128°30.640	1406018	21 Aug 2014
435	71°04.720	133°37.710	1406023	22 Aug 2014
434	70°10.720	133°33.390	1406030	23 Aug 2014
432	70°23.790	133°36.480	1406032	23 Aug 2014
428	70°47.480	133°41.770	1406036	23 Aug 2014
421	71°27.240	133°53.650	1406041	24 Aug 2014
460	72°08.810	130°48.810	1406043	25 Aug 2014
482	70°31.550	139°23.180	1406050	02 Sept 2014
470A	69°21.960	138°13.950	1406052	04 Sept 2014
470	69°25.810	137°59.070	1406053	06 Sept 2014
472	69°36.500	138°12.100	1406055	06 Sept 2014
474	69°47.860	138°26.090	1406056	06 Sept 2014
476	69°59.020	138°39.910	1406057	06 Sept 2014
478	70°10.050	138°54.600	1406058	07 Sept 2014
1040	71°14.800	157°09.970	1406060	10 Sept 2014
1041	71°19.790	157°19.990	1406061	10 Sept 2014
1042	71°24.620	157°29.340	1406062	10 Sept 2014
1043	71°29.810	157°40.120	1406063	11 Sept 2014
1044	71°34.670	157°50.340	1406064	11 Sept 2014
1036	71°43.610	155°24.680	1406065	12 Sept 2014
1038	71°34.400	155°45.460	1406066	12 Sept 2014
1034	71°54.440	154°58.180	1406071	13 Sept 2014
1032	72°03.300	154°37.310	1406074	14 Sept 2014
1030	72°12.370	153°56.400	1406075	14 Sept 2014
1085	75°03.680	167°08.410	1406078	16 Sept 2014
1100	75°04.090	161°15.670	1406082	18 Sept 2014
1105	74°47.230	157°34.180	1406084	19 Sept 2014
1107	74°37.150	155°58.810	1406085	19 Sept 2014
1110	74°19.670	148°16.760	1406086	20 Sept 2014
1115	73°56.600	147°22.450	1406087	21 Sept 2014
1125	73°00.050	144°40.140	1406088	21 Sept 2014
435			1406091	

2.2.2 Micrometeorology and eddy covariance flux tower

The micrometeorological tower located on the front deck of the *Amundsen* 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). In addition, radiation sensors were installed on the roof of the wheelhouse to provide information on incoming long-wave, short-wave and photosynthetically active radiation. All data were logged to Campbell Scientific data loggers; 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 and longitude) were measured to compensate measured apparent wind information for ship direction and motion.

This year, two different eddy covariance systems were installed on the tower. Each involved one LI7500A open path gas analyzer, as well as a sonic anemometer. One sonic anemometer was a Gill Windmaster Pro, and the other was a CSAT3 by Campbell Scientific. A closed path gas analyzer was also employed, which was located inside the container on the foredeck. While the open path gas analyzers had the benefit of making measurements concurrently with each sonic anemometer, the closed path gas analyzer was not as easily disturbed by adverse weather conditions.

In order to make sure that both the high and low frequency measurements 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 analyzers (LI-7500A) could not be calibrated as conveniently, and so they were calibrated approximately every two weeks. In general, this procedure was found effective for this instrument, which does 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 plane measurements of angular acceleration and rate), heading and location. Rotational motion was monitored using a multi-axis inertial sensing system. Data related to heading and locations were 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.

The slow sequence largely meteorological variables were scanned at 1-second intervals and saved as 1-minute averages. In regard to wind speed and direction, ship motion correction was applied in post-processing. The high frequency variables associated with the eddy covariance system were scanned at 0.1 second intervals and were 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. Fluxes are computed during post processing.

The variables that were monitored, the location where each sensor was installed, the purpose for each variable, along with the sampling and averaging frequency (if applicable) are shown in Table 2.3.

Table 2.3. Summary of variable inventory and application.

Variable	Instrumentation	Location	Purpose	Sample/Average Frequency (s)
Air temperature (Ta)	HMP45C-212	Foredeck tower	Meteorological parameter	1 / 60
Relative humidity (RH)	HMP45C-212	Foredeck tower	Meteorological parameter	1 / 60
Wind speed (ws-2D)	RM Young 05106-10	Foredeck tower	Meteorological parameter	1 / 60
Wind direction (wd-polar)	RM Young 05106-10	Foredeck tower	Meteorological parameter	1 / 60
Barometric pressure (Patm)	Vaisala PTB101B	Foredeck tower	Meteorological parameter	1 / 60
Sea surface temperature (Tsfc)	Apogee SI-111	Foredeck	Meteorological parameter	1 / 60
Ship heading (H)	OceanServer OS5000	Foredeck tower	Ancillary information	1 / --
Ship speed over ground (SOG)	Garmin GPS16x-HVS	Foredeck tower	Ancillary information	1 / --
Ship course over ground (COG)	Garmin GPS16x-HVS	Foredeck tower	Ancillary information	1 / --
Ship location (latitude, longitude)	Garmin GPS16x-HVS	Foredeck tower	Ancillary information	1 / --
Incident solar radiation	Eppley Pyranometer	Wheel-house platform	Heat budget, microclimate	2 / 60
Incident long-wave radiation	Eppley Pyrgeometer	Wheel-house platform	Heat budget, microclimate	2 / 60
Photosynthetically active radiation (PAR)	Kipp & Zonen PARLite	Wheel-house platform	Heat budget, microclimate	2 / 60
Wind speed 3D (u,v,w)	Gill Wind Master Pro and CSAT3	Foredeck tower	Air-sea flux	0.1 (10 Hz)
Sonic temperature (Ts)	Gill Wind Master Pro and CSAT 3	Foredeck tower	Air-sea flux	0.1 (10 Hz)
Atm. water vapour concentration (ρ_v)	LICOR LI7500 & LI7000	Foredeck tower	Air-sea flux	0.1 (10 Hz)
Atm. concentration of CO_2 (ρ_c)	LICOR LI7500 & LI7000	Foredeck tower	Air-sea flux	0.1 (10 Hz)
Rotational motion (accx, accy, accz, r x, r_y, r_z)	Systron Donner MotionPak	Foredeck tower	Air-sea flux	0.1 (10 Hz)
Barometric pressure (mbar)	All Sensors BARO-A-4V-MINI-PRIME	Foredeck tower	Air-sea flux	0.1 (10 Hz)
Upper sea water temperature (Tsw)	General Oceanics 8050 pCO_2	Under-way system, Forward engine room	Air-sea flux, ancillary information	3 / 60
Variable	**Instrumentation**	**Location**	**Purpose**	**Sample/Average Frequency (s)**
Sea water salinity (s)	General Oceanics 8050 pCO_2	Under-way system, Forward engine room	Air-sea flux, ancillary information	3 / 60

Dissolved CO_2 in seawater	General Oceanics 8050 pCO_2	Under-way system, Forward engine room	Air-sea flux, ancillary information	3 / 60
pH	General Oceanics 8050 pCO_2	Under-way system, Forward engine room	Air-sea flux, ancillary information	3 / 60
Dissolved O_2 in seawater	General Oceanics 8050 pCO_2	Under-way system, Forward engine room	Air-sea flux, ancillary information	3 / 60

2.2.3 Underway pCO2 system

A General Oceanics 8050 pCO_2 system was installed on the ship to measure dissolved CO_2 within the upper 5 m of the sea surface in near real time. The system 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. 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 removed H_2O from the air stream before passing into the sample cell.

2.3 Preliminary Results

At this time, no preliminary results are available.

2.4 Comments and recommendations

At this time, no recommendations to improve sampling rate or efficiency can be made, but a kind reminder that when we are at station, the ship must be pointed into the wind (when possible) so that the ship's smoke is not blown towards the met tower.

3 Distribution, air-sea flux and biogeochemical cycling of dissolved methane (CH_4) - Legs 1, 2 and 3

ArcticNet Phase 3 – Marine Biological Hotspots: Ecosystem Services and Susceptibility to Climate Change.
http://www.arcticnet.ulaval.ca/pdf/phase3/marine-ecosystem-services.pdf

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3.1 Introduction

Methane (CH_4) is the second most important greenhouse gas (after CO_2) in the atmosphere. The ocean has long been considered as a minor source of atmospheric CH_4 as compared to anthropogenic inputs and other natural sources (e.g., release from wetlands). However, climate warming, particularly over the Arctic region, may significantly change the global CH_4 budget. The thawing of the Arctic permafrost, a large part of which lies on coastal shelves, greatly increases the concentration of CH_4 in Arctic seawater either by direct injection of CH_4 into the water column or by increased, CH_4-enriched freshwater discharge. The increased river runoff also brings large amounts of dissolved and particulate organic materials to the Arctic Ocean, fuelling microorganisms, some of which produce CH_4. Methane is also injected into the water column from submarine hydrothermal vents, which are not rare in northern polar seas.

Few historic data are available about CH_4 distribution and its biogeochemical cycling in Canadian Arctic seas. Therefore, the current status of CH_4 in the Canadian Arctic is largely unknown. With the aim of assessing the impact of climate change on the CH_4 distribution and cycling in the Arctic Ocean, the objectives of this survey were to:

- Map the distribution of CH_4 in both surface and subsurface waters;
- Estimate air-sea fluxes of CH_4;
- Assess the net production (or consumption) of CH_4 in the water column;
- Identify potential CH_4 "hotspots" associated with hydrothermal activity or permafrost melting.

3.2 Methodology

Underway surface water samples were intermittently collected from the ship's pumping system located in the engine room. CH_4 profiles were collected at each Basic and Full stations, as well as at eleven Nutrient stations (412, 422, 426, 428, 430, 432, 470, 474, 476, 478 and 480) and at a special station (Pingo). Dark incubation samples for determining net production or consumption of CH_4 were taken at selected stations and depths (usually bottom and chlorophyll maximum). Underway air samples were also collected at irregular time intervals. CH_4 concentration was determined using a PP1 methane analyzer (Peak Laboratories).

3.3 Preliminary results

Several types of CH_4 vertical profiles were found following the measurements, including subsurface peaks, bottom enrichments, subsurface CH_4-enriched layers and minima values at middle (Figure 3.1). CH_4 concentration in the atmosphere was very stable throughout the cruise (~1.82 ppm).

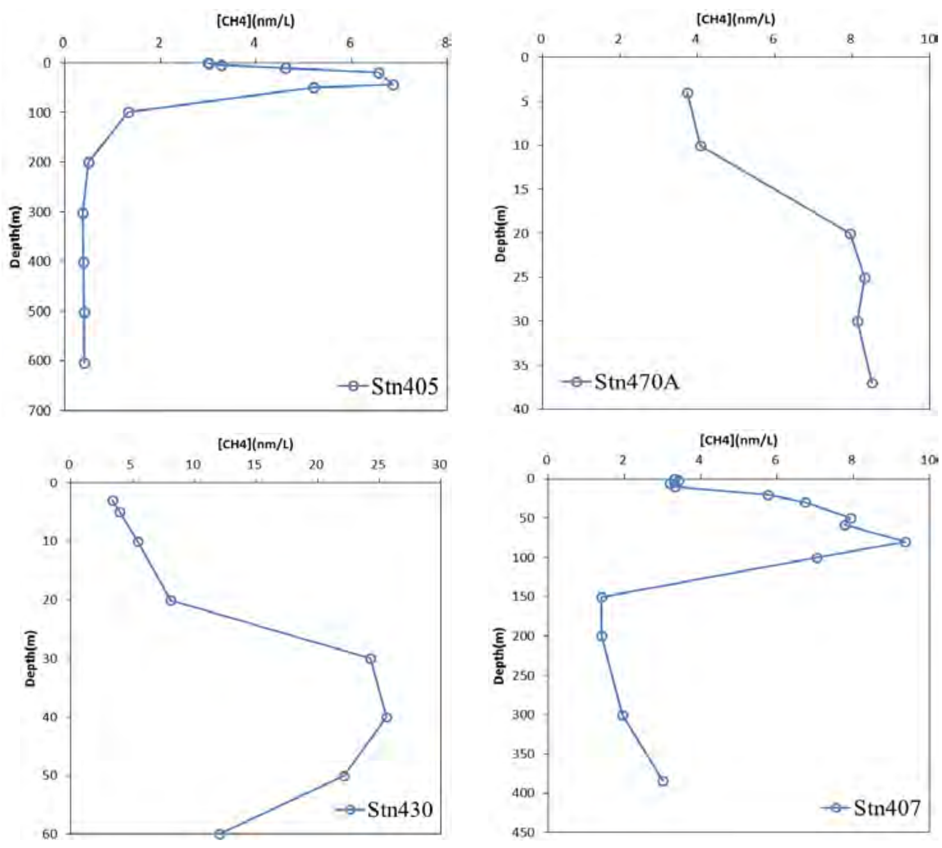

Figure 3.1. Different types of vertical CH_4 profiles, including subsurface peaks (up left), bottom enrichments (up right), subsurface CH_4-enriched layers (bottom left) and minima values at middle (bottom right).

Methane concentration was also found to increase with depth in relatively shallow water (shelf area around Barrow Canyon (Stations 1042 and 1038); CH_4 layer occurred on the slope area northeast of Barrow (Station 1030) and CH_4 was enriched in the subsurface water of the deep-water area (more than 3000 m) in the Canadian Basin (Figure 3.2).

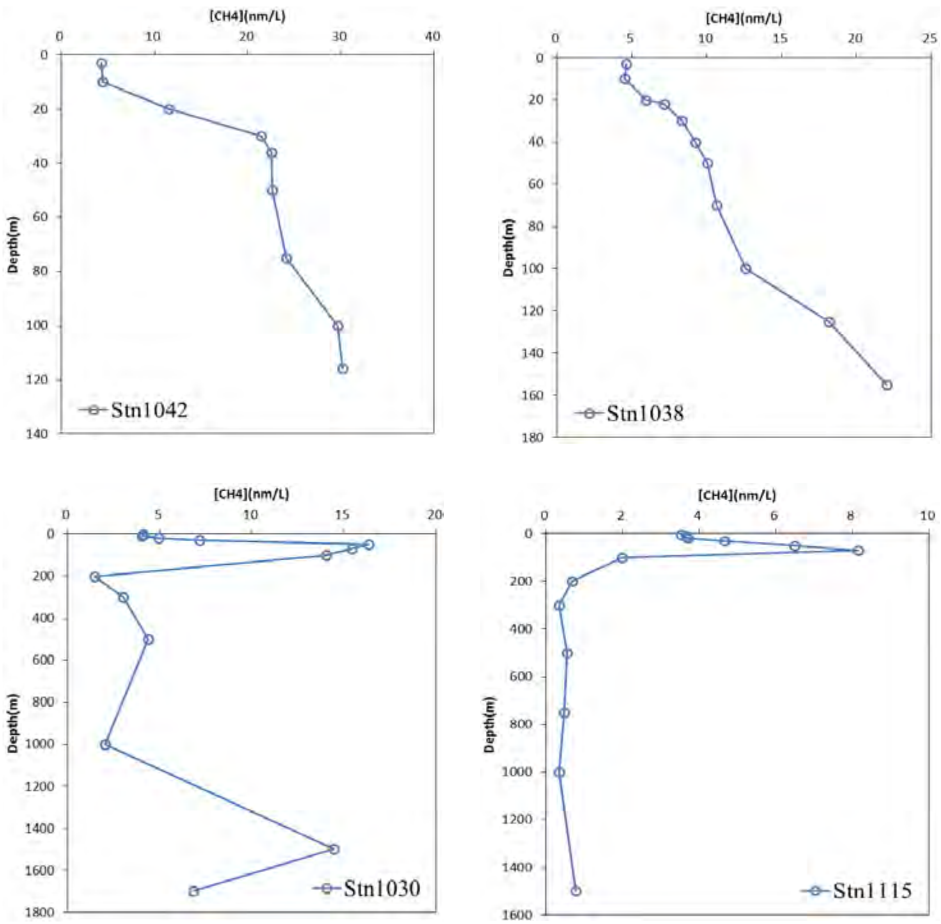

Figure 3.2. CH_4 profiles in shallow water (upper graphs) and deep water (lower graphs).

Potential CH_4 seepages were identified on the seafloor near Station 180, where CH_4 concentration in bottom water reached 72 nm/L (Figure 3.3). It should be noted that these preliminary results have not been confirmed with other approaches (e.g. ROV, echosounder scanning images). The CH_4 profile is notwithstanding quite similar to the one obtained for Station 170, which confirmed CH_4 seepages on the seafloor near Scott Inlet last year.

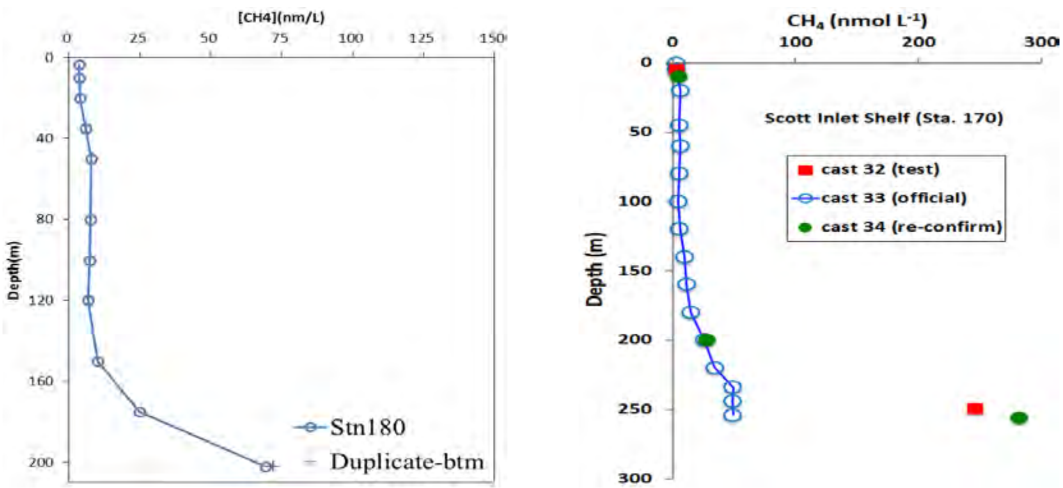

Figure 3.3. Vertical CH_4 profiles showing potential CH_4 seepages on the seafloor near Station 180 (left) and vertical CH_4 profile at Station 170 near Scott Inlet (right) (Xie 2013, personal communication).

3.4 Comments and recommendations

During Leg 2, CH_4 concentration in surface water across the freshwater-seawater transitional zone of the Mackenzie River estuary could not be measured due to weather conditions and lack of time. In the bottom water of the Canadian Basin, methane concentration could not be measured either, due to the Rosette capability. Moreover, the deep CH_4 layer on the slope area could not be confirmed because there was no time or station available.

Due to rough weather, the CH_4 concentrations at Station 170 and nearby could not be rechecked to test the hypothesis of the effect of CH_4 seepages during Leg 3.

4 Characterization of the Ocean-Ice-Atmosphere system – Legs 1, 2 and 3

ArcticNet Phase 3 – Sea Ice, Climate Change and the Marine Ecosystem.
http://www.arcticnet.ulaval.ca/pdf/phase3/sea-ice.pdf

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4.1 Introduction

Arctic climate has shown dramatic changes in recent decades. One of the primary indicators of the climate warming is the reduction in the extent of sea ice coverage. Through the years, a discrepancy between observed changes in the extent of the Arctic sea ice cover and the climate model predictions has been observed. Such a gap between observations and predictions can be attributable to a lack of understanding of the processes that govern sea ice melting. From this perspective, there is a need to better understand how much heat flux increases from the ocean to the atmosphere and how it influences the melting of sea ice in the Arctic region. Understanding changes in sea ice cover and surface air temperature is not only important for their direct impacts on local and global climate, but also for their societal impacts on human health, on the structure and functioning of the ecosystems and the economic activity and on new economic development (e.g. new shipping routes and excavation of oil gas in the Arctic Ocean).

This research project aimed to improve the climate predictions model and understand potential accurate climate changes by determining whether the increase of heat flux was associated with the climate variability of Canada. This project is part of an overall research initiative, dedicated to improving upon the understanding of the Arctic as a system, from the ocean, to ice features, and into the upper atmosphere. Globally, this initiative was divided into two programs:

4.1.1 Upper atmosphere program

The upper atmosphere program was designed to monitor the atmospheric variables that can affect the Arctic atmosphere-ocean interactions. The instrumentation used provided high temporal measurements of temperature, humidity, pressure and wind for the surface up to approximately 20 km. The boundary layer is of particular importance and was monitored using a Microwave Profiling Radiometer (MWRP) at a frequency of approximately 1s.

4.1.2 Ice island sampling program

The ice island sampling program was designed to investigate the microclimates surrounding large ice features, such as large sea ice floes and ice islands. The instrumentation used provided a clearer understanding of the ocean-ice-atmosphere interactions. A single ice island sampling event took place at PII-K on 5 August 2014. There were two stages of this sampling: continuous atmospheric data profile as the ship circumnavigated the ice feature and ocean column profiling.

4.1.3 Additional sampling program – Network of autonomous equipment (Leg 2)

During Leg 2, the University of Manitoba in collaboration with Exxon completed an in depth study on the interactions between the ocean-sea ice-atmosphere with respect to dynamics interactions as to monitor how ice drift and the ice packs responded to external forcing mechanisms. A key objective was to define with the help of a network of autonomous equipment the point at which ice drift changed from summer conditions to winter conditions and to define the ice state that dictated when such a transition occurred.

4.2 Methodology – Upper atmosphere program

It should be noted that during Leg 2a, a smaller subset of the atmospheric program was operational due to not having enough field participants onboard the *Amundsen*.

4.2.1 Microwave profiling radiometer instrumentation

A Radiometrics temperature and water vapour 3000A profiling radiometer (TP/WVP3000A) was used to measure the temperature and water vapour within the atmosphere up to 10 km using passive microwave radiometry at 22 – 29GHz, and 51 – 59GHz. The TP/WVP3000A was installed on a mount attached to the white container laboratory (the ‘Met Shack’) located directly behind the ship’s wheelhouse, approximately 19 m above sea level. 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 obstruction.

The instrument generated a vertical profile 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. The resolution of the instrument was 50 m from the surface to an altitude of 500 m, then increased to 100 m from 500 m to 2 km altitude, and was 250 m for measurements from 2 km to 10 km (note: the height given for 50 m is actually 69 m as the instrument assumes it’s at sea level when it’s mounted 19 m above sea level). 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. A rain-sensor detected the presence of any precipitation. It should be noted that the fog registered as precipitation during much of the field season. 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.

The calibration of the water vapour profiling process was continuously maintained by hourly tip curves. An external liquid-nitrogen-cooled blackbody was used to intermittently calibrate the temperature profiling process. All channels also viewed an internal black body target every 5 minutes for relative calibration. Temperature and humidity values (0 to 200 m at 50 meter intervals, 500 to 2000 m at 100 meter intervals, and 2000 to 10,000 m at 250 meter intervals) were derived from microwave brightness temperatures using the manufacturer's neutral network retrievals that had been trained using historical radiosonde measurements, and a radiative transfer model (Solheim et al. 1998). Historical radiosonde data from Inuvik N.W.T. was used to develop neural network coefficients for the Southern Beaufort Sea Region.

4.2.2 Vaisala Radiosondes

Balloon launches were used to profile low-pressure systems, cyclones, and periods of significant warm or cold-air advection aloft.

Vertical profiles of temperature, pressure, relative humidity, wind speed and wind direction were obtained using Vaisala RS92G GPS wind-finding radiosondes. The sondes were attached to 200 gm helium-filled balloons at a target ascent rate of 2 to 5 m/s to ensure a good vertical resolution through the boundary layer. An 8-channel uncoded GPS receiver in each sonde automatically detected all satellite signals in visible range. Raw wind vectors were transmitted to the ground station every 0.5 seconds during the flight via digital 1200 baud downlink. All wind computation was done within the ground equipment. Temperature was measured with a THERMOCAP® Capacitive bead, which has a +600°C to -900°C range, resolution of 0.10°C and accuracy of 0.20°C up to 50 hPa (most launches terminated before this level). The sensor also had a lag of less than 2.5 seconds in 6 m/s flow at 1000 mb. Pressure was measured with a BAROCAP® Capacitive aneroid. Its measuring range was 1060 mb to 3 mb with a resolution of 0.1 mb and accuracy of 0.5 mb. Humidity was measured with a HUMICAP® thin film capacitor. Its measuring range was from 0 to 100% relative humidity, with a resolution of 1% relative humidity and accuracy of 3%.

The sensor also had lag of 1 second in 6 m/s flow, 1000 mb pressure and +200°C. The temperature, pressure and humidity sensors were collectively sampled at 7 times per 10 seconds. All raw data from the sonde were processed at the ground station through a DigiCORA/MARWIN processor. The DigiCORA was connected to a computer, where data could be viewed in real time throughout the launch and where the data was archived. PILOT and TEMP codes were also produced after the launch terminated. PILOT and TEMP codes, as well as raw and edited measurements were archived for each launch. The edited data was stored in a text file in delimited columns.

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 UHF 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 was used to generate an ensemble of time series data (Table 4.1).

Table 4.1. Variable denotation header found within radiosonde data files.

Record name:	Unit:	Data type:	Divisor:	Offset:
time	sec	float (4)	1	0
Pscl	ln	short (2)	1	0
T	K	short (2)	10	0
RH	%	short (2)	1	0
v	m/s	short (2)	-100	0
u	m/s	short (2)	-100	0
Height	m	short (2)	1	30000
P	hPa	short (2)	10	0
TD	K	short (2)	10	0
MR	g/kg	short (2)	100	0
DD	dgr	short (2)	1	0
FF	m/s	short (2)	10	0
AZ	dgr	short (2)	1	0
Range	m	short (2)	0.01	0
Lon	dgr	short (2)	100	0
Lat	dgr	short (2)	100	0
SpuKey	bitfield	unsigned short (2)	1	0
UsrKey	bitfield	unsigned short (2)	1	0
RadarH	m	short (2)	1	30000

During the 2014 campaign, two radiosondes were launched daily off the CCGS *Amundsen* at 00Z and 12Z between September 27th and October 9th (Figure 4.1). However, due to strong winds and a tailwind, balloons could not be launched on September 30th (12:00 UTC), October 1st (00:00 UTC) and October 2nd (00:00 UTC). As part of the Environment Canada agreement, two radiosonde launch data sets were sent to their FTP site for input into their local forecast models. These radiosondes were launched at 0000 UTC and 1200 UTC.

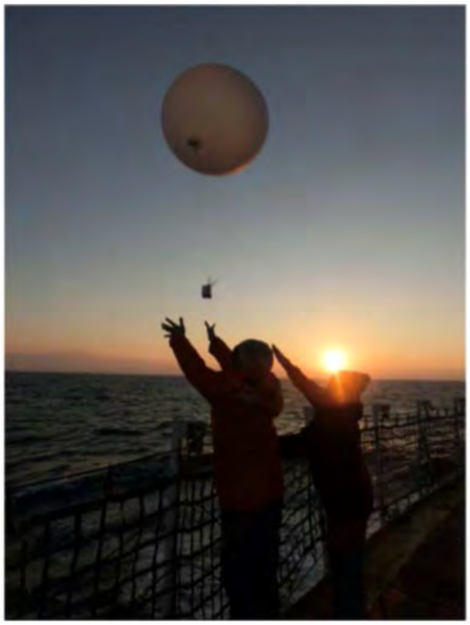

Figure 4.1. Balloon launch during Leg 3.

4.2.3 Vaisala Ozonesondes

In conjunction with the launch of radiosondes, ozonesondes were attached to 8 balloons (Table 4.2) to better understand the atmospheric profile of ozone.

Table 4.2. Schedule of the ozonesondes launch dates and times.

Date	Time (UTC)	Latitude (N)	Longitude (W)
15/07/2014	00:00	68°33.000	064°03.000
16/07/2014	00:00	70°02.400	066°03.000
17/07/2014	00:00	71°31.120	071°34.800
20/07/2014	17:42	74°08.400	091°07.800
21/07/2014	00:00	74°10.200	091°15.000
21/07/2014	12:00	74°08.400	092°07.800
21/07/2014	16:20	74°08.400	092°07.800
24/07/2014	00:00	74°21.600	094°32.400

4.2.4 Vaisala CT25K Ceilometer

The Vaisala CT25K laser ceilometer measured cloud heights and vertical visibilities using pulsed diode laser LIDAR (Light Detection And Ranging) technology, where short powerful laser pulses were sent out in a vertical or near-vertical direction. The laser operates at a centre wavelength of 905 ± 5 nm, a pulse width of 100 ns, beamwidth of ±0.53 mrad edge, ±0.75 mrad diagonal and a peak power of 16 W. The manufacturer suggested measurement range is 0 – 25,000ft (0 – 7.5 km), however, it has been found that high, very visible cirrostratus clouds (~18-20 kft) were consistently undetected by the unit (Hanesiak

1998). The vertical resolution of the measurements was 50 ft, but decreased to 100 ft after ASCII data file conversion. The reflection of light backscatter caused by haze, fog, mist, virga, precipitation, and clouds was measured as the laser pulses traverse the sky. The resulting backscatter profile (i.e., signal strength versus height) was stored, processed and the cloud bases were detected. Knowing the speed of light, the time delay between the launch of the laser pulse and the backscatter signal indicated the cloud base height. The CT25K is designed to detect three cloud layers simultaneously, given suitable conditions. Besides cloud layers, it detected whether there was precipitation or other obstruction to vision. No adjustments in the field were needed. Output files were created hourly by the system and are in ASCII format.

4.2.5 All-Sky Camera

The all-sky camera system took images of the sky and cloud cover. The system consisted of a Nikon D-90 camera outfitted with fish-eye lenses with a viewing angle of 160 degrees, mounted in a heated weatherproof enclosure. The camera was programmed to take pictures using an external intervalometer set at 10-minute intervals, or 144 images per day. The system was mounted in a small 'crow's nest' immediately above the ship's wheelhouse.

4.2.6 Manual Meteorological Observations

Manual meteorological observations were conducted hourly throughout Legs 1, 2 and 3 (Table 4.3). Observations included current conditions with relation to precipitation type and intensity, visibility, cloud cover (octets), and sea ice coverage (tenths). Basic meteorological values were read and recorded from the onboard weather station, which is owned and operated by the Meteorological Service of Canada. Visibility, cloud octets, sea ice concentration, and precipitation type and intensity observations were subjective based on the observer. If the cloud coverage was not 100% it was not recorded at 8/8, similarly if the coverage has even 1% of clouds the cloud fraction was not recorded as 0/8.

The CCGS *Amundsen* was equipped with an AXYS Automated Voluntary Observation Ship (AVOS), with all sensors located on the roof of the wheelhouse. The AVOS is an interactive environmental reporting system that allows for the hourly transmission of current meteorological conditions to a central land station via Iridium satellite telemetry. Temperatures (air and sea surface), pressure, relative humidity (RH), wind speed, wind direction, and current GPS location were updated every ten minutes and displayed on a computer monitor located in the wheelhouse of the ship. The AVOS deploys a Rotronics MP 101A sensor for temperature and RH, with a resolution of 0.1°C and an accuracy of ± 0.3°C, and a 1% ± 1% accuracy for temperature and RH, respectively. Atmospheric pressure was obtained from a Vaisala PTB210 sensor with a 0.01mb resolution and an accuracy of ±0.15 mb. Wind speed and direction were collected from an RM Young 05103 anemometer, accurate to ±3° in direction and ±0.3 m/s.

As part of the 2013 agreement with Environment Canada, observations were inputted into the AVOS system. This was done a minimum of 4 times per day, preferably at 0000 UTC, 0600 UTC, 1200 UTC and 1800 UTC.

Table 4.3. Manual meteorological parameters recorded by the observer.

Parameter	Units
Date	UTC
Time	UTC
Latitude	decimal degrees
Longitude	decimal degrees
Temperature	ºC
Relative Humidity	%
Wind Speed	kts
Wind Direction	º
Precipitation Type	snow, rain etc.
Precipitation Intensity	Heavy, moderate, light etc.
Visibility	km
Cloud Fraction	Octets
Wave Height	m
Beaufort Sea State	0-10
Sea Ice Concentration	Tenths
Sea Ice Type	MYI, FYI, rotten, icebergs

4.3 Methodology – Ice island sampling program

4.3.1 Microwave Profiling Radiometer Instrumentation

As discussed previously, the microwave profiling radiometer generated a profile of temperature and water vapour and was especially helpful in profiling the immediate surroundings of ice features. The data collected using this instrument provided a better understanding of the interactions between atmosphere and ocean and how large ice features generate microclimates. Mounted near the top of the ship, the radiometer continuously recorded data as the ship circumnavigated around the ice island, generating a full profile of the atmosphere.

4.3.2 GoPro Videos

Three cameras were mounted above the wheelhouse on monkeys island to document the ship's track around the ice island. One camera was mounted on the port side, one on starboard and a forward-looking camera. The cameras were set to record a video of the entire track to allow for a visual of the ship's proximity to the ice island.

4.3.3 Ocean Column Profiling

To accompany the atmospheric data profiles, ocean column profiling was conducted using the Zodiac. CTD profiles were generated at the surrounding of the ice island in the upper layer of the ocean (0-50 m) (Table 4.4). The objective was to characterize the effect of melting ice on the upper ocean layer. The Ocean Seven 304 CTD probe (Idronaut) measured pressure, temperature, conductivity, salinity, and turbidity. The instrument was set to take measurements at a rate of 8 Hz. The system was deployed by hand at a rate of about 1 m/s. The CTD remained at the maximum cast depth (50 m) for a few seconds before it was retrieved.

CTD measurements were conducted on four radial lines during Leg 1, consisting of 2 sample stations. Each line started at the ice island and terminated at the second station approximately 200 m away from the ice island face.

Table 4.4. Station identification and main characteristics for water column profiles conducted at the ice island.

Station #	Latitude (N)	Longitude (W)	Time (UTC)	Tair (°C)	SST (°C)
1	79°03.842	071°38.912	17:20	4.38	1.44
2	79°03.815	071°39.210	17:32	4.84	1.77
3	79°04.035	071°37.480	17:40	3.80	1.28
4	79°04.009	071°37.251	17:50	4.47	1.67
5	79°04.436	071°37.035	18:03	4.95	1.20
6	79°04.479	071°36.901	18:11	4.77	1.20
7	79°04.418	071°38.287	18:20	3.77	1.09
8	79°04.470	071°38.496	18:26	4.34	1.49

4.4 Methodology – Network of autonomous equipment

A network of autonomous equipment was deployed on multiyear sea ice floes in the Beaufort Sea during Leg 2 and left to drift with the icepack. The network utilized the Iridium satellite communications network and transmitted *in situ* data back to the University of Manitoba. As shown in Figure 4.2, the equipment included:

- 13 ice beacons, deployed on multiyear ice floes and used to track ice drift;
- 9 weather stations, deployed on multiyear ice floes and collecting *in situ* observations of surface winds, air temperature, humidity and air pressure;
- 2 Acoustic Doppler Current Profilers (ADCPs), deployed through multiyear ice floes and measuring upper ocean currents.

Since the duration of the equipment was subject to the stability of the ice floe, equipment had to be preferentially deployed on large, thick, multiyear ice floes that were more likely to last through the end of the melt season and freeze into the ice pack during winter

The *in situ* observations were supplemented with remotely sensed data from Radarsat that were used to calculate local ice concentrations and floe size distributions. A similar study was carried out in 2012 during the spring season as part of the Beaufort Regional Environmental Assessment (BREA). The analysis focused on the seasonal change in the scaling factor and turning angle between surface winds and ice drift, the scaling factor between ocean currents and ice drift, and ice drift at inertial frequencies.

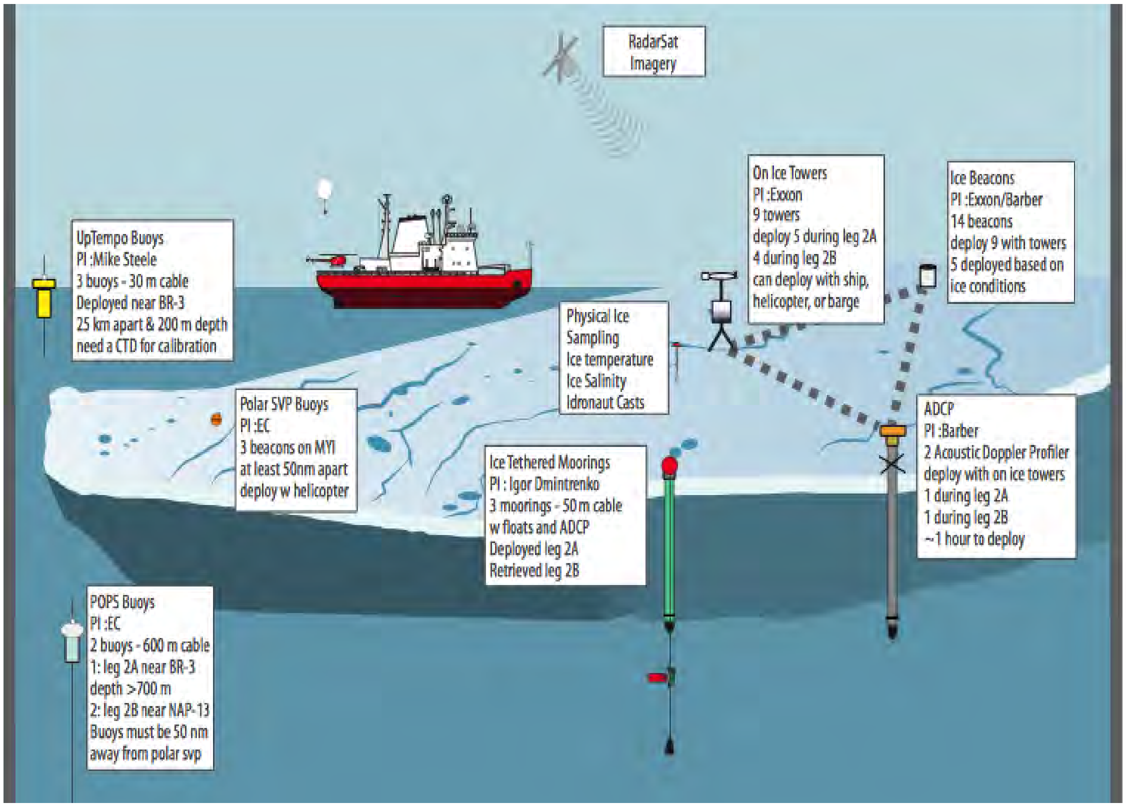

Figure 4.2. Ocean-Sea Ice-Atmosphere sampling methods.

4.4.1 On Ice Meteorological Towers

The initial goal was to deploy 9 on ice towers during Leg 2. Due to time constraints and bad weather resulting in being unable to fly the helicopter, only 5 of these towers were deployed (Table 4.5). The deployment of each tower required finding the correct type of ice (Figure 4.3). Typically the ice floes in the area were rotting first year ice, making the finding of a suitable thick piece of ice difficult. The goal was to find a piece of ice that would survive through the melt and into the fall freeze up, and possibly through to the next summer.

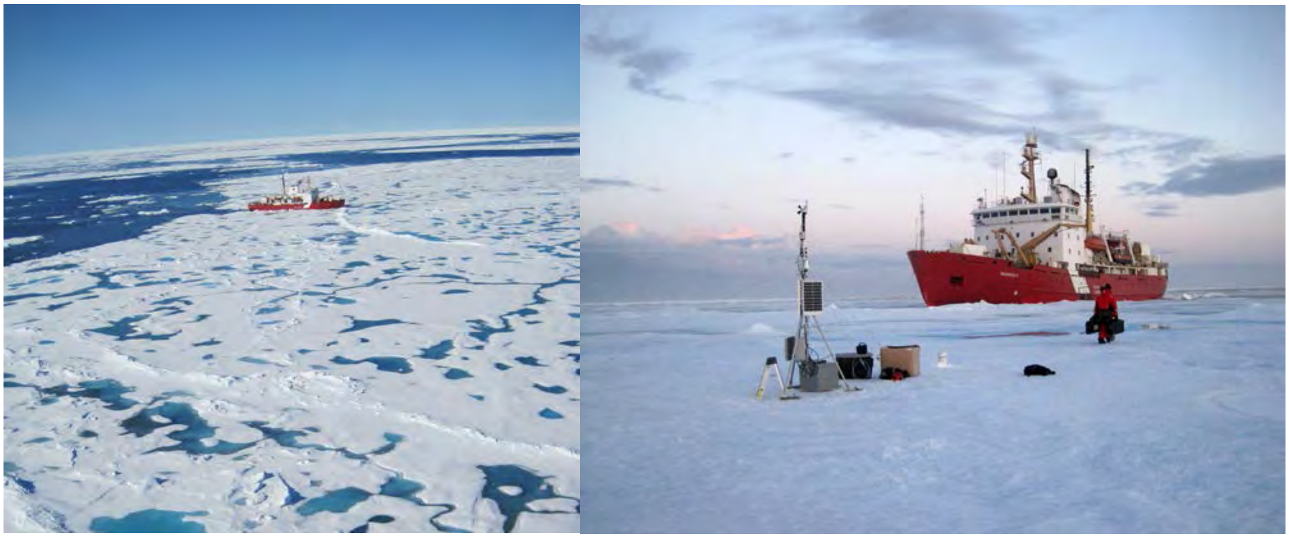

Figure 4.3. The ship positioned in the ice floe where the first on ice tower was deployed. The helicopter was used to access the correct location on the ice floe and determine how suitable the ice conditions were (left). The deployment of the third on ice tower via the ship (right).

Each tower was equipped with a marine grade wind anemometer and compass, a temperature and relative humidity sensor and pressure sensor (Figure 4.3). The tower had 2 deep cycle batteries connected to 3 solar panels to ensure that the batteries were fully charged as Arctic winter approached. Deployment from the ship took approximately 2 hours. Due to time constraints, no physical sampling was done.

Table 4.5. Details of the on ice met tower deployments.

Ice station	Deployment date	Lost date	Latitude (N)	Longitude (W)	Ice thickness (m)
1	Sept 22 18:00 UTC		72°24.936	138°00.620	4.5
2	Aug 28 20:00 UTC		73°24.398	129°18.937	2.3
3	Aug 29 04:24 UTC	01-Sep	73°29.720	126°48.698	3.5
4	Aug 30 00:36 UTC		73°16.769	128°33.324	4.3
5	Sept 22 22:45 UTC		72°18.113	139°37.199	2.6

4.4.2 Ice beacons

A total of 5 ice tracking beacons were deployed. The beacon can be deployed while at an ice station but also from the helicopter while doing surveys. While on the ice floe, an 8" hole was augured into the ice for the installation of the beacon. At hourly intervals, the instrument recorded its location and transmitted this information to an email server. The beacons transmitted data via an iridium satellite in the form of an email attachment. Each beacon weighed 9.5 kg and was 72 cm tall with a 15 cm diameter.

As part of the 2014 agreement with Environment Canada, CEOS deployed one Polar SVP beacon.

4.4.3 UpTempo-IM Buoys

Three buoys were deployed from the *Amundsen*, each 397 lbs and 83" x 31" x 36" (Figure 4.4). For more information, refer to the user's manual, which includes deployment instructions.

The assembly of each buoy was not all that "quick." It involved attaching the individual ocean sensors along the pre-marked cable, and then attaching the cable to the floating hull in the proper way.

Each buoy had a 1-meter mast and a 30-meter string of ocean sensors. They were deployed in the SE Beaufort Sea in open water conditions, somewhere off the continental shelf.

Figure 4.4. The UpTempO Buoy in wooden shipping crate.

4.4.4 POPs Buoys

A POPs buoy was deployed from the *Amundsen* for Environment Canada. Unfortunately, due to time constraints, it was not possible to deploy the second buoy.

The surface unit was the same as the UpTempo Buoys however the cable was 600 meters long and had a NOVA profiling unit on it. The deployment of the buoy took about 2 hours. The buoy had to be deployed weight first, unreel most of the cable into the water, attach the profiler and lower the profiler into the water, then lower the surface unit in. The unit then had to be turned on using the Zodiac, as the buoy must first be in the water before the unit can be activated.

4.5 Preliminary Results

4.5.1 Upper atmosphere program and Ice island sampling program

No preliminarily results were available at the end of Leg 1.

Following the data acquisition from the AVOS during Leg 3, observation area and sea surface temperature could be mapped (Figure 4.5 and 4.6).

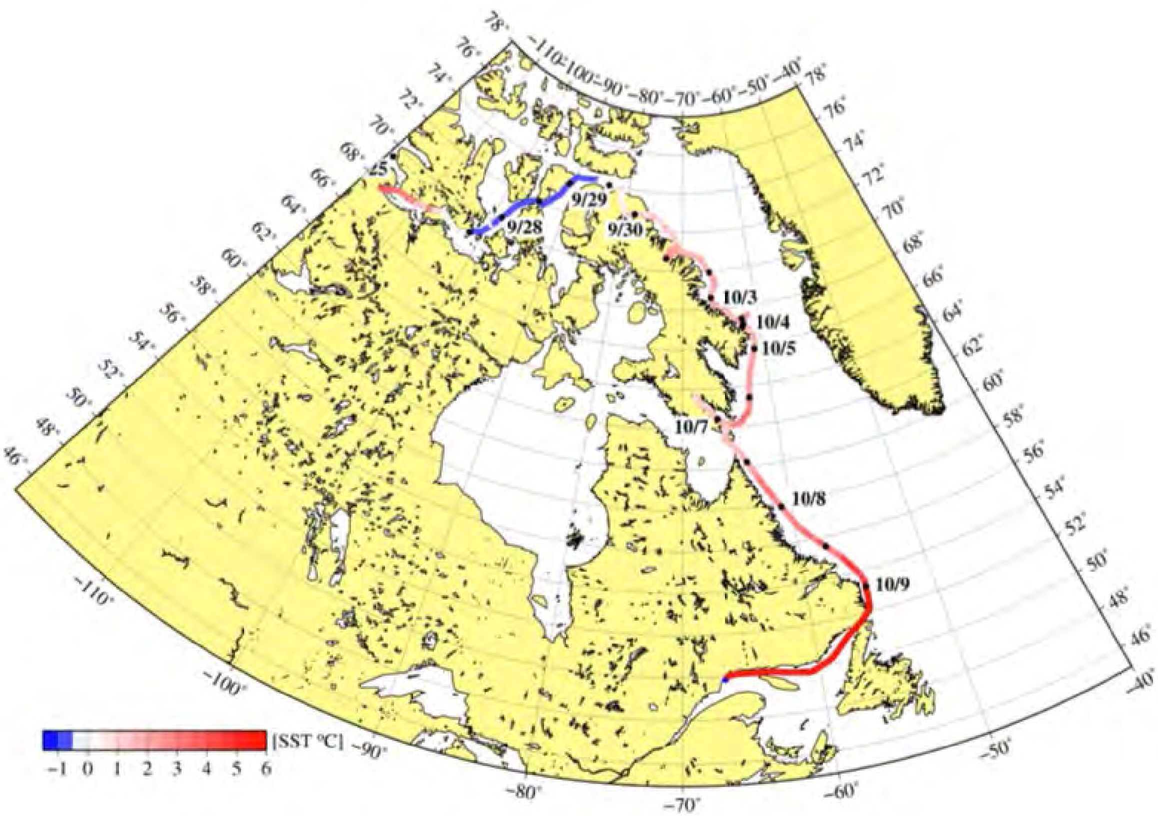

Figure 4.5. Location map of the observation area. Colors represent sea surface temperatures recorded from an Automated Voluntary Observation Ship (AVOS).

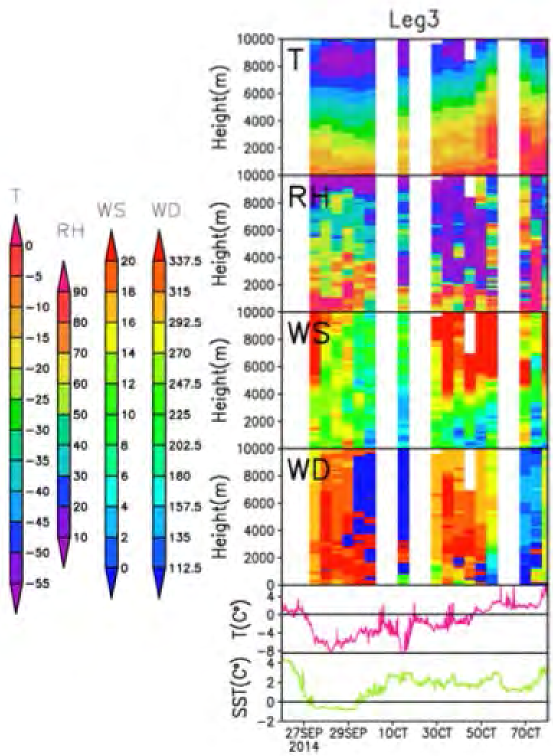

Figure 4.6. Time sequences of vertical profiles of observed air temperature, humidity, wind speed and wind direction, surface air temperature and sea surface temperature.

Table 4.6. Part of Leg 3 hourly manual meteorological observations.

Month	Day	UTC	Lat (dd.m	Long (dd.m	T (deg	RH	P (adj)	Wspd (kt)	Wdir (deg	Se a	Ice Type	Cloud (8ths)	Precip	Fog	Visibility (km)	Waves (m)	Beaufort Scale	Notes
…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…
10	3	11:00	67.24	62.10	−0.4	60	1009.9	20	330	0		8	0		20	2	3	
10	3	12:20	67.28	61.45	−2.5	83	1009.9	18	285	0		8	a_little_snow		10	2	3	
10	3	13:00	67.27	61.44	−1.6	86	1009.9	21	315	0		8	strong snow		3	1.5	3	
10	3	14:00	67.28	61.45	−0.4	78	1010.0	19	300	0		8	0		15	1	2	
10	3	15:20	67.30	61.44	−2.2	77	1010.2	19	330	0		8	a_little_snow		10	1.5	3	
10	3	16:00	67.33	61.34	−1.9	78	1010.0	21	300	0		8	snow		10	1.5	4	
10	3	17:00	67.32	61.22	0.6	72	1010.1	18	315	0		4	sun		20	1.5	3	
10	3	18:00	67.25	61.21	−1.4	72	1010.5	17	315	0		4	sun		25	1.5	3	
10	3	19:00	67.17	61.44	−1.2	63	1010.4	11	300	0		3	sun		25	1.5	3	
10	3	20:10	67.10	62.13	−2.0	63	1011.8	6	240	0		5	sun		25	0.5	1	
10	3	21:00	67.11	62.06	−1.8	67	1012.2	16	240	0		4	0		25	0.5	1	
10	3	22:00	67.08	62.14	−1.9	62	1012.6	9	270	0		2	0		25	1	1	
10	3	23:00	67.08	62.05	−1.5	61	1013	17	240	0		2	0		25	0.5	1	
…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…
…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…
…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…

4.5.2 *Network of autonomous equipment (Leg 2)*

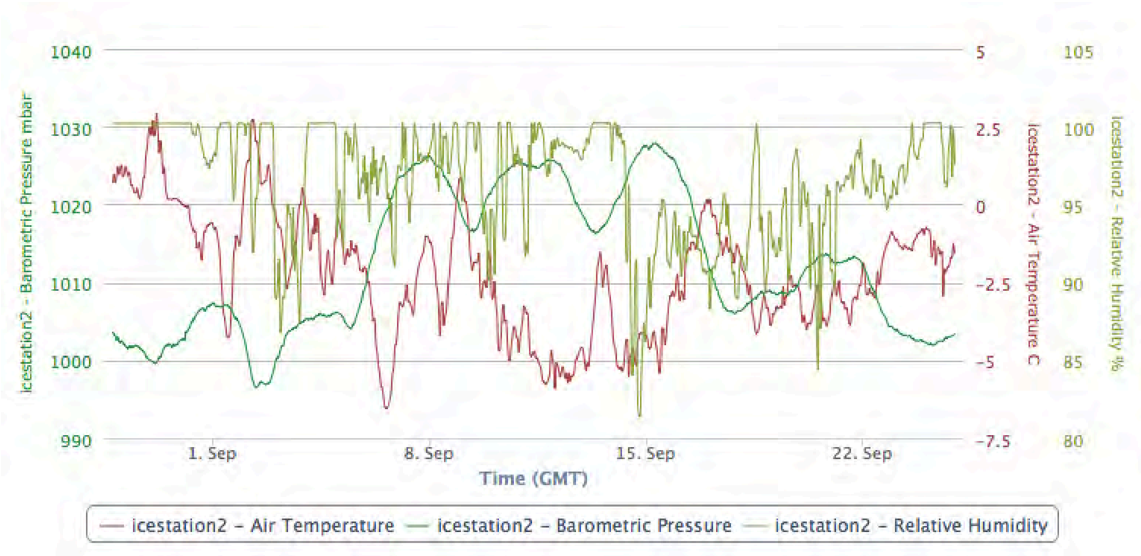

Figure 4.7. Air temperature, pressure and relative humidity data coming in from the first on ice met tower deployed on August 28, 2014.

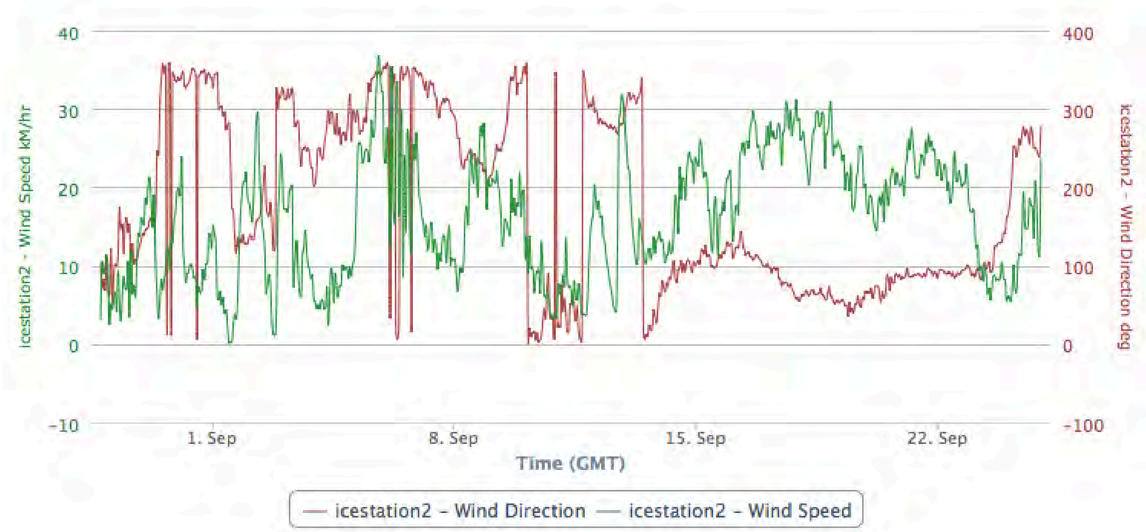

Figure 4.8. Wind direction (red) and wind speed (green) from the first tower deployed on August 28, 2014.

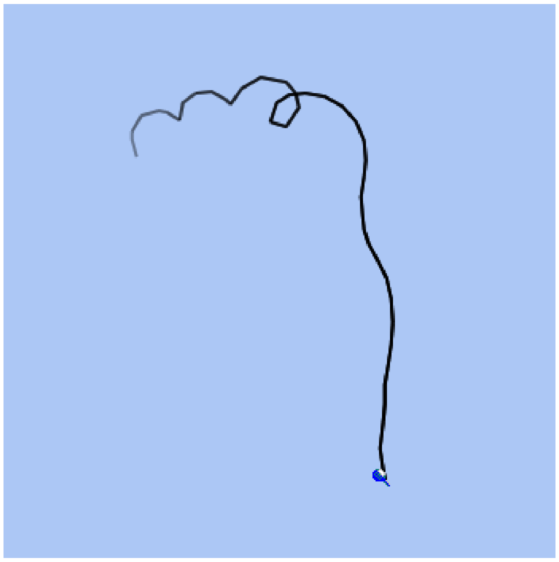

Figure 4.9. Trajectory of the second on ice met tower showing the inertial oscillations before the wind event broke up the ice on September 1st and the equipment was lost.

4.6 Comments and recommendations

4.6.1 Upper Atmosphere Program

The upper atmosphere program ran smoothly during Leg 1. The only recommendations that are made would be to have a sun photometer to measure the optical depth of the atmosphere and to have several high resolution forward, port, starboard and aft looking cameras to give relative directions to ice features of interest and to give the sea state.

4.6.2 Ice Island Sampling Program

To increase the spatial resolution of the water column profiling, adding in additional stations along each radial line would be beneficial. By doing so, a higher resolution dataset could be generated to examine the interactions between ice features and the upper column of the ocean.

During Leg 3, both the Canadian Archipelago and Baffin Bay were not covered by sea ice resulting in a fast cruise speed. These conditions made it difficult for the team to conduct the research that matched the purpose of the study.

4.6.3 Network of autonomous equipment

During Leg 2a there were many logistical issues with the on ice work. The thick fog and bad weather prevented the helicopter from flying and the ice conditions were only ideal in the northern part of Banks Island. One on ice tower was destroyed in less than a week due to a strong wind event even though it was deployed on ice that was greater than 3 meters thick. The tower recorded winds of >50 kts. Two of the towers survived this event and it was likely due to the location of the towers being deployed further into the ice pack. In future legs, it would be highly recommended that, if deploying long term monitoring instruments, they be deployed into the ice pack and away from the open water.

References

Hanesiak, J.M., Barber, D.G. and Flato, G.F. 1998. The role of diurnal processus in the seasonal evolution of sea ice and its snow cover. Geoscience and Remote Sensing Symposium Proceedings, p. 2496-2498.

Solheim, F., Godwin, J.R., Westwater, E.R., Han Y., Keihm, S.J., Marsh, K. and Ware, R. 1998. Radiometric profiling of temperature, water vapor and cloud liquid water using various inversion methods. Radio Science, 33 (2): 393-404.

5 Ice island field operations – Leg 1b

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5.1 Introduction

Ice islands have been frequently observed in the Canadian Arctic recently due to calving events of northwest Greenland's floating glacial tongues and the northern Ellesmere Island's ice shelves (Copland et al. 2007, Mueller et al. 2013, Peterson 2011). These ice features are potential hazards to offshore activities such as shipping and natural resource exploration and extraction, both of which are anticipated to take place in regions through which ice islands drift (Stephenson et al. 2013, McGonigal et al. 2011, Prowse et al. 2009). There has been a limited amount of *in-situ* ice island dimensional, deterioration or drift data collected for analysis, drift and deterioration modeling or remote-identification technique development. The ice island field program on board the CCGS *Amundsen* for the 2014 ArcticNet science cruise set out to gather *in-situ* data from an ice island in the northern Baffin Bay or Kane Strait regions. The Petermann Glacier's floating glacial tongue, located along Greenland's northwest coast, was expected to be the source of this ice island. This work is building on recent ice island fieldwork expeditions, which took place from the CCGS *Amundsen* in 2011 and 2013 (Forrest et al. 2012, Hamilton et al. 2012). Other recent campaigns which collected *in-situ* data from an ice island included the Beaufort Regional Environmental Assessment (BREA) project "Detection, Motion and RADARSAT Mapping of Extreme Ice Features in the Southern Beaufort Sea" and a collaboration with the British Broadcasting Corporation (Wagner et al. 2014).

This year's fieldwork campaign from the CCGS *Amundsen* aimed to improve the ice island dimensional database as well as instrument the ice island for data collection regarding drift and deterioration. This data will be used to assess what controls ice island drift and deterioration and to identify the most important processes for inclusion in ice island specific drift and deterioration models. Data from the 2014 field campaign will be used specifically to assess the internal structure of the ice island, document and analyse where the ice island drifts and why, and lastly, determine the mass balance of the ice island upon re-visit.

Opportunistic sampling and mapping were also conducted from the CCGS *Amundsen* while the on-ice team was working. The on-ship operations included Rosette casts, moving vessel profiler (MVP) measurements and mapping of the ice island's underwater sidewalls and adjacent bathymetry with the EM302. These operations have been conducted since 2011. They have allowed for the exploration into the oceanographic effects of an ice island's presence and melt, as well as increase the underwater (keel) dimensional dataset.

5.2 Methodology

The locations of ice island targets were monitored by tracking beacons belonging to the University of Manitoba, which were deployed during Leg 1b of the 2013 ArcticNet cruise. Location updates were also provided by the Canadian Ice Service (Environment Canada, Ottawa). Two ice islands were visited before the on-ice fieldwork, which was conducted on 5 August. PII-A-1-f (35 km^2) was reached on 26 July 2014. It was then located at 73º57.000 N, 75º40.000 W. Fog and low water/sky reference caused on-ice operations to be cancelled. However, the ship circumnavigated the ice island and mapped the underwater sidewalls with the ship's EM302 sonar while a freeboard photo-set was collected from the helicopter deck with a digital single lens reflex (DSLR) camera. The circumnavigation took 2h40 min, resulting in ~1300 photos, taken at 5 second intervals. This dataset is anticipated to be turned into a 3D model of the ice island's perimeter.

PII-A-1-c (2 km^2), the second ice island fieldwork target, was flown over by helicopter on 2 August. This ice island was within Greenland territorial waters as it was only 9 nautical miles from its shore (77º54.000 N, 73º31.000 W). Operations were cancelled as no scientific permits had been obtained for this visit. An aerial photoset was collected, which is also expected to be used for photogrammetrical modeling and analysis. Photos were taken at 2-second intervals out the window (open) from the front passenger seat. The angle from nadir of this position is ~27º. Helicopter speed was 80 knots, with photosets taken at 1000 ft.

The ice island on which fieldwork was conducted on was reached on 5 August when located at 79º04.000 N, 71º41.000 W. The on-ice team worked for 9 hours on the selected ice island (Petermann Ice Island – Kane (PII-K)) after an initial polar bear check with the helicopter. The team consisted of Anna Crawford (team leader), and Jean-Sébastien Côté and Jonathan Gagnon (Université Laval) as volunteers and bear monitor.

The team established two sites on the ice island, located at opposing ends of the longest dimension of the ice island (Figure 5.1). A differential global positioning system (dGPS; Trimble 7) was installed at Site 1 to monitor the drift of the ice island over the rest of the day so that all science work, both on-ice and on-ship, could account for the constant change in the ice island's position. A Polar ISVP tracking beacon, provided by Weather Environmental Monitoring (WEM; Environment Canada) was also deployed at this site. The beacon transmitted hourly positions to the Joubeh Technologies' asset managing website. An ablation stake was installed with a 2" auger to a depth of 3.5 m. A Hobo temperature sensor/logger (OnSet Computer Corp.) and corresponding radiation shield were installed at the site. This stake's height above the ice surface (and that of other stakes installed) will be re-measured upon revisit to the ice island to determine the surface ablation magnitude. The temperature record could be assessed along with this ablation with the collection of the temperature sensors. The helicopter stayed with the team at this location, as only 45 minutes were needed for the work.

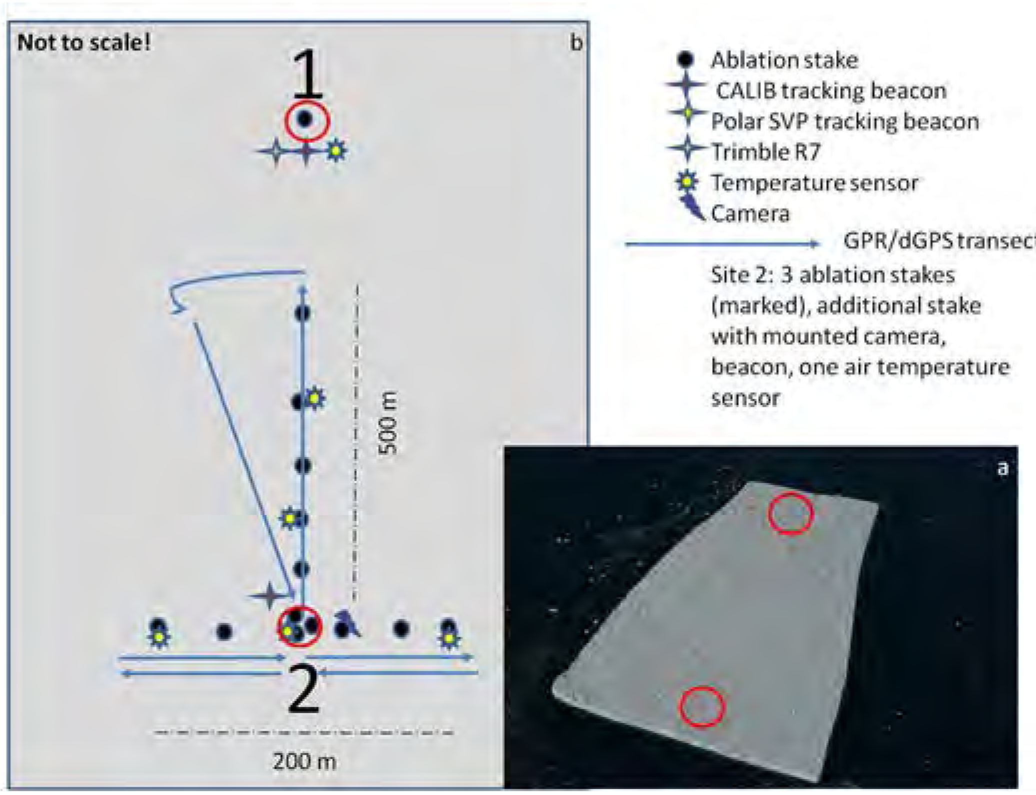

Figure 5.1. Field work sites on PII-B. (a) Aerial view of PII-K with sites 1 and 2 being located at the approximate location of the red circles and (b) the fieldwork conducted via illustrative summary (b).

The team was flown to Site 2, after which the helicopter returned to the ship. The volunteers drilled 3 x 3.5 m deep holes (2” diameter) while Crawford set-up the ground penetrating radar (GPR; Figure 5.2) with 25 MHz antennas for ice thickness measurement. The GPR consists of a receiver and transmitter, contained in individual Pelican cases, which are set on cross-country skis 9 m apart from each other. A dGPS (TopCon HiperV) was set-up on the transmitter’s skis for elevation measurement. The team towed (one ahead pulling a tow rope, one behind holding a second rope to keep the two cases at constant distance apart) the GPR/dGPS along a 500 m transect down the center (length dimension) of the ice island, towards Site 1. A point GPR measurement was taken every 100 m (measured as two lengths of a 50 m measuring line) and the center point between the receiver and transmitter was spray painted for following ablation stake placement. The center point between the receiver and transmitter had been previously marked on the rope connecting the two cases. The team turned at 500 m and returned to Site 1, continuing to tow the GPR/dGPS. It was attempted to follow a parallel line to the initial transect. When the team returned to Site 1, a point measurement was taken where the aforementioned ablation stakes holes were drilled. A central midpoint survey was also conducted here, which consists of taking repeated spot GPR recordings while varying the distance between the receiver and transmitter. A second transect was walked with the GPR/dGPS, also from Site 1 but perpendicular to the first transect, resulting in a ‘T’ of thickness and elevation records. Spot thickness measurement and ablation stake marking were taken every 50 m along this 200 m line, finishing the GPR/dGPS work.

Figure 5.2. The GPR system being towed during the 500 m transect.

The team returned to Site 2 and installed three ablation stakes in the three pre-drilled holes. These three stakes had been previously marked with black Gorilla tape in 1 cm increments (1 cm black tape, 1 cm white pole, 1 cm black tape...). A fourth ablation stake with a mounted camera was installed at this main site to monitor the surface ablation by taking photographs of the striped stakes at 1-hour intervals. An iButton temperature sensor/logger (Maxim Integrated) was installed on one ablation stake at this site. The TopCon dGPS was left in one of the stakes for additional ice island drift and rotation monitoring (along with Site 1’s Trimble dGPS) while the team finished the field day.

Ablation stakes were then installed at each of the pre-marked spots along the GPR/dGPS transects. There were five installed on the length transect (100 m separation, 500 m line), and four along the width transect (50 m separation, 200 m line). The width transect is bisected by the main site and extends 100 m on either side of this main site (Figure 5.1).

The height above the ice surface of all ablation stakes, temperature sensors/radiation shields and dGPS units was measured. The measurement was done from the bottom of a cross-country ski to the point of interest. This was done twice, the second time with the ski situated perpendicular to the first position (making a cross). Waypoints for all ablation stakes were taken on a handheld Garmin GPS.

A CALIB (MetOcean) GPS beacon was deployed at Site 2. An approximately 0.75 m hole was drilled by an 8” auger with a powerhead for the cylindrical beacon to sit within. The beacon also updated hourly to the Joubeh Technologies’ asset management website.

Melt water and sediment samples were taken for multiple researchers on board the ship. These included sediment and melt water from two cryoconite holes for Connie Lovejoy (microbiology analysis) and melt water for Vicki Irish (contaminants analysis). While the on-ice team was at work, the *CCGS Amundsen* circumnavigated the ice island for underwater sidewall mapping with the ship’s EM302 sonar. A 500 photoset was taken of the freeboard (above water sidewalls) during this period as well. These last two items will complement an aerial photo- taken from the ship’s helicopter during multiple passes of the ice island at 1000 ft altitude at a speed of 60 knots. A handheld Garmin was used to record the flight path, with the flight track recorded by the helicopter’s GPS also being available. The photos were taken by a dSLR camera at 1-second intervals from the backseat of the helicopter with the door open. The camera angle was approximately 35° from nadir and the helicopter’s skid/float was used as a reference for frame position consistency. RAW and fine JPEG files were recorded.

Crawford was the only passenger on the aerial photo flight, as the equipment and volunteers had been dropped off after finishing work at Site 2. The decreased weight allowed the helicopter to operate at a slower speed, which was optimal for photo-collection and subsequent photogrammetric modeling and analysis. Upon finishing the helicopter photo-work, both sites 1 and 2 were re-visited and Crawford retrieved the two dGPS units, which had been operating until that point.

Total work time for the on-ice team was 9.5 hours, with the ship time being slightly less as the on-ice team set-off while the ship was in transit to the ice island and returned after the ship had already begun steaming to the next ocean sampling station.

5.3 Preliminary results

Both GPS tracking beacons were updating to Joubeh Technologies’ website, with the ice island showing initial drift north before switching to a southern track (Figure 5.3). The ice island was still located within the Kane Basin as of 10 August. At that time the ice island was 3 km SW from its location at the time of fieldwork. However, the beacons have recorded a looping drift track and the ice island has drifted an approximate cumulative distance of 23 km.

The output from the GPR transects showed that the ice island ranged from being 140 to 170 m thick (Figure 5.4). This was corroborated by the EM302 data, which mapped the underwater sidewalls to an approximate depth of 130 m.

Figure 5.3. Location of PII-K in the Kane Basin at time of fieldwork (a) and drift of PII-K between 5-10 August 2014 (b). Images are courtesy of WEM (Environment Canada), Joubeh Technologies' asset management system and MetOcean (Dartmouth, NS).

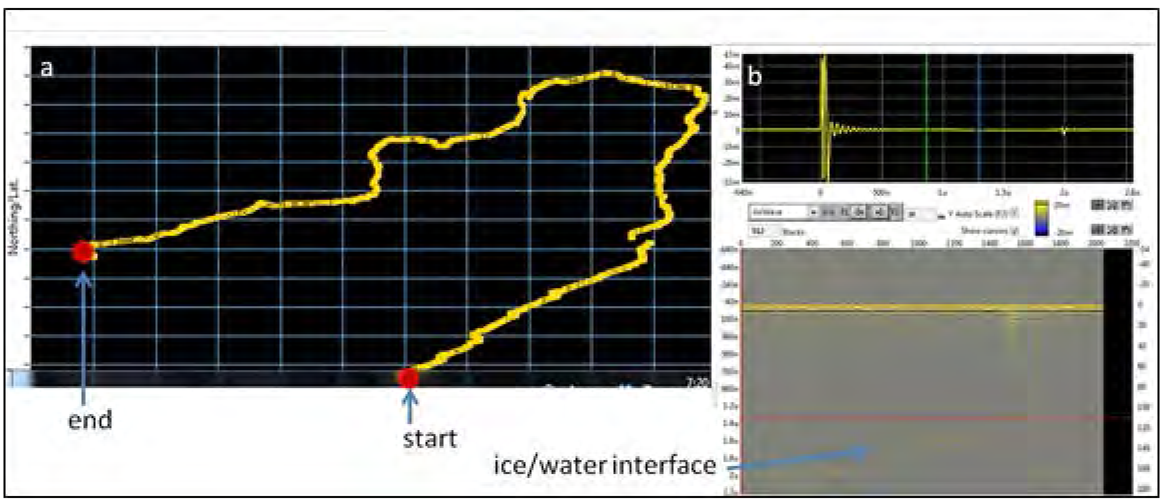

Figure 5.4. GPR data: (a) shows the start and stop points of the length transect. The ice island drift is apparent in this figure, since the start and stop points were at the same location on the ice island (Site 2), and (b) depicts the GPR's radargram output with the faint line (blue arrow) representing the ice/water interface. The vertical axis on the plot represents thickness.

A revisit to the ice island is necessary to ascertain surface ablation, subsurface ablation, mass balance and air temperature measurements. The team is attempting to obtain a RADARSAT-2 Fine-Quad (8 m resolution) acquisition over the ice island to determine its present length, width and surface area dimensions. Following RADARSAT-2 acquisitions will allow for deterioration monitoring.

5.4 Comments and recommendations

Ice island fieldwork has consistently been difficult to coordinate due to weather, the ship's tight science schedule and extenuating circumstances. This year was no different; however the efforts of both the ship and science crews were persistent and resulted in a full and successful day of on-ice fieldwork. Future ice island operations should remember to take advantage of good weather, as this year we were likely only successful since it was decided to work on a target, which had previously not been identified as 'high-priority'. It is advised to be prepared and pack well in advance of the planned fieldwork in case an opportunity arises with good weather beforehand.

The thickness measurements were taken with a GPR set-up that was towed on two sets of cross-country skis. It is recommended that future GPR transects be done on a modified set-up, with either ski tips of greater curvature or sleds. This will hopefully allow for less 'jamming' into holes or troughs and allow for an increased distance to be covered.

When conducting photogrammetric surveys, it is advised to record in either RAW or JPEG if trying to acquire photographs at 1-sec intervals. The other option is to fly at a higher altitude or set the intervalometer to record at >1 sec intervals.

A. Crawford had a difficult time retrieving the Trimble R7 GPS antenna at Site 1 due to the great tightening of the radiation shield's u-bolts around the ablation stake, which the antenna's range pole sat within. It is recommended that a multi-head screwdriver and small wrench be carried in the pocket of the team leader at all times. This had been done throughout the day until the conclusion of work at Site 2; however, it is now noted to continue carrying these items until finally settled back on the ship.

Lastly, the quality of the EM302 underwater mapping was hindered at times due to either the ship being at too great a distance from the ice island or having multiple, extraneous sensors and filters turned on. Jean-Guy Nistad (HCU Hamburg, Germany) has written a concise document for future mapping of ice islands from the CCGS *Amundsen*. This is also applicable to any underwater vertical structure.

References

Copland, L., Mueller, D.R., Weir, L. 2007. Rapid loss of the Ayles Ice Shelf, Ellesmere Island, Canada. Geophysical Research Letters. doi:10.1029/2007GL031809.

Forrest, A.L., Hamilton, A.K., Schmidt, V., Laval, B.E., Mueller, D., Crawford, A., Brucker, S., and Hamilton, T. 2012. Digital terrain mapping of Petermann Ice Island fragments Canadian High Arctic. Proceedings of the 21st International Symposium on Ice held 11-15 June in Dalin, China.

Hamilton, A.K., Forrest, A.L., Crawford, A., Schmidt, V., Laval, B.E., Mueller, D.R., Brucker, S., Hamilton, T. 2012. Project ICEBERGS Final Report. Report prepared for the Canadian Ice Service, Environment Canada, Ottawa, Ontario. 36 pp.

McGonigal, D., Hagen, D., Guzman, L. 2011. Extreme ice features distribution in the Canadian Arctic. Proceedings of the 20th International Conference on Port and Ocean Engineering under Arctic Conditions held 11-14 July in Montéal, Quebec. POAC 11-045.
Mueller, D., Crawford, A., Copland, L., VanWychen, W. 2013. Ice island and iceberg fluxes from Canadian High Arctic sources. Report prepared for the Northern Transportation Assessment Initiative, Innovation Policy Branch, Transport Canada. Ottawa, Ontario. 22 pp.
Prowse, T.D., Furgal, C., Choulnard, R., Mulling, H., Milburn, D., Smith, S.L. 2009. Implications of climate change for economic development in Northern Canada: Energy, Resource, and Transportation Sectors. Ambio 38:272-28.
Peterson, I.K. 2011. Ice island occurrence on the Canadian East Coast. Proceedings of the International Conference on Port and Ocean Engineering under Arctic Conditions. Held 10-14 July in Montréal, Canada. POAC11-044.
Stephenson, S.R., Smith, L.C., Brigham, L.W., Agnew, J.W. 2013. Projected 21st-century changes to Arctic marine access. Climatic Change. DOI:10.1007/s10584-D12-0685-D.
Wagner, T.J.W., Wadhams, P., Bates, R., Elosequi, P., Stern, A., Vella, D., Povl Abrahamsen, E., Crawford, A, Nicholls, K.W. 2014. The “footloose” mechanism: Iceberg decay from hydrostatic stresses, Geophysical Research Letters, 41, 1-8, doi:10.1002/2014GL060832.

6 A hydrographer's observations of ice island mapping – Leg 1b

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6.1 Introduction

On 26 July 2014, the CCGS *Amundsen* performed a circumnavigation of a 6 km diameter (approximate value) ice island in Baffin Bay. One aspect of the circumnavigation included the "mapping" of the ice island. It was somewhat unclear if the mapping involved the bottom mapping around the island or the mapping of the sidewalls of the ice island. It was later understood that the mapping of the ice sidewalls down to a depth of 100-200 meters was deemed more important than the underlying bathymetry (about 800 meters at the position of the ice island). As a 30 kHz shallow to medium ocean depth echosounder, the Simrad EM302 fitted on board the *Amundsen* was not the most appropriate echosounder for mapping close-range, near-surface vertical structures such as ice islands, quay wharfs, etc. This was mainly due to the operational frequency of the echosounder and to the mounting installation. Nevertheless, it is still possible to achieve some form of ice island mapping if appropriate steps are taken. These steps are outlined below, but first, here is the ideal scenario for mapping vertical structures.

Close-range, near-surface vertical structures extending to about 100m in depth can be properly mapped using a 200 - 400 kHz multibeam echosounder pole-mounted on a small survey launch (Figure 6.1). The echosounder transducers should be tilted so that the normal to the face of the transducers makes a 30-degree angle with respect to nadir away from the survey launch. This gives a physical mounting angle to the echosounder. Further, if the echosounder is equipped with manual beam steering control, the beams can be further focused towards the vertical structure in order to maintain all beams within a 80 degree swath angle (approximate value). For example of products of what can be achieved using this technique, see the product realisation section of CIDCO (Interdisciplinary Centre for the Development of Ocean Mapping; www.cidco.ca).

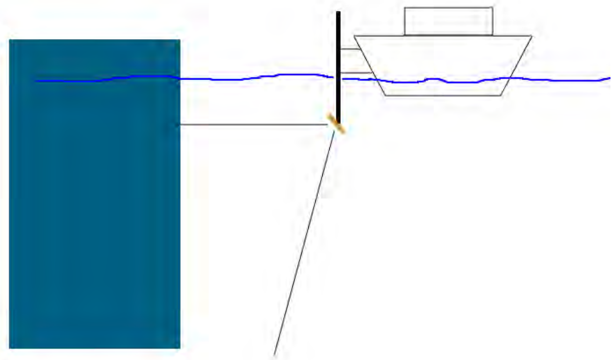

Figure 6.1. Ideal configuration for the mapping of vertical structures.

6.2 Methodology

The Simrad EM302 echosounder on board the *Amundsen* can still map vertical structures albeit at a much coarser resolution and only from a deeper depth due to its 7 meter draft. To optimize data quality, the following steps should be considered:

1. Make sure that the ship has the ice island on its port side

The EM302 is slightly "blinded" on its starboard side: 5 degrees of the swath opening angle is lost due to the presence of the keel. Hence, it is preferable to have the ice island on the port side of the ship when circumnavigating.

2. Deactivate external K-sync trigging to maximize the ping rate of the EM302

The K-sync allows for the synchronisation of multiple acoustic instruments thanks to a triggering mechanism. This avoids acoustic interference between instruments. The problem is that this reduces the ping rate of individual instruments since each must wait its turn. If it is not crucial for other instruments to be pinging during the mapping of vertical structures, then they may be deactivated and the external triggering bypassed to allow full ping rate of the multibeam.

3. Choose the shallowest mode of operation and limit the depth window

The range setting of the EM302 should be limited to approximately 200 m in order to force bottom detection to this maximum range. Conventional multi- beam echosounder offer manual control over the range setting. Due to its automated nature, the EM302 is somewhat different. A few experiments need to be performed in order to ensure that one can produce the same effect by forcing the use of the "shallow" mode of operation and by limiting the depth window (i.e. maximum depth set to approximately 200m).

4. Reduce the swath by focusing all beams to port

The EM302's swath opening angle should be set to:

- Port = 65
- Starboard = 0

This is in order to focus all beams on the port side, where the vertical structure is located.

5. Make sure WC (Water Column) logging is enabled

With WC enabled, even if bottom detection were to fail to "lock" on the vertical structure, it would still be possible to extract soundings from the WC files.

6. Ensure that the EM302's transmit sectors have been adjusted with a Tx diagram adjustment procedure

The Tx diagram adjustment procedure's purpose is primarily to optimize seabed backscatter data. Still, the adjustment will also be beneficial for WC data since the amplitude response of the vertical structure will be normalized across the different transmission sectors.

On 5 August 2014, a second attempt was made to map the sidewalls of a second ice island. This attempt proved more successful than the first attempt on 26 July. Yet, some adjustments still need to be made. Of the previous six recommendations, #1 to #5 were implemented during this attempt and worked as expected, except for #4. It was believed that by reducing the swath width, the multibeam would focus all its beams within that reduced swath width. Instead, the multibeam simply disabled the beams that were outside the reduced swath width. Therefore, either the beam focusing feature is not implemented in the EM302 or the control to do so is elsewhere and we have not discovered it yet.

Data collected during this second attempt showed that the optimal across-track distance to the ice island wall seemed to be between 50 and 100 meters. It also showed the difficulty for the EM302 to track something else than the bottom. As compared to RESON Seabat systems, it seems to have more difficulties tracking something else than the bottom.

The second attempt also allowed adding three new recommendations to the previous six. Following the same chronological ordering:

7. Activate Sonar mode

The *Sonar mode* option available under *Runtime parameters→Filter and Gain* should be checked. This option allows "manual" control of the echosounder. Basically, it allows the operator to select the appropriate range (using the modes). This will determine the pulse length. In this mode, the Min Depth and Max Depth settings of the *Depth Settings* section become slant-range limits.

8. Remove filters

Under the *Filter and Gain* tab, make sure that the *aeration* and *slope* filters are unchecked. Put all other filters to their weakest setting.

9. Use equi-angle

In order to avoid reliance on bottom depth for the equi-distance calculation, use equi-angle mode. This will come at the cost of a slight reduction in across-track resolution.

7 Mooring Program – BaySys (Hudson Bay), BREA (Beaufort Sea) and JAMSTEC

ArcticNet Phase 3 – Long-Term Observatories in Canadian Arctic Waters.
http://www.arcticnet.ulaval.ca/pdf/phase3/marine-observatories.pdf
ArcticNet Phase 3 – Freshwater-Marine Coupling in the Hudson Bay IRIS.
http://www.arcticnet.ulaval.ca/pdf/phase3/freshwater-marine-coupling.pdf

Project Leaders: David Barber[1] and Louis Fortier[2]
Mooring operations participants BaySys (CCGS *Henry Larsen*): Shawn Meredyk[2] and Luc Michaud[2]
Mooring operations participants BREA: IMG-Golder Corporation, Shawn Meredyk[2] and Luc Michaud[2]
Mooring operations participants JAMSTEC: Shawn Meredyk[2], Luc Michaud[2], Takashi Kikuchi[3], Hirokatsu Uno[3] and Jonaotaro Onodera[3]

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[2] ArcticNet, Pavillon Alexandre-Vachon, 1045 Ave. de la Médecine, Local 4081, Université Laval, Québec, QC, G1V 0A6, Canada.
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7.1 Introduction

7.1.1 BaySys - Hudson Bay

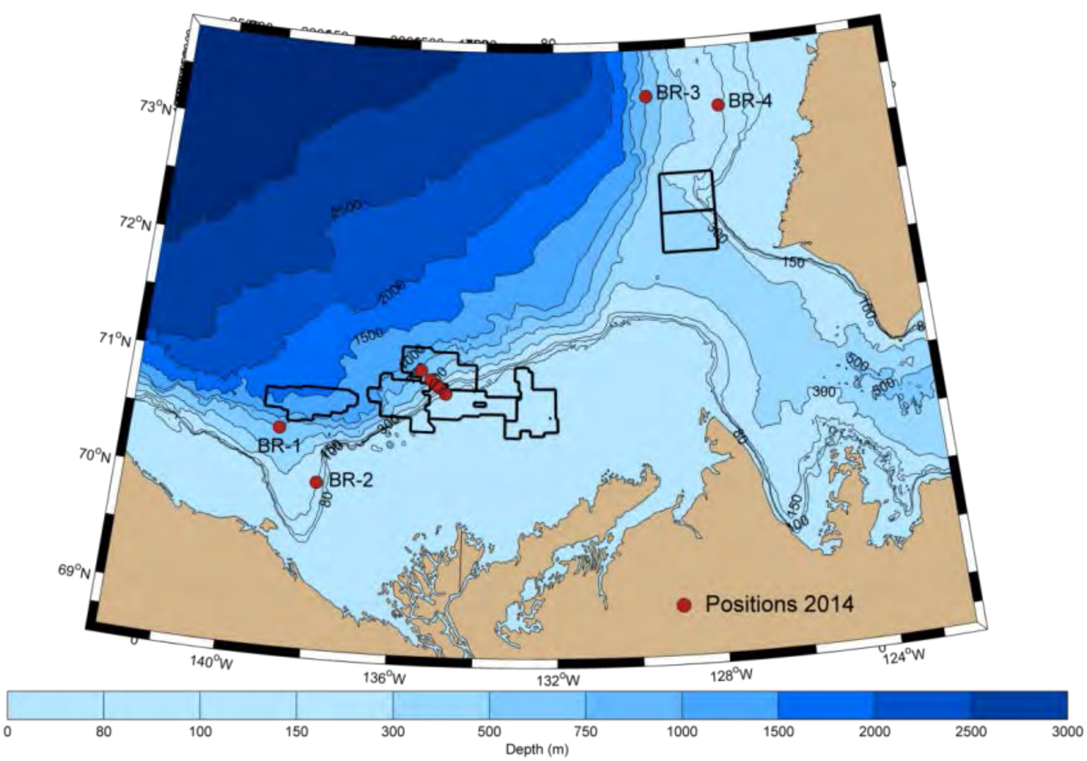
Freshwater loading has a major influence on coastal arctic marine waters. Freshwater fluxes into Hudson Bay are dominated by the large scale hydrological cycle of the Hudson Bay watershed; an area which covers most of the Great Plains of North America and a substantial portion of the Precambrian Shield. Variations in this freshwater outflow, consistent with a decreasing trend in arctic runoff, have the potential to affect the formation of dense water in the Labrador Sea. The annual cycle of sea ice and precipitation over Hudson Bay also plays an important role in the freshwater budget of the Bay and the associated circulation of freshwater between the estuaries, coastal current, and sea ice features. The BaySys mooring and sampling program was initiated in the fall of 2005 and has been maintained almost every year since to examine freshwater fluxes into Hudson Bay.

The main objective of the 2014 BaySys program was to service one mooring (AN01-13), strategically positioned in southern Hudson Bay and to perform a CTD cast to determine the oceanographic properties of the water column at the mooring site.

7.1.2 BREA – Beaufort Sea marine observatories project

The Leg 2a mooring program was focused on the long term Southern and Eastern Beaufort Sea Marine Observatory System, which continues a four-year project under the BREA program. In 2012, during the second year of this project, 5 moorings (BR-A-12, BR-B-12, BR-G-12, BR-1-12, BR-2-12) were deployed (Golder 2012). BR-A-12 and BR-B- 12 were located in Exploration License (EL) 476, and BR-G-12 was in EL 477. BR-1-12 and BR-2-12 were deployed to the west, north of the Mackenzie Trough and on its east flank, respectively. All five moorings were recovered during the 2013 field program onboard the CCGS Sir Wilfrid-Laurier, but were not re-deployed that year (Golder 2013).

The objective for the 2014 field program was to re-deploy three of the moorings recovered during the 2012 field program (BR-G-14, BR-1-14, BR-2-14) and to deploy three new BREA moorings: BR-K-14, (a shelf-break mooring aligned with BR-G-14), as well as BR-3-14 and BR-4-14 which were to be deployed on the continental shelf and slope, west of Banks Island. In addition, three new ArcticNet moorings (BS-1-14, BS-2-14, and BS-3- 14) were organized for deployment in the central Beaufort region. The new ArcticNet moorings were aligned with the locations of BR-G and BR-K to complete a cross-shelf-slope array between 80 m and 700 m water depth across EL 478 and EL 477 (Figure 7.1).



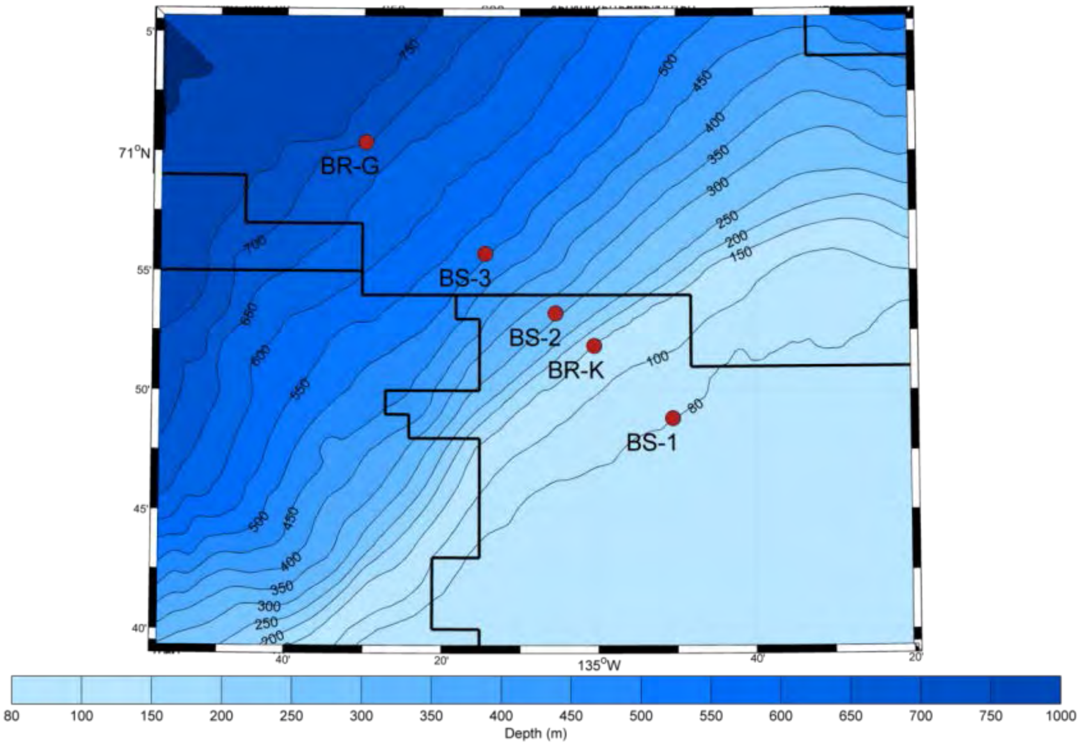


Figure 7.1. Map of 2014 BREA and ArcticNet mooring locations (previous page) and inset map of the cross-shelf-slope mooring array composed of BREA and ArcticNet moorings (above).

The BREA moorings will provide long-term observational data on sea ice drift and thickness, ocean circulation and waves, water mass structure, and biogeochemical fluxes for comparison with historical and present shelf and slope data collected in the Canadian Beaufort Sea. The planned cross-shelf-slope array in the central Beaufort region will assist in resolving the seasonal and spatial variability of the shelf-break current that conveys water of Pacific origin along the slope, and to investigate interactions with other large-scale circulation features (e.g. Beaufort Gyre, up-welling and down-welling flows) and the role the shelf-break current plays in generating mesoscale eddies and sediment erosion and dispersal across the upper slope.

Area of study

The Mackenzie Trough, a cross-shelf canyon in the Beaufort Sea shelf, has been observed to be a site of enhanced shelf-break exchange via upwelling (caused by wind- and ice-driven ocean surface stresses). The canyon provides a conduit for bringing deeper, nutrient rich water to the shelf. Shelf waters in the area are seasonally influenced by freshwater output from the Mackenzie River, both in terms of temperature-salinity properties and suspended sediments / turbidity.

Capturing the Beaufort gyre's anti-cyclonic (west) movement relative to a long-shore counter-current (east) plays an important role in understanding deep and shallow water movements relative to nutrient and particle fluxes.

Ice cover, examined by moored ice profilers and satellite imagery, plays a significant role in terms of affecting momentum transfer from wind to water, constrained (in the case of landfast ice) and enhanced (in the case of drift ice) by wind.

Hydrophone recordings on the shelf-slope area will monitor bioacoustics vocalizations throughout the year to better understand the potential impact that future operations in the Beaufort Sea could have on the marine mammals.

7.1.3 JAMSTEC

Mooring operations during Leg 2b (September 8- September 25) were a collaborative effort in maintaining (recovery and redeployment) three JAMSTEC mooring arrays (Barrow Canyon, Northwind Abyssal Plain and Chukchi Abyssal Plain).

Barrow Canyon is one of the main gateways of Pacific water-masses flowing into the Arctic basins. In particular, most of warm and fresh Pacific Summer Water (PSW) is flowing along the Alaskan coast, though the Barrow Canyon, and then into the Beaufort Sea (Figure 7.2). Seasonal and inter-annual variation of fluxes and water properties appeared to be large in previous years. In-order to monitor volume, heat and freshwater fluxes passing through the Barrow Canyon, JAMSTEC has been maintaining this mooring array since 1996. Results from the long-sustained mooring arrays have provided evidence of heating of the inflowing PSW, which is a potential heat source, enhancing sea ice melting during summer and reducing sea ice formation during winter in the western Arctic Ocean. Monitoring Barrow Canyon fluxes is important for better understanding changing oceanographic conditions, sea-ice condition and the marine ecosystem, in the Canada Basin.

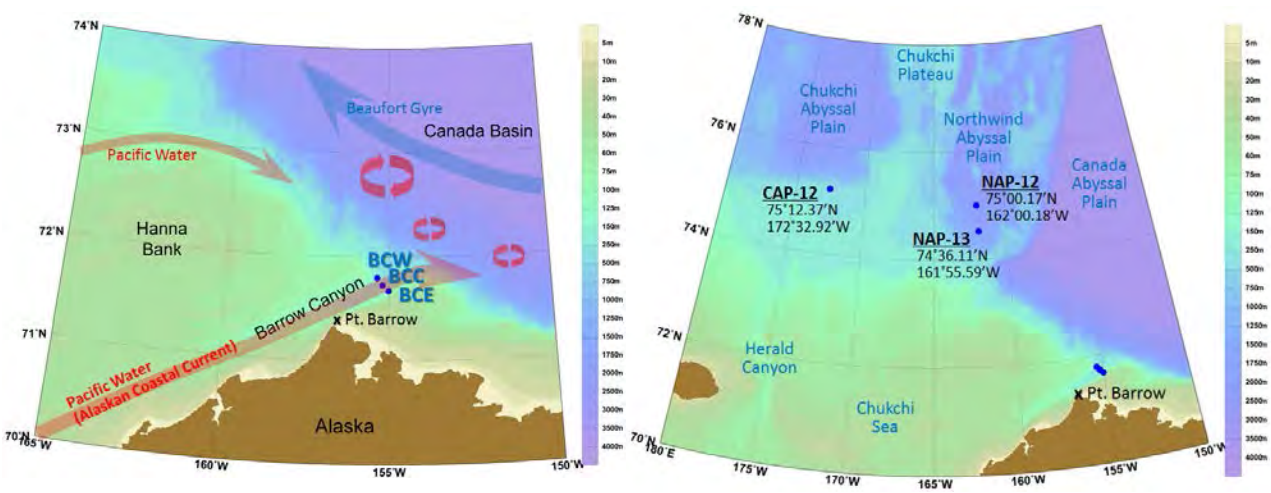


Figure 7.2. Recovered and deployed 2014 JAMSTEC mooring array in Barrow Canyon (left) and in Northwind and Chukchi Abyssal Plains (right).

Northwind and Chukchi Abyssal Plains are important in order to decipher the response of biogechemical cycles to the recent sea-ice decrease trend. While the upper water masses around the Northwind Abyssal Plain are influenced by the Pacific and Beaufort Gyre waters, the upper water mass in the Chukchi Abyssal Plain is influenced by the East Siberian shelf waters. The nutrient condition for phytoplankton in the Chukchi Abyssal Plain is better than that of the Northwind Abyssal Plain. The activated sea surface circulation and eddy formation, by decreased sea-ice concentration, induce lateral transportation of shelf materials to basin. Analyzing time-series data, from two different hydrographic settings, different patterns of biogeochemical and marine ecosystem responses can be observed within the physical oceanographic and particle flux data. The Northwind and Chukchi Abyssal plains moorings are focused on time-series monitoring of particle fluxes to the Abyssal plains relative to year-round oceanographic conditions, while examining / monitoring responses of lower-trophic marine ecosystems relative to biogeochemical cycles with decreased sea-ice formation (Figure 7.2).

7.2 Methodology – Hudson Bay mooring operations (BaySys)

The BaySys expedition took place in the Hudson Bay, ~100 nm NE of Churchill, Manitoba, Canada, between 1 and 4 October. AN01 is a mooring station with multiple moorings that has been problematic to recover, since 2012.

Mooring AN01-13 was deployed to monitor the W–SW area of the Hudson Bay`s inter-annual water mass movements. This mooring location (AN01) is a long-term mooring site at ~107m depth with 8 years of data already recorded (Figure 7.3).

Figure 7.3. 2014 BaySys Mooring Location AN01 (nomenclature: Mooring ID – Year deployed, i.e. AN01-11,12,13).

7.2.1 Mooring design and instrumentation

Table 7.1. Description of oceanographic equipment as recovered from AN01-12.

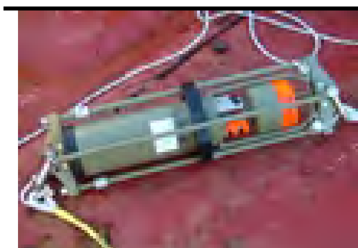
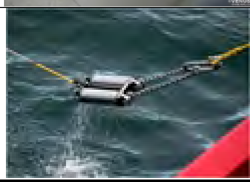
Photo	Description and specifications
	The Aanderaa RCM11 was used to record the CTD and single-point (0.1m resolution) water current velocity. Depth 30m
	The RDI-Teledyne 300 kHz Quarter Master (QM) Acoustic Doppler Current Profiler (ADCP) was housed in stainless steel cage and four Viny floats were attached to each side of the ADCP cage. The upward looking profiler was used at approximately 75m water depth to profile currents with a vertical resolution of 0.8 m with a standard deviation of 2.84 cm/s upwards for 82m. Depth 74 m

Photo	Description and specifications
	Technicap PPS 3/3-24S 24 cup sequential sediment trap was deployed to record the annual cycle in vertical carbon flux. Depth 85m
	Dual / tandem RDI-Teledyne Benthos 861B2S acoustic releases were used as the primary recovery / release device. Depth 100m

Mooring AN01-13 was a taut-line configuration consisting of a top float, CTD (RCM11), hydrophone (Aural M2), in-line float, current profiler (ADCP), sediment trap (Technicap PPS 3/3), two mooring releases (Benthos 861B2S) and an anchor (two train wheels).

7.2.2 Field calibrations

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. Therefore, it was important to calibrate internal compasses near the approximate latitude where they were deployed and care was taken to eliminate all ferrous material in the mooring cages and in the calibration environment (shipboard calibrations are therefore not possible).

The *Henry Larsen* was unable to make port in Churchill due to adverse weather; therefore, the *Larsen's* helicopter was used to make passenger and equipment transfers. All ArcticNet personnel wore coast guard-standard Helicopter immersion suits for Helicopter transfers to and from the *Larsen*. A safety briefing was conducted prior to boarding the helicopter and the mooring team attended the *Larsen* safety briefing and familiarization on the ship in addition to having completed a certified helicopter ditching safety course.

The compass calibrations, prior to deployment, were completed at a new location due to flight restrictions from the airport. Therefore, a site was selected on the spit across the Port of Churchill, Manitoba (58°45.607 N, 94°14.116 W). It was situated south of the Prince of Wales Fort, across from the Churchill seaport, on September 30th, 2014 by two ArcticNet personnel (Figure 7.4).

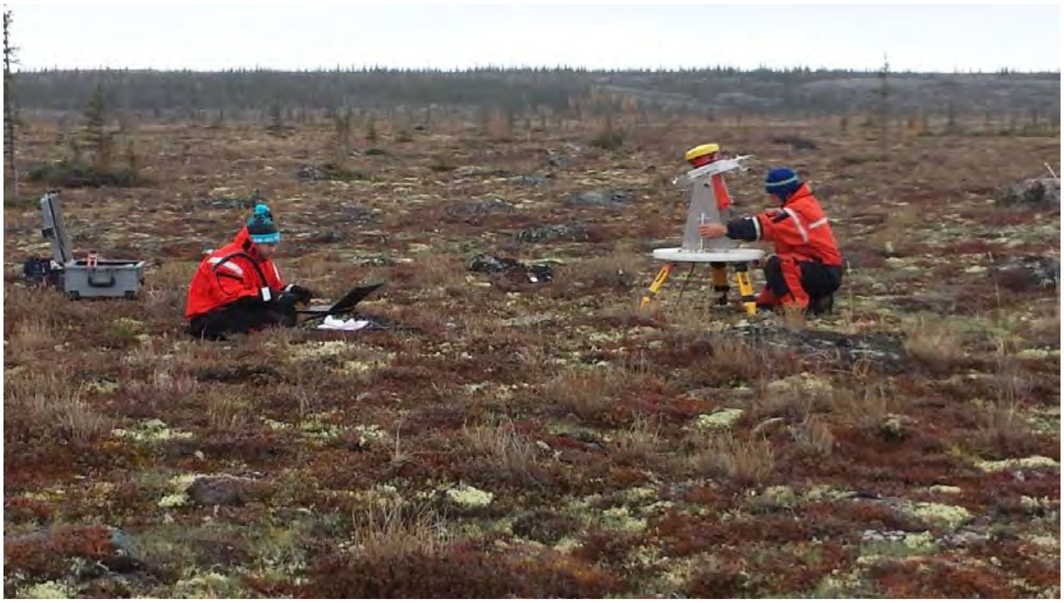


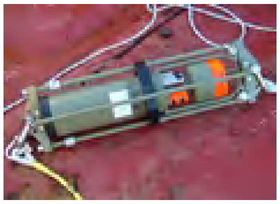
Figure 7.4. Calibration location and setup with ADCP in calibration jig / table.

The calibrations were conducted with a leveled tilt and rotate jig / table (Figure 7.5). The calibration procedures followed standard manufacturer protocols for each instrument. The general calibration procedure is briefly described below:

- Communication was established with the instrument using the manufacturer's calibration software after a serial communication line was connected to the instrument;
- Power was provided to the instrument by the instrument's internal battery pack;
- The current meters were oriented in the configuration in which they would be deployed (up/downward facing);
- On-screen directions were followed to rotate the instrument through 360 degrees with varying degrees of pitch and roll, until a successful calibration was achieved.

True North was determined by placing a marker along the same longitude as the calibration table 0 heading (placed using a handheld Garmin GPS). Magnetic declination was determined by observing the difference between the magnetic north heading seen on an analog magnetic compass and the heading of true north identified by the distant marker, then comparing it to the theoretical value identified on aeronautical charts (provided by helicopter pilot).

Table 7.2. Oceanographic equipment and calibration procedures for replacement instruments.

Equipment	Location	Purpose	Equipment Used	Calibration Procedure
Aanderaa RCM #277 	Churchill, MB 58°45.607 N 094°14.116 W	Single-Point water velocity profiler and CTD	Calibration Table / Jig, RCM Deck Unit, Laptop to record readings from Deck Unit	Install into calibration table, point to 0 heading and record the sensor readings, when similar consecutive readings are recorded, advance the table by 10° and continue until 360° is reached. These readings are converted into headings and the deviation between device and calibration table heading is determined.
RDI 300 kHz Quarter Master ADCP #3778 	Churchill, MB 58°45.607 N 094°14.116 W	4 beam 3D water velocity profiler	Calibration Table / Jig, Laptop with WinSC installed, USB to Serial adapter	Install into calibration table, point to 0 heading and open WinSC software, 'test' unit to verify all tests pass, set unit to zero pressure, set unit to UTC, verify compass, calibrate compass using af command, record the heading deviation by using pc2 to view the heading of the ADCP relative to the calibration table heading, measured at 10° intervals.

Calibration Problems

RCM11 (#277) appeared to have a magnetic bias at ~180°, as the degrees of error increased as the unit was near these headings. Factory calibration is recommended before next use.

ADCP Sentinel (#3778) didn't have any problems obtaining < 5° of error after hard and soft iron calibration corrections were performed (9° before calibration and 4.5° after calibration using RDI calibration routines (soft and hard iron)).

7.2.3 Mooring operations

Mooring recovery

Mooring AN01-13 was not recovered due to complications in communicating with the Benthos mooring releases. A weighted transducer (metal rod taped to the cable, just above the transducer head) and Benthos deck boxes (three different units) were used to communicate with the mooring releases. The enable codes were confirmed and reconfirmed, to no avail. After 6 hours of trying to communicate with the releases, efforts to release AN01-13 were abandoned and recovery of mooring AN01-12 and AN01-11 were attempted (Figure 7.5).

AN01-12	Opération	Date	Profondeur de la station (m)	Press.Atm. mbar	Échelle de Beaufort	Temp. oC	Vit. Vents Nœud/Dir.	Position (de MatLab): 59 57.8883 N ; 91 58.01 W
	Déploiement	29-août-12	114	1008	3	8	20knts/70º	Couvert nuageux:
	Récupération	1-octobre-2014	114		8	7	42knts/355°	Couvert nuageux:

Component	Unit Length (m)	Top Height (m)	Top Depth (m)	DEPLOY UTC Time In water	RECOVER UTC Time On Deck	Numéro de Série	# série DSU ou Moteur des trappes	Comment
ORE SS-30	1.0	81.0	32.6		11:00			
Kevlar 5/16	5.0	80.0	33.6					
RCM 11	0.6	75.0	38.6			285		
Kevlar 5/16	20.0	74.4	39.2					
ORE SS-30	1.0	54.4	59.3					
Kevlar 5/16	20.0	53.4	60.3					
ADCP300kHz	1.0	33.4	80.4		11:07	3045		
RBR XR420-CTD	0.0	32.4	81.4					RBR: 13203
Kevlar 5/16	10.0	32.4	81.4					
Technicap PPS 3/3-24s	2.0	22.4	91.5				09-349	
Kevlar 5/16	5.0	20.4	93.5					
4*Benthos (17¨)	2.0	15.4	98.5					
Kevlar 5/16	5.0	13.4	100.5					
2*Acoustic releases	1.0	8.4	105.6		11:30			# 41437 Rx= 9.0 , # 41438 Rx= 9.5
BENTHOS	0.6	7.4	106.6					Tx:12 En: E Rel: F Tr:12 En: G Rel: H
Chain 1/2	0.7	6.8	107.2					Profil CTD après déploiement: ctd an01-2012
Poly rope 3/4	5.0	6.1	107.9					
Chain 1/2	0.6	1.1	112.9					Profil CTD avant récupération: non - trop rough
2*Wheel	0.5	0.5	113.5					
Bottom		0.0	114.0					

Figure 7.5. Mooring AN01-12 recovery instrumentation details.

Mooring recovery procedure

- One ~110m mooring (AN01-12) was recovered in 2014 in the Hudson Bay.
- The mooring was recovered top-down, starting with the top float and ending with the two acoustic releases.
- Sea ice was not present during the deployment, there were cloudy skies and the sea state was very rough (Beaufort F8 – 42 kt winds (northeast); 4-6m wave/swell height; Air Temp 7°C). These sea conditions were past safe working conditions (mooring operations) for this vessel.
- No rust was seen on the shackles and the ADCP float was ripped-off in the surf and from hitting the vessel during recovery.
- The mooring was recovered using a short sling and a u-cinch knot instead of a Yale grip or Chicago grip \ Bull-dog grip. A Chicago grip would have made this operation safer and quicker, along with a pulley (on crane) that could be opened from one side.
- The sediment trap's titanium post was bent at the lower end during recovery while it was being secured in-order to be removed from the mooring line.
- Only one release released. The release was sent an enable command, but no response was heard. The release command was send immediately after and again, no response,

but, the release did in-fact release the mooring line. This release shouldn't have released without giving an acknowledgement, but it did. RDI – Teledyne – Benthos was contacted shortly after the recovery mission to determine the difficulty with their releases (results (2015): nothing appeared to be wrong with the devices, according to Benthos). Benthos releases showed no sign of corrosion and anodes were half used (red – rusty paste results from anode use).

7.2.4 Mooring recovery lessons learned

When the weather was too rough for Zodiac deployments then it was too rough for safe mooring operations. Mooring operations could be performed, but instruments would most likely be damaged during recovery. Moreover, there was a very high risk of someone getting hurt in such conditions.

Moorings designed to be recovered and deployed using a variety of boats was difficult and required intimate knowledge of mooring operations onboard said vessels. However, some simple items (Chicago / bull grip and open pulley) would make deployment and recoveries easier and safer onboard other boats such as the *Radisson* and *Larsen*.

Mooring deployment

Mooring AN01-12 was released without any acknowledgement from the releases (communication problems due to a combination of sea state and malfunctioning releases). Mooring AN01-11 responded to the deck box commands (albeit not in the expected fashion (1 or 5 beeps for all types of communication)), however, it did not release the mooring when commanded.

7.3 Methodology – BREA mooring operations

The existing BREA mooring locations (BRG, BR1, BR2) and the new BREA moorings (BRK, BR3 and BR4) accompanied by three new ArcticNet moorings (BS1, 2, 3), allowed for three shelf –slope arrays, examine depth-slope effects on particle fluxes in the southern Beaufort Sea. These moorings perform a long-term (since 2004) integrated observation of ice, water circulation and particle fluxes concerning shelf and slope locations in the southern Beaufort Sea.

Figure 7.6 outlines the expedition plan for the 2014 Leg 2a operations (Leg 2a activities started in Kugluktuk, NWT, Canada, August 14th, 2014).

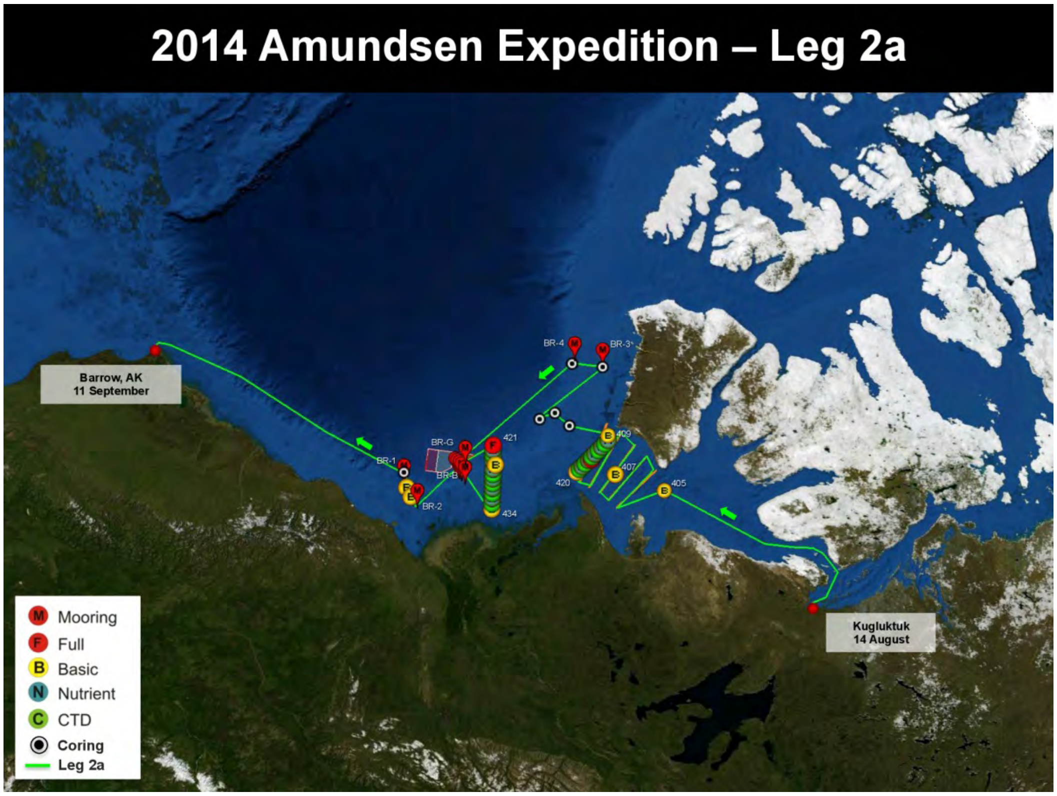


Figure 7.6. 2014 ArcticNet Leg 2a operations plan.

New BREA Moorings BR3 (700m) and BR4 (155m) were deployed, in an effort to collect data on the NE extent of the Beaufort gyre current along with the ongoing effort to assess ocean circulation, biogeochemical fluxes and sea ice motion and thickness distribution in a region very much under-studied (Figure 7.7).

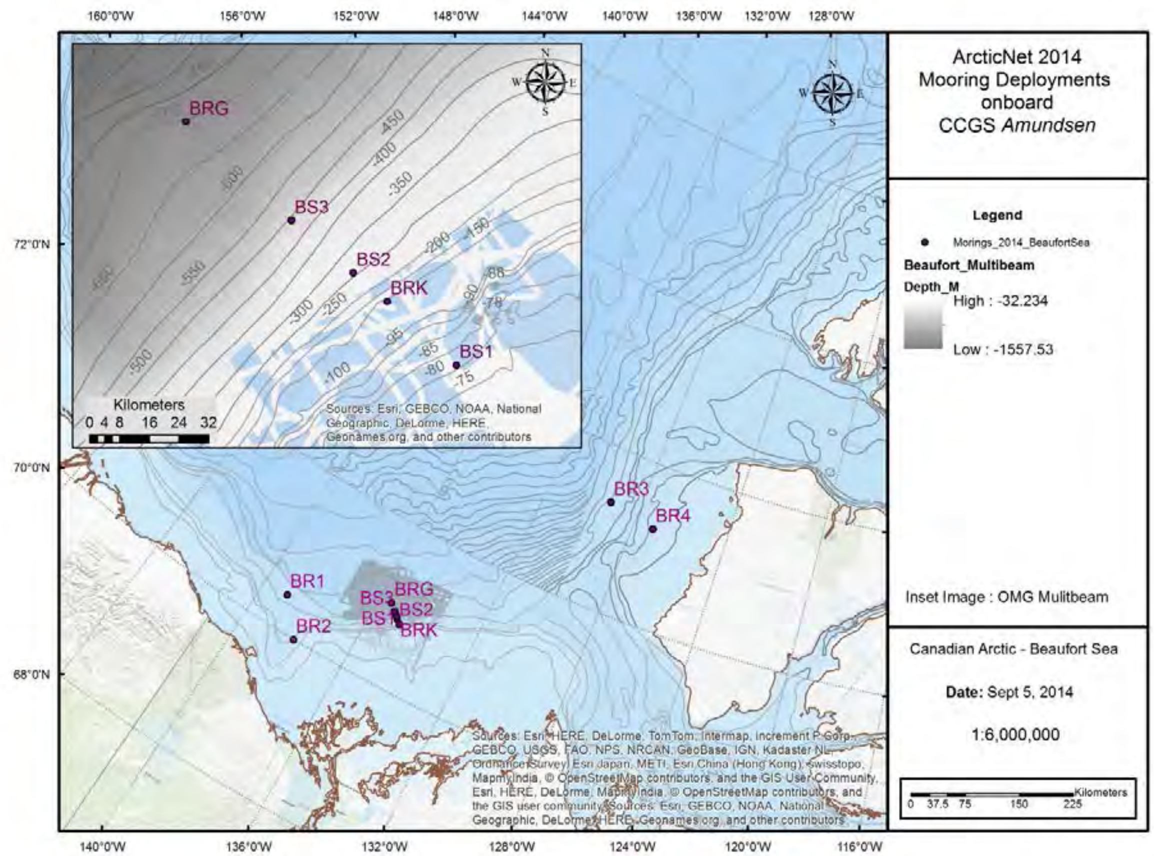


Figure 7.7. Deployed 2014 BREA-ArcticNet mooring array.

Moorings BS1 (80 m), BRK (156 m), BS2 (300 m), BS3 (500 m), BRG (701 m), BR1 (757 m) and BR2 (159 m) were located in the Mackenzie Trough and were deployed as part of the ongoing effort to assess ocean circulation (the southern extent of the Beaufort gyre current near the Mackenzie Trough), biogeochemical fluxes and sea ice motion and thickness distribution key areas of the Mackenzie shelf-slope system.

7.3.1 Mooring design and instrumentation

A list of oceanographic mooring equipment deployed with the moorings of both ArcticNet and IMG-Golder can be found in Table 7.3.

Table 7.3. Oceanographic equipment used in ArcticNet- BREA mooring designs.

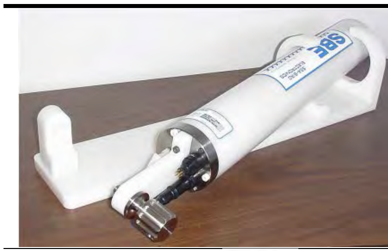
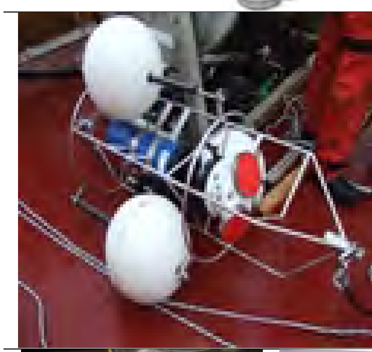
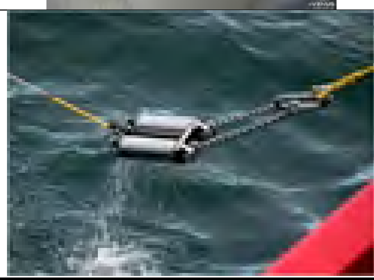
Photo	Description and specifications
	The SBE 37 was used to record the conductivity, temperature and depth (CTD) Depth 50m intervals on ArcticNet moorings
	The AURAL M2 hydrophone from Multi-électronique was deployed to record underwater sounds at a sampling rate of 16 kHz. Depth 100-150m, on ArcticNet moorings only
	The Nortek 190/ 470 kHz Continental model of Acoustic Doppler Current Profiler (ADCP) was housed in stainless steel cage and six panther floats were attached to each side of the ADCP cage. The upward and downward looking profilers were designed to record 100 to 200m of water column velocity data (binning of 4m). Depth 100 and / or 300m, depending on proposed mooring depth of ArcticNet moorings only
 	Semi-Permeable Membrane Devices (SPMDs) were designed to be installed on the ADCP cages and mooring line as well, in an effort to trap persistent organic pollutants (POPs) within a gel matrix within the traps. Deployed Depths: 50, 60, 100, 200 and 300m
	RBR XR420 CT device is used to measure conductivity and temperature (CT) , along with Dissolved Oxygen (DO), Turbidity (TU) and Fluorometry (FL) Depths: 100, 200, 300 and 400m

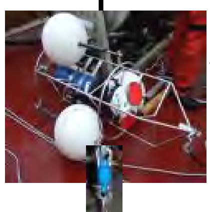
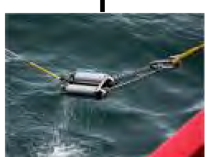
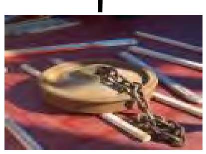
Photo	Description and specifications
	LISST-100x particle analyzer identifies the size of particulate matter in the water column at its designated deployment depth. Depth 130-150m, BR-K, BR-2, BR-4 shallow moorings
	Technicap PPS 3/3-24S 24 cup sequential sediment trap was deployed to record the annual cycle in vertical carbon flux. Depth 100 and / or 200m and / or 300m, depending on proposed mooring depth
	Tandem OCEANO, CART or 8242XS acoustic releases were used as the primary recovery / release devices. Depth: 5m (Oceano) or 12m (CART / 8242XS) above proposed mooring depth

The ArcticNet moorings were generally designed to be of taut-line configuration consisting of a top float (50m depth);

- SBE37 - Conductivity, Temperature and Depth (CTD) probe to record water characteristics;
- Two current profilers (Continental 470 (Up) / 190 (down looking) kHz) with 1 - 2m resolution respectively, to record the water velocities within the upper and middle water column;
- Hydrophone (Aural M2) with a 8 kHz, two-hour sampling rate to listen to bioacoustics signatures within the water column;
- In-line floatation (30" ORE float) to balance the weight/ float balance throughout the mooring line;
- Sediment trap (Technicap PPS 3/3 with 24 sample cups – semi-monthly sampling rate) to trap descending sediment for particle flux analysis and accumulation rates;
- 190 kHz Nortek Continental current profiler (down looking) to complete the water column velocity profile record;
- Tandem mooring releases (Oceano or ORE);
- An anchor (two to four train wheels).

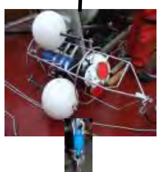
BS1-14 **Southern Beaufort Sea - Mackenzie Trough**

	Longitude	Latitude
Proposed Position		
Decimal degrees (WGS84)	-135.50173	70.65616
Triangulated Position	-134.85061	70.81078667
Target Depth (m):	80	

~ Instr. Depth (m)		Instrument	Water	Other Equipment	Net weight (kg)
45m		ORE 30¨Buoy Buoyancy 168kg	 168.0		
		15m Kevlar line 5/16¨		SBE 37 #10851 and SPMD (50m)	
60m		Nortek Currentmeter #6070 Continental 470kHz Weight in water 15kg Cage (Weight in water) 6 Panther buoys Buoyancy 17.6kg Galv shackles, swivel	 -15.0 -18.0 105.6		
		15m Kevlar line 5/16¨		RBR XR420 CT 17113 (75m)	
75m		OCEANO acoustic releases Tandem assembly Weight in water 22kg	 -44.0		196.6
		~3m polyrope line shackle ~2 m chain			
80m		Anchor (800 lbs train wheel) 2 train wheels	 -1600.0		

BS2-14 **Southern Beaufort Sea - Mackenzie Trough**

	Longitude	Latitude
Proposed Position:		
Decimal degrees (WGS84)	-135.69183	70.68495
Triangulated Position:	-134.09446	70.88123667
Target Depth (m) :	**300**	

Instrument Depth (m)		Instrument	Water Weight (kg)	Other Equipment	Net weight (kg)
41m		ORE 30¨Buoy Buoyancy 168kg	 168.0		
		50m Kevlar line 5/16¨		SBE 37 #10852 and SPMD (50m)	
91m		Nortek Currentmeter #6063 Continental 470kHz (UL) Weight in water 14kg Cage (Weight in water 18kg) 6 Panther buoys Buoyancy 17.6kg Galv shackles, swivel 2m Kevlar line 5/16¨	 -14.0 -18.0 105.6	RBR XR420 CT #15270 (100m) and SPMD	
94.5m		Nortek Currentmeter #6107 Continental 190kHz (DL) Weight in water 14kg Cage (Weight in water 18kg) 6 Panther buoys Buoyancy 17.6kg Galv shackles, swivel 50m Kevlar line 5/16¨	 -14.0 -18.0 105.6		
146m		Aural M2 hydrophone #31 (8 kHz , 120min cycle/ 10min 50m Kevlar line 5/16¨	-19.0	SBE 37 #10849(150m)	
199m		Sediment trap Technicap PPS 3/3-24s Weight in water 18kg 75m Kevlar line 5/16¨	 -18.0	RBR XR420 CT #15258 and SPMD (200m) Sediment trap #30	
274m		4 Benthos Buoy 17¨ Buoyancy 25kg 5 m Kevalr Line 5/16"	 100.0		
295m		OCEANO acoustic releases Tandem assembly Weight in water 22kg ~3m polyrope line shackle ~2 m chain	 -44.0		334.2
300m		Anchor (800 lbs train wheel) 3 train wheels	 -2400.0		

BS3-14 **Southern Beaufort Sea - Mackenzie Trough**

	Longitude	Latitude
Proposed Position :		
Decimal degrees (WGS84)	-135.83698	70.72443
Triangulated Postion:	-135.2357867	70.92594
Target Depth (m) :	500	

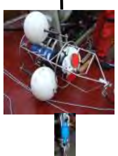
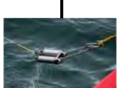
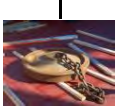
Instrument Depth (m)		Instrument	Water Weight (kg)	Other Equipment	Net weight (kg)
51m		ORE 30¨Buoy Buoyancy 168kg	168.0		
				SBE 37 #10850 and SPMD (50m)	
		45m Kevlar line 5/16¨			
96m		Nortek Currentmeter #6064 Continental 470kHz (UL)	-14.0		
		Cage	-18.0		
		6 Panther buoys Buoyancy 17.6kg each	105.6		
		Galv shackles, swivel 2m Kevlar line 5/16¨			
				RBR CT #15278 and SPMD (100m)	
98m		Nortek Currentmeter #6116 Continental 190kHz (DL)	-14.0		
		Cage (Weight in water 18kg)	-18.0		
		6 Panther buoys Buoyancy 17.6kg	105.6		
		Galv shackles, swivel 50m Kevlar line 5/16¨			315.2
148m		ORE 30¨Buoy Buoyancy 168kg	168.0		
		2m Kevlar line 5/16¨			
150m		Aural M2 hydrophone (8 kHz , 120min cycle/ 10min sample)	-19.0	SBE 37 #10196 (150m)	
		50m Kevlar line 5/16¨			
198m		Sediment trap Technicap PPS 3/3-24s	-18.0	RBR XR420 CT #15269	
		100m Kevlar line 5/16¨			
298m		Nortek Currentmeter #6112 Continental 190kHz (DL)	-14.0		
		Cage (Weight in water 18kg)	-18.0	SPMD on cage (300m) and RBR XR 420 #15271	
		6 Panther buoys Buoyancy 17.6kg each	105.6		
		Galv shackles, swivel 180m Kevlar line 5/16¨			
		4 Benthos Buoy 17¨ Buoyancy 25kg	100.0		
		~~10m Kevlar line 5/16¨~~			
495m		OCEANO acoustic releases Tandem assembly Weight in water 22kg each	-44.0		
		~3m polyrope line shackle ~2 m chain			220.4
500m		Anchor (800 lbs train wheel) 4 train wheels	-3200.0		

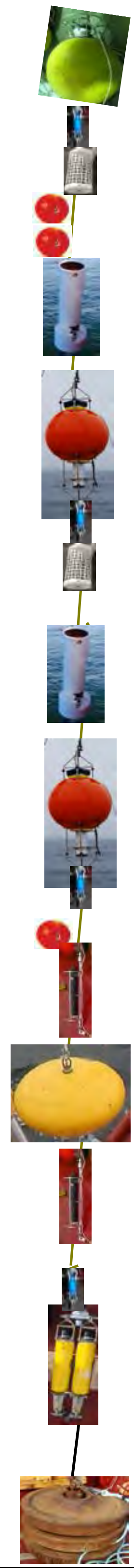
Figure 7.8. Mooring designs BS1-14, BS2-14 and BS3-13 deployed in southern Beaufort Sea during Leg 2a.

The BREA-ArcticNet moorings were designed to be of a taut-line configuration. The long moorings (BRG, BR3, BR1) consisted of the following key components:

- ASL Ice Profiling Sonars (IPS) were used at approximately 60 m depth to measure ice draft. IPS were mounted in 30-inch spherical Mooring Systems International (MSI) syntactic foam floats;
- 150 kHz Teledyne RDI (TRDI) Quarter Master Acoustic Doppler Current Profiler (QM ADCP) were used at approximately 200 m water depth to profile currents with a vertical resolution of 8 m, as well as to measure ice velocity using the Bottom-Track feature. The QM ADCPs were mounted up-looking in 40-inch syntactic foam floats manufactured by Flotation Technologies;
- 75 kHz TRDI Long Ranger ADCP (LR ADCP) were used at approximately 450 m water depth to measure water velocity profile at a coarser 16 m resolution. The LR ADCPs were mounted up-looking in 40-inch syntactic foam floats manufactured by Flotation Technologies;
- In water depths greater than 500 m, high frequency short-range (<1m) Nortek Aquadopp DW (AQD) point current meters were used approximately every 100 m to measure water velocity;
- Two Technicap PPS 3/3-24S 24 cup sequential sediment traps were deployed between the IPS and LR ADCP to record the annual cycle in vertical carbon flux;
- RBR Conductivity and Temperature (CT) loggers were installed at various depths to measure water temperature and salinity and to compute sound speed (used to improve IPS and ADCP processing). In some cases Conductivity, Temperature, and Depth (CTD) loggers were used on the moorings;
- Various smaller syntactic foam floats were distributed along the mooring as required;
- Tandem acoustic releases were used as the primary recovery device.

BR-G-14	Slope in Pokak
Target Instrument Depth (m)	Instrument
60	Ice Profiling Sonar IPS5 #51104
	MSI cage
	30" MSI syntactic spherical buoy
	Benthos UAT 27kHz 47748
	Swivel, galv shackles
	SBE37 #12236 (clamped to mooring line below cage)
100	RBR CTD #17352 clamped to line
	5/16" Amsteel 2 rope, 63 m
	2 12B3 floats with prusek hitch
	Stainless shackle
125	Technicap PPS 3/3 24 S sediment trap #48
	Stainless shackle
	5/16" Amsteel 2 rope; 75 m
150	RBRXR420 CTD logger #15273 clamped to mooring line
	Stainless shackle
	150 kHz QM ADCP DR #8784
203	Ext batt case (4 BP) #34333
	Flotec M40 1500m extended frame
	Benthos 364A/EL acoustic pinger 27 kHz #47753
	RBRXR420 CT logger #15280
	Novatech RF/Flasher: X06-054
	Swivel, galv shackles
	5/16" Amsteel 2 rope, 100 m
	Stainless shackle
	Technicap PPS 3/3-24S sediment trap #45
306	Stainless shackle
	5/16" Amsteel 2 rope; 150 m
	Galv shackles
	Novatech RF/Flasher: X06-066
458	75 kHz ADCP DR #13079
	External battery case (4 BP) #2031
	Flotec M40 1500m extended frame
	Benthos 364A/EL acoustic pinger 27 kHz #47751
	RBRXR420 CT logger #15266
	Galv shackles, swivel
	5/16" Amsteel 2 rope; 125 m
	galv shackle; prusek
	16" Flotec Hard Ball (3000m)
	shackles
586	Nortek Aquadopp Current Meter #9473
	Aquafin instrument cage
	5/16" Amsteel 2 rope; 100 m
	shackles
	1000 m ellipsoid float
	shackles
687	Nortek Aquadopp Current Meter #9847
	MSI instrument cage with welded vane
	RBR CT #15272
	galv shackles
	5/16" Amsteel 2 rope; 2m
	Swivel, galv shackles
	dual 8242 releases #33697 &33698
	Tandem assembly
690	
	chain, D-ring 5/8-inch shackle
	10m 3/4" polysteel drop line
	~2 m chain, 7/8" shackle
	3 train wheels
703	

BR-3-14	Slope near Banks Island
Target Instrument Depth (m)	Instrument
60	Ice Profiling Sonar IPS5 #51109
	30" MSI syntactic spherical buoy
	MSI cage
	Benthos 364A/EL acoustic pinger 27 kHz
	RBRXR420 CT logger #15264
	Stainless shackle, Swivel, galv shackles
62	SPMD (clamped to mooring line)
	2 12B3 floats with prusek hitch
	5/16" Amsteel 2 rope, 63 m
	Stainless shackle
	Technicap PPS 3/3-24S sediment trap #39
125	motor # 09-845
	Stainless shackle
	5/16" Amsteel 2 rope; 70 m
	Stainless shackle
	150 kHz QM ADCP DR #12823
198	Ext batt case (4 BP) #2034
	Flotec M40 1500m extended frame
	Benthos 364A/EL acoustic pinger 27 kHz
	RBRXR420 CT logger #15263
	Novatech RF/Flasher:
	Swivel, galv shackles
201	SPMD (clamped to mooring line)
	5/16" Amsteel 2 rope, 125 m
	Stainless shackle
	Technicap PPS 3/3-24S sediment trap #47
	motor # 12-25
326	Stainless shackle
	5/16" Amsteel 2 rope; 125 m
	Stainless shackle
	Novatech RF/Flasher:
453	75 kHz ADCP DR #18785
	External battery case (4 BP) #2029
	Flotec M40 1500m extended frame
	Benthos 364A/EL acoustic pinger 27 kHz #47744
	RBRXR420 CT logger #15281
	Galv shackles, swivel
	5/16" Amsteel 2 rope; 125 m
	galv shackle; prusek
	16" Flotec Hard Ball (3000m)
	shackles
581	Nortek Aquadopp Current Meter AQD8418
	Aquafin instrument cage
	5/16" Amsteel 2 rope; 100 m
	Swivel, galv shackles
	1000 m ellipsoid float
	Swivel, galv shackles
682	Nortek Aquadopp Current Meter AQD2756
	Aquafin instrument cage
	shackles
	5/16" Amsteel 2 rope; 2m
	RBRXR420 CT logger #15275
	Swivel, galv shackles
	dual CART releases #33749 & 33748
	Tandem assembly
686	
	chain, D-ring 5/8-inch shackle
	10m 3/4" polysteel drop line
	~2 m chain, 7/8" shackle
700	3 train wheels



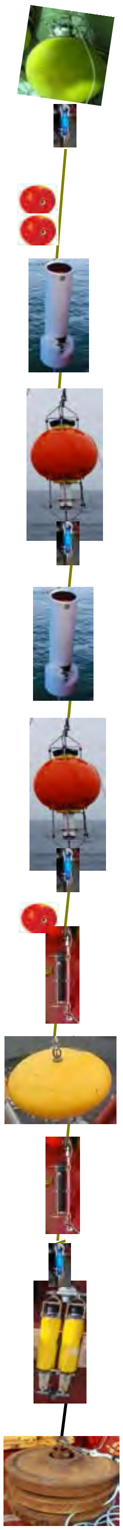
BR-1-14		Slope in Mackenzie Trough
Target Instrument Depth (m)		Instrument
60		Ice Profiling Sonar IPS5 #51105
		MSI cage
		30" MSI syntactic spherical buoy
		Benthos UAT 27kHz 47752
		RBRXR420 CT logger #15262
		Swivel, galv shackles
		2 12B3 floats with prusek hitch
		5/16" Amsteel 2 rope, 63 m
		Stainless shackle
		Technicap PPS 3/3-24S sediment trap #28 motor #07341
125		
		Stainless shackle
		5/16" Amsteel 2 rope; 75 m
		Stainless shackle
		150 kHz QM ADCP DR #12699
203		Ext batt case (4 BP) # 2032
		Flotec M40 1500m extended frame
		Benthos 364A/EL acoustic pinger 27 kHz #47747
		RBRXR420 CT logger #15279
		Novatech RF/Flasher: X06-065
		Swivel, galv shackles
		5/16" Amsteel 2 rope, 125 m
		Stainless shackle
		Technicap PPS 3/3-24S sediment trap #29 motor #1116
331		Stainless shackle
		5/16" Amsteel 2 rope; 125 m
		Stainless shackle
		Novatech RF/Flasher: X06-067
458		75 kHz ADCP DR #12943
		External battery case (4 BP) #2039
		Flotec M40 1500m extended frame
		Benthos 364A/EL acoustic pinger 27 kHz #47292
		RBRXR420 CT logger #15267
		Galv shackles, swivel
		5/16" Amsteel 2 rope; 125 m
		galv shackle; prusek
		16" Flotec Hard Ball (3000m)
		shackles
586		Nortek Aquadopp Current Meter #6270
		Aquafin instrument cage
		RBRXR420 CT logger #15268
		5/16" Amsteel 2 rope; 150 m
		shackles
		1000 m ellipsoid float
		shackles
737		Nortek Aquadopp Current Meter #8414
		Aquafin instrument cage
		shackles
		5/16" Amsteel 2 rope; 2m
		Swivel, galv shackles
		dual CART releases #35661 & 35660
		Tandem assembly
741		
		chain, D-ring 5/8-inch shackle
		10m 3/4" polysteel drop line
		~2 m chain, 7/8" shackle
755		3 train wheels

Figure 7.9. Mooring designs BRG-14, BR3-14 (previous pages) and BR1-14 (above) deployed in Western Arctic.

The shallow moorings (BRK, BR4,BR2) consisted of the following key components:

- IPS were used at approximately 60 m depth to measure ice draft. The IPS were mounted on an ASL dual cage with 8 Viny 12B3 floats;
- 300 kHz TRDI Workhorse Sentinel Acoustic Doppler Current Profiler (WHS ADCP) were used at approximately 130 to 140 m water depth to profile currents with a vertical resolution of 8 m, as well as to measure ice velocity using the Bottom-Track feature. The WHS ADCPs were mounted upward looking in 33-inch syntactic foam ellipsoid floats manufactured by MSI;
- RBR CT loggers were installed at various depths to measure water temperature and salinity and to compute sound speed (used to improve IPS and ADCP processing). In some cases CTD loggers were used on the moorings. Additionally, certain RBR loggers also have auxiliary sensors to measure turbidity, dissolved oxygen, fluorometry – chlorophyll;
- Sequoia LISST 100X laser diffraction systems were located 18 m above the seafloor to provide measurements of particle size distributions and associated volume concentrations in the lower water column. The LISST measurements will help to better quantify the seasonal and annual variability of vertical and horizontal fluxes of organic and inorganic solids;
- 1 MHz Nortek Aquadopp profiling current meters (AQP) were mounted down-looking below the LISST instrument to provide details of the flow and acoustic backscatter structure near the seafloor on the continental shelf edge. The AQP's measure three-dimensional current velocities and provide a measure of acoustic backscatter intensity in 2 m range bins from the bottom to about 16 m above seabed. Combined with the velocity profile information from upward looking ADCP's the profilers provide a detailed and complete view of the water column vertical structure;
- An additional syntactic foam ellipsoid float was located above the LISST cage to provide floatation for the lower portion of the mooring;
- Tandem acoustic releases were used as the primary recovery device.

Site BR-K-14	Shelf edge in Ajurak Area
Target Instrument Depth (m)	Instrument
60	Ice Profiling Sonar IPS5 #51108
	ASL Dual cage
	4 12B3 floats
	4 12B3 floats
	Novatech RF/Flasher #X06-061
	Benthos 27kHz UAT #47745
	1/2" galv shackle, swivel, 3 x 7/16" galv shackles
	SBE37 #12235 (clamped to mooring line below cage)
	5/16" Amsteel 2 rope; 74m
100	RBR CTD +Tu + DO titanium #10419
	1/2" shackle
136	
	300 kHz WH ADCP #2646
	Ext BC for ADCP #3835
	MSI Ellipsoid float
	MSI steel cage
	Benthos 27kHz UAT #47873
	Swivel, galv shackles
	300 m ellipsoid float
	5/16" Amsteel 2 rope; 2 m
	galv shackle
	XR420CTm+Tu+Fl+DO #22044
	LISST-100x particle analyzer #1473
	instrument frame
	galv shackles, swivel
	1 MHz Nortek Aquadopp Current Profiler AQD #11147
142	instrument cage with vane
	5/16" Amsteel 2 rope; 2 m
	Swivel, galv shackles
	dual CART releases #33738 & 33737
	Tandem assembly
	D-ring 3/4-inch shackle
	10m 3/4" polysteel drop line
	~2 m chain + 7/8" shackle
156	
	2 train wheels

BR-2-14	Shelf edge near Mackenzie Trough
Target Instrument Depth, m (159)	Instrument
60	Ice Profiling Sonar IPS5 #51106
	ASL Dual cage
	4 12B3 floats
	4 12B3 floats
	Benthos 364A/EL acoustic pinger 27 kHz #47151
	RBRduo CT logger #61551
	Novatech RF/Flasher: X06-065
	Swivel, galv shackles
	3/8" Amsteel 2 rope; 74 m
	Stainless shackle
136	Benthos 364A/EL acoustic pinger 27 kHz #47749
	300 kHz WH ADCP w/ BT #7844
	External battery case for ADCP #40037
	MSI ellipsoid float and ADCP cage
	Swivel, galv shackles
	300 m ellipsoid float
	5/16" Amsteel 2 rope; 2 m
	galv shackles
141	XR420CTm+Tu+Fl+DO #17112
	LISST-100x particle analyzer #1447
	instrument frame (estimate)
	galv shackles, swivel
142	1 MHz Nortek Aquadopp Current Profiler #9715
	instrument cage with vane
	3/8" Amsteel 2 rope; 2 m
	Swivel, galv shackles
	dual CART releases #33743 & 33740
	Tandem assembly
	D-ring 3/4-inch shackle
	10m 3/4" polysteel drop line
159	~2 m chain + shackles
	2 train wheels

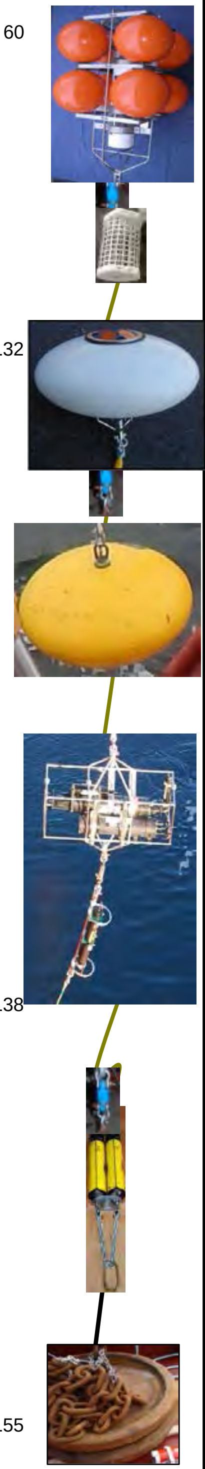
BR-4-14		Shelf edge near Banks Island
Target Instrument Depth (m)		Instrument
		
60		Ice Profiling Sonar IPS5 #51103
		8 12B3 floats
		ASL Dual cage
		Novatech RF/Flasher
		XR420CT #15274
		Benthos 27kHz UAT #45783
		1/2" galv shackle, Swivel, 7/16" galv shackles
		SPMD (on cage)
		5/16" Amsteel 2 rope; 70m
		1/2" shackle
132		
		300 kHz WH ADCP #6320 (high pressure housing)
		Ext BC for ADCP #222
		MSI ellipsoid float
		MSI steel cage
		Benthos 27kHz UAT
		Swivel, galv shackles
		300 m ellipsoid float
		5/16" Amsteel 2 rope; 2 m
		165 inches between LISST pressure and ADCP head
		galv shackle
		XR420CTm+Tu+Fl+DO #17114
		LISST-100x particle analyzer #1319
		instrument frame
		Benthos 27 kHz pinger
		galv shackles, swivel
		1 MHz Nortek Aquadopp Current Profiler #9752
138		instrument cage with vane
		5/16" Amsteel 2 rope; 2 m
		Swivel, galv shackles
		dual CART releases #33745 & 33744
		Tandem assembly
		D-ring 3/4-inch shackle
		10m 3/4" polysteel drop line
		~2 m chain + 7/8" shackle
155		
		2 train wheels

Figure 7.10. Mooring designs BRK-14, BR2-14 (previous page) and BR4-14 (above) deployed in Western Arctic during Leg 2a.

Additional Seabird Electronics SBE37 CTD loggers were mounted on moorings in the cross-shelf-slope array (BRG and BRK), at approximately 60 m for consistency with the BS1, BS2, and BS3 moorings. RBR CTDs were mounted at 100 m on BRK and at 100 m and 150 m on BRG to maintain consistency with the ArcticNet moorings.

Semi-permeable membrane devices (SPMDs) were deployed on moorings BS1 (50 m), BS2 (50, and 100 m), BS3 (50 and 200 m), BR3 (60 m), BR4 (60 and 200 m). The SPMDs are small passive water samplers that clamp directly to the mooring line or instrument cage. The goal of the SPMDs was to monitor concentrations of persistent organic pollutants (POPs) in the mixed surface layer (Pacific water mass and the deep Atlantic waters).

7.3.2 Field calibrations

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. Therefore, it was important to calibrate internal compasses near the approximate latitude where they were deployed and care was taken to eliminate all ferrous material in the mooring cages and in the calibration environment. A list of oceanographic equipment that contains internal compasses can be found in Table 7.4.

Calibration of the RDI LR/QM ADCPs was performed in 2013 in Inuvik, NT by IMG-Golder and the calibration of the RDI WHS ADCPs was performed in 2014 in Kugluktuk, NWT by IMG-Golder. For further information on the 2013 calibration procedure, please refer to the 2013 ArcticNet Mooring Report.

The 2014 compass calibrations, prior to vessel departure, required that all Nortek devices were sent back to the factory (Norway) for inspection and recalibration. The inspection and recalibration were needed on short notice due to compass error discrepancies between factory and field calibrated units.

Prior to 2014 mooring deployments, a compass calibration of the remaining RDI Sentinel ADCPs was completed in a public baseball field in the hamlet of Kugluktuk, NWT on August 13, 2014 by two IMG-Golder personnel. The calibration was conducted with a tilt and rotate jig (Figure 7.8). The calibration procedures followed standard manufacturer protocols for each instrument.

<u>RDI ADCP Field Calibration Procedure</u>

ADCP calibrations were conducted with a leveled tilt and rotate jig / table. The calibration procedures followed standard manufacturer protocols for each instrument (Table 7.4). The general calibration procedure is briefly described below:

- Communication was established with the instrument using the manufacturer's (RDI BBtalk) calibration software over a RS-232 serial communication line;

- Power was provided to the instrument by an external adapter powered by a portable battery pack / battery charger with a 120 VAC outlet;
- The current meters were oriented in the configuration in which they would be deployed (facing Up);
- The calibration table was rotated in 10° increments, through 360 degrees, having recorded the varying degrees of pitch, roll and heading relative to true north, until a successful (< 5° compass error) calibration was achieved.

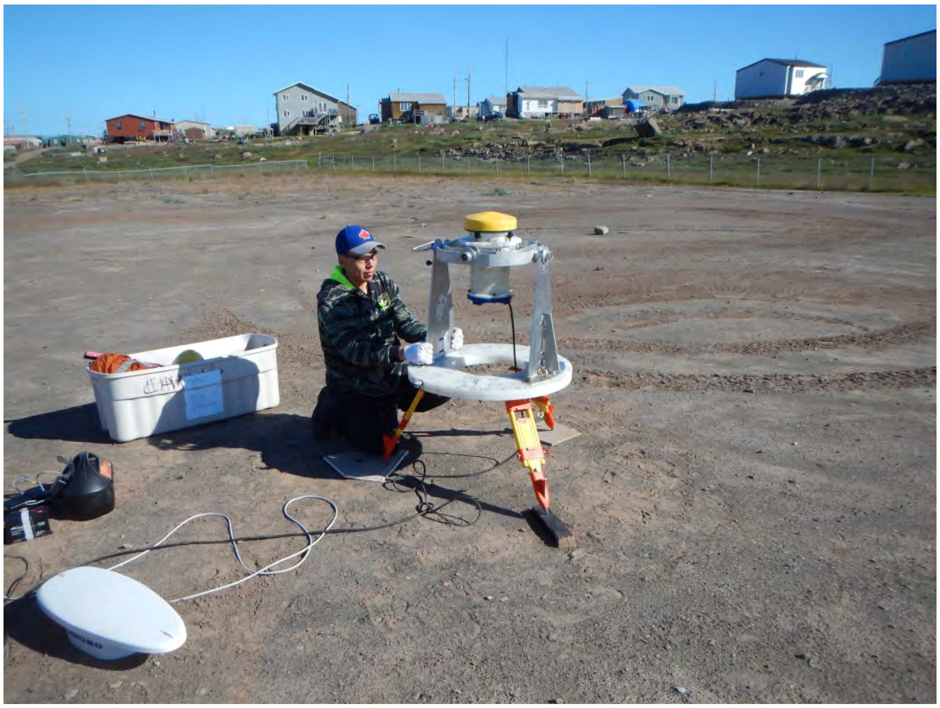
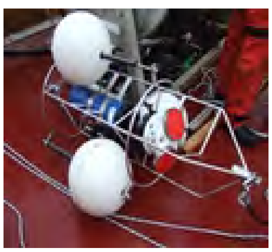


Figure 7.11. Tilt and rotate calibration jig / table as utilized for Kugluktuk, NWT calibrations, 2014. Image courtesy of IMG-Golder.

A Furuno SC-30 Satellite Compass was used to determine true North based on two internal GPS antennas (Figure 7.11). Compass calibrations were verified by rotating the current meter through 360 degrees and measuring the headings corrected for magnetic declination at each 10 degree increments and comparing these against the true North measurements from the satellite compass.

Table 7.4. Oceanographic equipment that required compass calibration, including calibration procedures.

Equipment	Location	Purpose	Equipment Used	Calibration Procedure
Nortek Aquadopp 	Nortek Factory, Norway (2014)	Single-Point water velocity profiler	None	Nortek software does not correct compass bias for soft iron effects. The hard iron effects are negligible for the BREA project due to non-magnetic frame designs and lithium batteries ~50cm away from the transducer heads; thereby, negating hard-iron effects and removing the need to perform hard-iron calibrations on these devices.
Nortek Continental 190 / 470 kHz ADCP 	Nortek Factory, Norway (2014)	3 beam - 3D water velocity profiler	None	Nortek software does not correct compass bias for soft iron effects. The hard iron effects are negligible for the BREA project due to non-magnetic frame designs and lithium batteries ~50cm away from the transducer heads; thereby, negating hard-iron effects and removing the need to perform hard-iron calibrations on these devices.
RDI 75 /150 kHz Long ranger / Quarter Master ADCP 	Inuvik, NT (2013)	4 beam 3D water velocity profiler, with bottom tracking	Calibration Table / Jig, Laptop with WinSC installed, USB to Serial adapter	Install into calibration table, point to 0 heading and open WinSC software, 'test' unit to verify all tests pass, set unit to zero pressure, set unit to UTC, verify compass, calibrate compass using af command, record the heading deviation by using pc2 to view the heading of the ADCP relative to the calibration table heading, measured at 10° intervals.
RDI 300 kHz Work Horse Sentinel ADCP 	Kugluktuk, NWT (2014)	4 beam 3D water velocity profiler, with bottom tracking	Calibration Table / Jig, Laptop with WinSC installed, USB to Serial adapter	Install into calibration table, point to 0 heading and open WinSC software, 'test' unit to verify all tests pass, set unit to zero pressure, set unit to UTC, verify compass, calibrate compass using af command, record the heading deviation by using pc2 to view the heading of the ADCP relative to the calibration table heading, measured at 10° intervals.

Calibration Problems

All Nortek equipment was calibrated at the Nortek factory two weeks prior to the CCGS *Amundsen*'s Québec city departure, due to a discovery of compass calibration errors within the Nortek equipment and a deficiency within Nortek's calibration subroutine (June-July, 2014).

7.3.3 Health and Safety

All scientific personnel used Survitec Group immersion suits for transfers to and from the CCGS *Amundsen*. ArcticNet provided Survitec Group immersion suits for personnel transfers and advised that all mission participants needing to complete a helicopter ditching survival course provided by Survival systems (Dartmouth, NS, Canada). A safety briefing was conducted prior to boarding the helicopter in Kugluktuk, NWT and again onboard the *Amundsen* prior to transfer from the ship. The mooring team also attended the *Amundsen* safety briefing and familiarization onboard the ship and participated in the fire drill.

7.3.4 Mooring Operations Safety Documents

A Job Safety Assessment (JSA) / ÉPST (French version of JSA) concerning mooring operations was completed and made available to all crew members. The JSA identified potential risks and hazards involved in mooring operations. The JSA was approved by the ArcticNet Scientific operations supervisor (Keith Levesque). The JSA was also completed following the Canadian Coast Guard template and was made available to all crew members; however, it contained the same information as the JSA.

In addition to completing a JSA, a mooring operations familiarization presentation was presented (in French by the Mooring Team Leader – Shawn Meredyk) to all of the relevant crew members (Captain, Boatswain, Chief Officer, deckhands) several days before deployment operations commenced.

A 'Toolbox' meeting (mini pre-deployment meetings) was also held ~5 min before deployment operations began. The 'toolbox' meeting identified the risks, roles and responsibilities required during mooring deployment operations. The 'toolbox' is an essential step within mooring operations and creates a safe working environment for all involved.

7.3.5 Mooring operations

Mooring deployment

All nine moorings (BS1, 2, 3; BR-1, 2, 3, 4, K, G) were successfully deployed at their planned locations and very near their proposed depths (Table 7.5).

Table 7.5. Mooring deployment summary.

Leg	Mooring ID	Latitude (N)	Longitude (W)	Depth (m)
2a	BS1	70°48.647	134°51.037	81.2
2a	BRK	70°51.747	135°01.198	152.3
2a	BS2	70°52.874	134°05.667	299.7
2a	BS3	70°55.556	135°14.147	498.2
2a	BRG	71°00.128	135°30.565	705.0
2a	BR4	73°13.240	127°02.885	153.8
2a	BR3	73°24.516	129°21.390	702.2
2a	BR2	69°59.733	137°58.612	157.1
2a	BR1	70°25.909	139°01.370	754.1

7.3.6 Mooring deployment procedure

- Program and mount instruments into respective frames / floats;
- Verify Mooring releases function properly;
- Assemble the mooring Top-down on the fore-deck as per mooring design;
- Confirm / double check mooring Equipment attachments;
- Toolbox meeting with Mooring and Ship's mooring crew to identify roles and safety considerations (Zodiac® deployed as needed);
- Launch Zodiac® (if needed);
- Record date and time at the start of mooring operations by a fourth mooring team member, stationed on the bridge;
- Attach a throw-line to top metal loop of the top float and secure the SeaCatch® (connected to the bottom of the frame, using the 500hp winch line), paying attention to the release arm of the SeaCatch® so that it is free to lift up and outward without restriction;
- Throw the throw-line to the Zodiac and have the Zodiac attach the throw-line to the bow horn / tack;
- The mooring line is then tacked / secured and the Zodiac is then instructed to maintain a taught-line (not tight), unless otherwise instructed by the lead mooring professional / chief officer;
- Raise the top float off the deck and extend the A-frame, undoing the mooring line tack before the instrument reaches the deck edge;
- Descend the instrument and release the safety pin of the SeaCatch®, at deck level, then subsequently releasing the SeaCatch® and top float at the water surface. *Depending on wave conditions, timing of SeaCatch® release may need to be timed with a lull in wave period;

- The SeaCatch® is then brought back to the deck level (A-frame brought back in at the same time) and attached to the next solid structure (i.e. cage), pearl link / d-ring (added to the top-side of next device to be lifted);
- Pay-out the mooring line until there is 10-30m remaining (30m is advisable for rough seas). Then put the mooring line on-tack;
- The next instrument is then raised by the 500hp winch wire as the mooring line in-tack is released;
- The same procedure of lowering the device to the water then putting the mooring line on tack, then attaching the SeaCatch® to the top-side of the next device follows until each device is in the water. Meanwhile, the Zodiac continues to maintain a taught-line, so as to not allow for the deployed / in-water equipment to get entangled;
- The final release of the anchor is preceded by the Zodiac releasing its tack of the top float (trying to retain its tack line, or at least a good portion of it) and the chief officer confirms the tagline release from the Zodiac and confirmation that the vessel is at the desired depth / position;
- The SeaCatch® on the Anchor chain shackle (located in the middle of the 2m anchor chain, just above the protective chain cylinder) is then released and the mooring free-falls into position;
- The Zodiac® and 4th team member on the bridge then marks the time and mooring / target location of the last seen vertical position of the top float on-descent;
- The Zodiac® returns to the vessel and the A-frame and 500hp winch are stopped and secured;
- The vessel then proceeds to 3 triangulation points ~100m around the target location and verification of acoustic release communications through ranging / 'pinging' allow for the anchor position to be calculated. These data will then be input into a MatLab® triangulation script to determine the triangulated position of the mooring and kept within the field deployment sheets (Figure 7.12);
- Multibeam survey is performed to confirm the orientation and position of the mooring. Depending on the vessel's proximity to the mooring line, equipment and top-float depths might be visible if the vessel travels directly over-top the mooring. The multibeam images for each mooring deployment are kept within the field deployment workbook (EXCEL) and also archived at ArcticNet (Figure 7.13);
- A post-deployment CTD cast / profile needs to be taken, though pre-deployment cast is sufficient if the CTD-Rosette is programmed to take several water samples at the same time as profiling the water column. The CTD profile plots for each mooring are kept within the field deployment workbook (EXCEL) and also archived at ArcticNet (Figure 7.14);
- The fore deck is cleaned of debris and remaining mooring equipment / cages are secured on the foredeck.

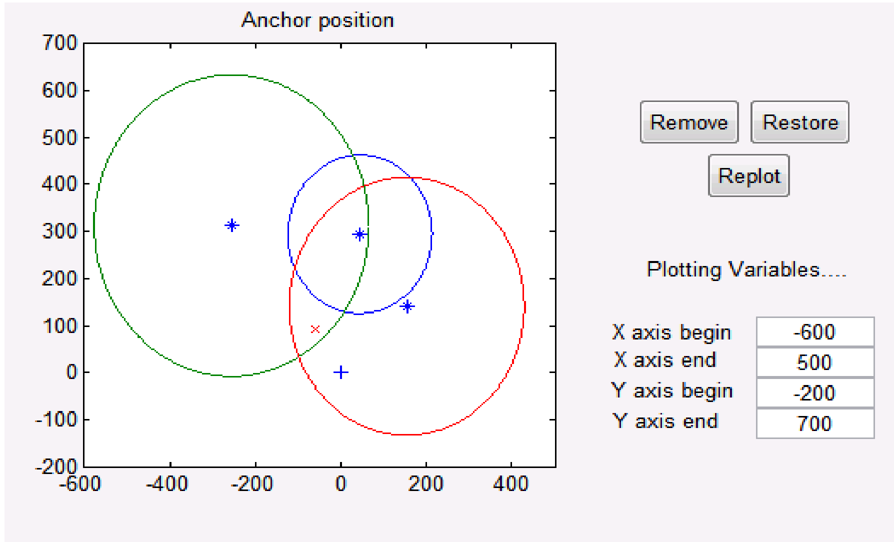


Figure 7.12. Triangulation plot from BS1-14 using Art's Acoustic Survey Matlab Script.

Figure 7.13. Multibeam imagery identifying orientation and instrument depths (screenshot courtesy of ArcticNet multibeam processing team).

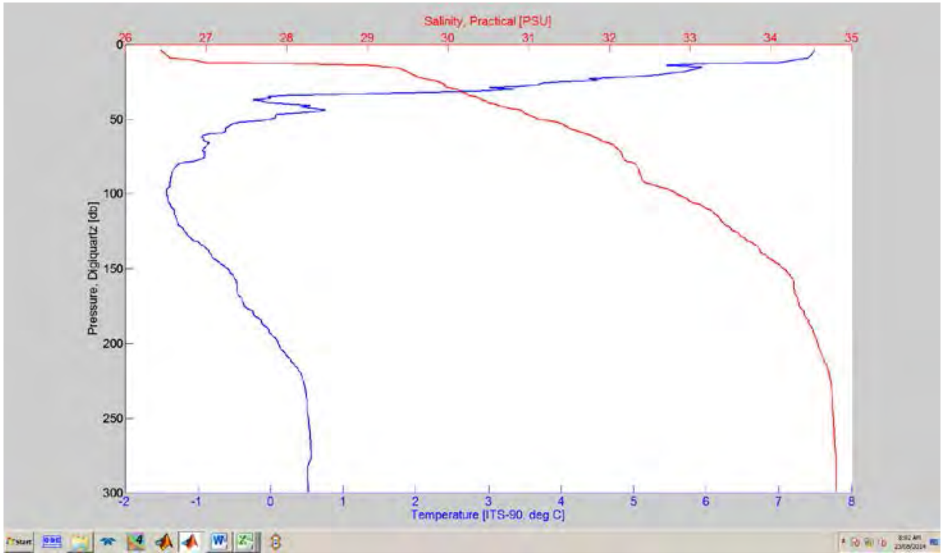


Figure 7.14. Rosette Temperature - Salinity profile example plot (BS2-14).

7.3.7 Mooring Deployment Instrumentation Setup/Programming

Before programming and deploying the instruments on the moorings, standard manufacturer procedures and pre-deployment tests were followed to provide verification of instrument operation.

Prior to deployment of the LISST-100X on moorings BR-K-14, BR-2-14, and BR-4-14 background scattering measurements were obtained using the test chamber and de-ionized water. The windows of the optics were cleaned using a mild soap solution per manufacturer specification. Obtaining a background scattering measurement prior to instrument deployment is critical for good instrument performance and is used to check the overall health of the instrument. The LISST-100X uses the technique of laser diffraction to obtain a particle size- distribution (PSD) and a concentration by volume distribution for each size fraction. It records the scattering intensity over 32 ring-detectors whose radii increase logarithmically. This measurement is known as the volume scattering function and is subsequently inverted mathematically to produce the PSD. The background scattering is subtracted from measured data to obtain a true measurement of the light scattered from particles.

7.4 Methodology – JAMSTEC mooring operations

Barrow Canyon mooring array consists of three moorings (BCE, BCC and BCW). Northwind Abyssal Plain mooring array consists of two mooring locations (NAP-12, NAP-13) and Chukchi Abyssal Plain mooring (CAP-12). See Table 7.6 for the full list of JAMSTEC mooring details.

Table 7.6. JAMSTEC mooring details.

Mooring ID	Latitude (N)	Longitude (W)	Depth (m)	Operations
BCW-13	71°47.742	155°20.750	170	Recover + Deploy
BCC-13	71°42.585	155°11.108	283	Recover + Deploy
BCE-13	71°40.353	154°59.742	106	Recover + Deploy
NAP-12	75°00.170	162°00.180	1975	Recover + Deploy
NAP-13	74°36.110	161°55.590	1681	Recover
CAP-12	75°12.370	172°32.920	1975	Recover

Figure 7.15 outlines the expedition plan for the 2014 Leg 2b operations (Leg 2b activities started in Barrow, Alaska, USA, August 14th, 2014).

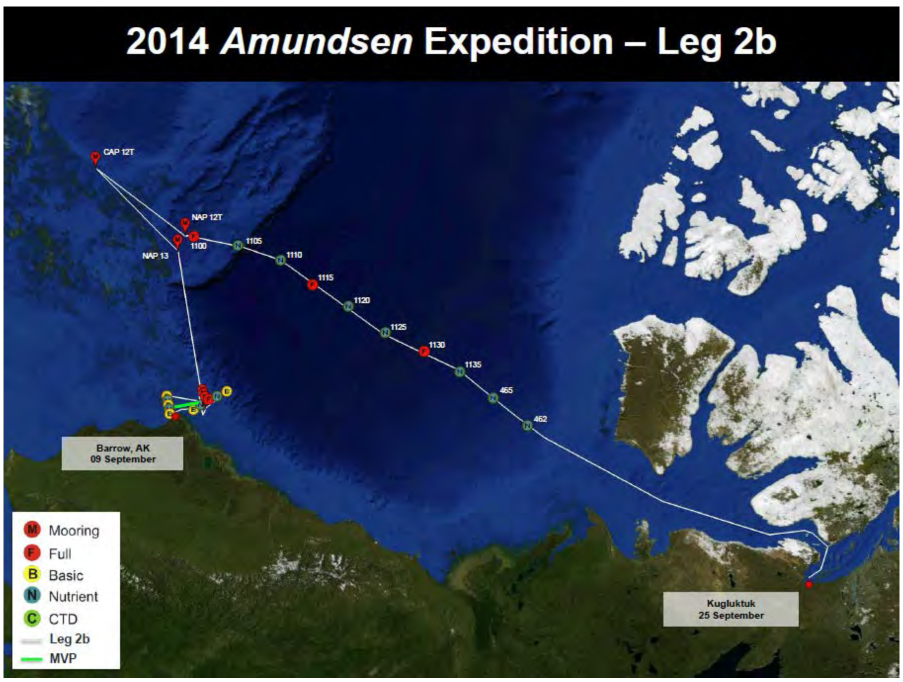


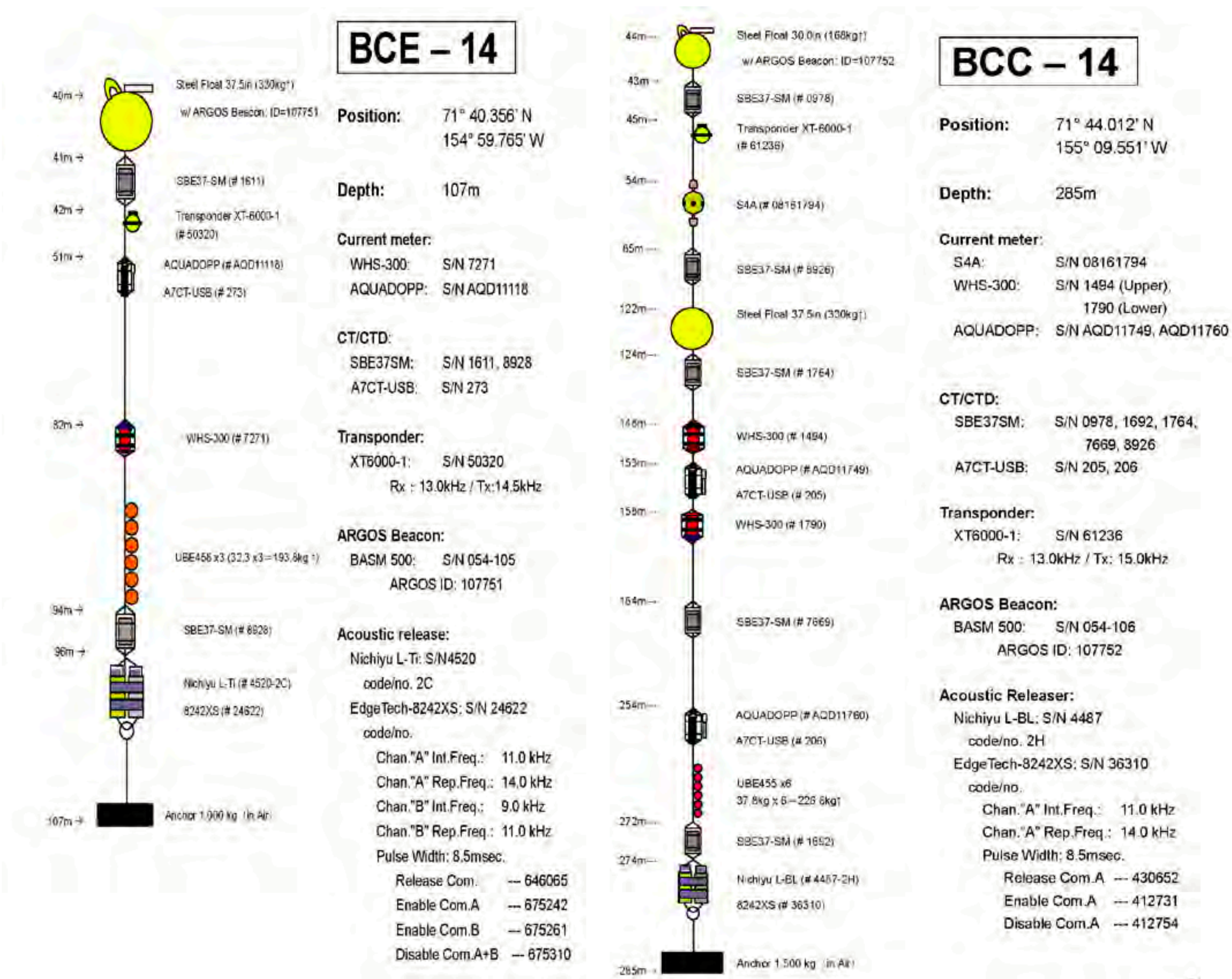
Figure 7.15. 2014 ArcticNet Leg 2b operations plan.

7.4.1 Mooring design and instrumentation

The JAMSTEC Barrow Canyon moorings were generally designed to be of taut-line configuration consisting of a top float (~40m depth);

- Top float with ARGOS Beacon;
- SBE37 - Conductivity, Temperature and Depth (CTD) probe to record water characteristics;
- Benthos Transponder XT-6000-1 for tracking;
- S4A current meter (current speed at ~50 m);
- SBE37 - Conductivity, Temperature and Depth (CTD);
- In-line floatation, to balance the weight/ float balance throughout the mooring line;

- ADCP 300 kHz, recoding water profile to surface;
- Nortek Aquadopp current meter;
- ADCP 300 kHz, recoding water profile to bottom;
- SBE37 - Conductivity, Temperature and Depth (CTD);
- Nortek Aquadopp current meter;
- JFE-ALEC A7CT-USB – conductivity, Temperature;
- Releaser Buoyancy (6 – ‘mickey mouse’ floats with 2 x3m chain sections);
- Tandem mooring releases (8242XS + Nichiyu L-BL);
- Anchor (three to four train wheels).



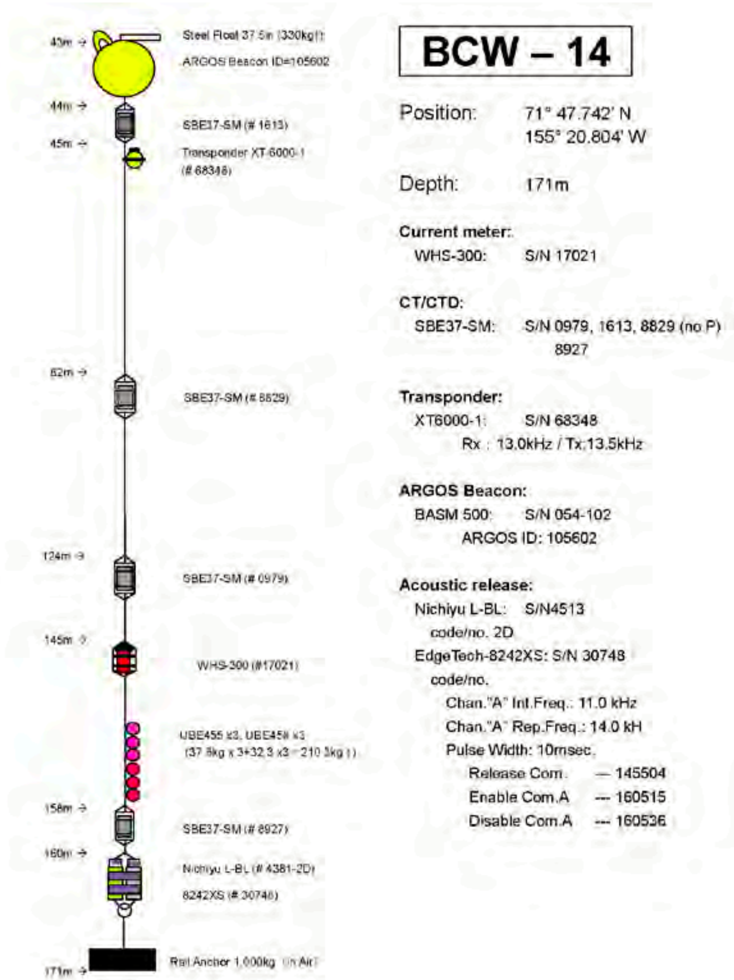


Figure 7.16. Mooring designs BCE-14, BCC-14 (previous page) and BCW-14 (above) deployed in Barrow Canyon during Leg 2b.

The JAMSTEC Abyssal Plains moorings were generally designed to be of taut-line configuration consisting of a top float (~38 m depth),

- Ice profiler (IPS5) in ASL IPS5 donut float, to image ice keels;
- SBE37 - Conductivity, Temperature and Depth (CTD) probe to record water characteristics;
- Benthos Transponder XT-6000-13” for tracking;
- 5 x Benthos glass floats (~50 m);
- ADCP 300 kHz, recoding water profile to surface;
- 5 x Benthos glass floats;
- 5 x Benthos glass floats;
- SeaGuard CT,pH,EXO sensors;
- Nichiyu Sediment Trap with CT and camera;
- S4A current meter;
- 5 x Benthos glass floats;
- Nichiyu Sediment Trap with CT;

- 5 x Benthos glass floats;
- Tandem mooring releases (865A and Nichiyu);
- Anchor (three train wheels).

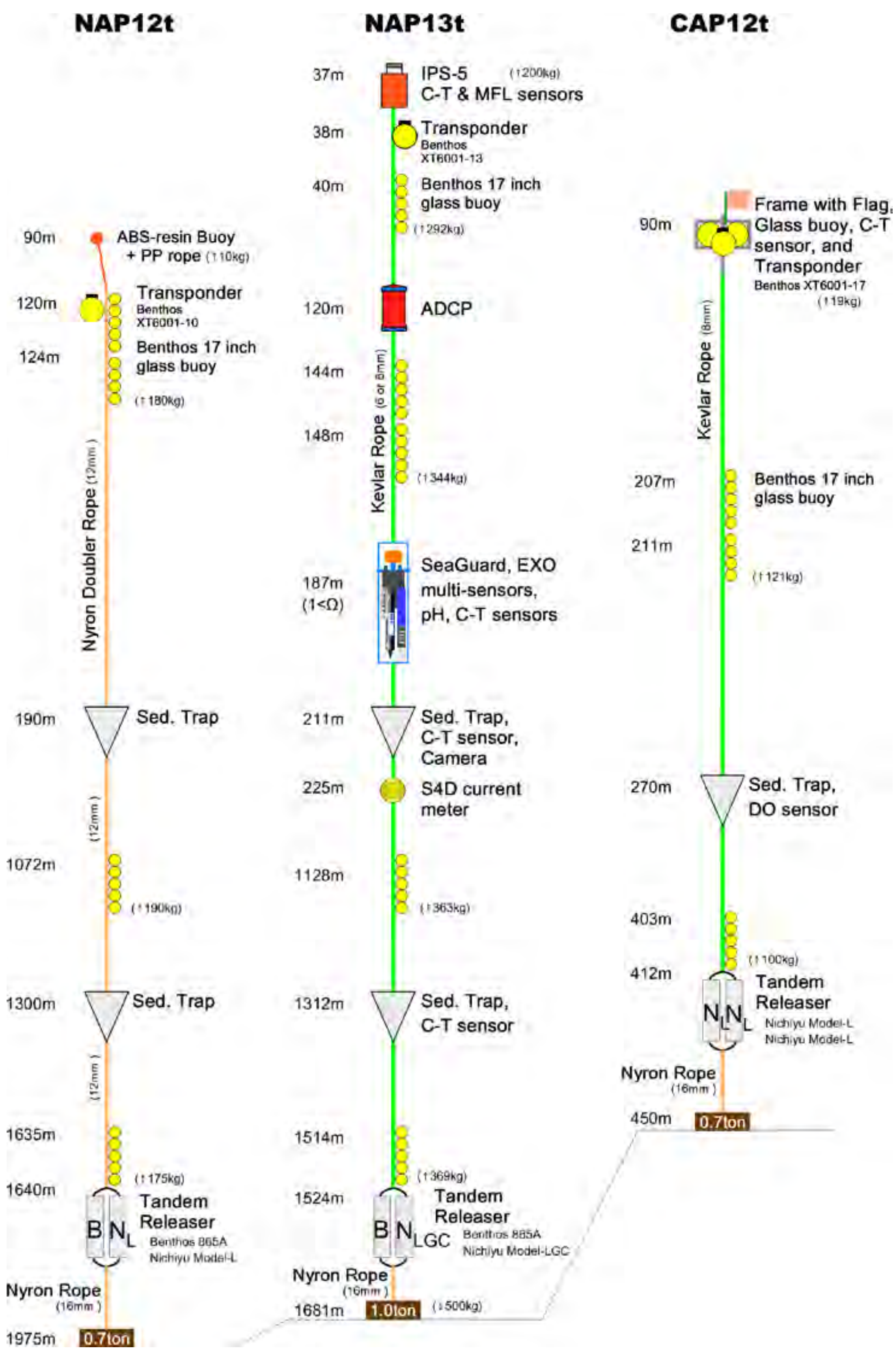
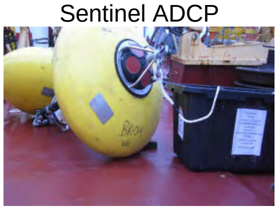


Figure 7.17. Mooring designs NAP12t, NAP13t and CAP12t deployed in Abyssal Plains.

7.4.2 Field calibrations

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. However, the JAMSTEC ADCPs were not field calibrated, but a compass calibration of the RDI Sentinel ADCPs was completed by JAMSTEC, at JAMSTEC, Japan. A list of oceanographic equipment that contains internal compasses can be found in Table 7.7.

Table 7.7 Oceanographic equipment that required compass calibration, including calibration procedures.

Equipment	Location	Purpose	Equipment Used	Calibration Procedure
Nortek Aquadopp 	Nortek Factory, Norway (2014)	Single-Point water velocity profiler	None	Nortek software does not correct compass bias for soft iron effects A hard-iron calibration was done at JAMSTEC, Japan before mobilization.
RDI 300 kHz Work Horse Sentinel ADCP 	Tokyo, Japan (2014)	4 beam 3D water velocity profiler, with bottom tracking	None	JAMSTEC calibration procedure unknown, but ADCPs were calibrated by JAMSTEC at JAMSTEC, before being shipped to Québec city, June 2014.

7.4.3 Calibration problems

JAMSTEC equipment was calibrated at JAMSTEC (Japan) before shipping to Québec City, June 2014. JAMSTEC calibration procedures are unknown.

7.4.4 Health and Safety

All scientific personnel used Survitec Group immersion suits for transfers to and from the CCGS *Amundsen*. ArcticNet provided Survitec Group immersion suits for personnel transfers and advised that all mission participants needing to complete a helicopter ditching survival course provided by Survival systems (Dartmouth, NS, Canada). A safety briefing was conducted prior to boarding the helicopter in Kugluktuk, NWT and again onboard the *Amundsen* prior to transfer from the ship. The mooring team also attended the *Amundsen* safety briefing and familiarization onboard the ship.

7.4.5 Mooring operations safety documents

A Job Safety Assessment (JSA) / ÉPST (French version of JSA) concerning mooring operations was completed and made available to all crew members. The JSA identified potential risks and hazards involved in mooring operations. The JSA was approved by the ArcticNet Scientific operations supervisor (Keith Levesque). JSA was also completed following the Canadian Coast Guard template and was made available to all crew members; however, it contained the same information as the JSA.

In addition to completing a JSA, a mooring operations familiarization presentation was presented (In English by the Mooring Team Leader – Shawn Meredyk) to all of the relevant crew members (Captain, Boatswain, Chief Officer, deckhands, JAMSTEC) the day before recovery and deployment operations commenced.

A 'Toolbox' meeting (mini pre-deployment meetings) was also held ~5min before mooring operations began. The 'toolbox' meeting identified the risks, roles and responsibilities required during mooring deployment operations. The 'toolbox' is an essential step within mooring operations and creates a safe working environment for all involved.

7.4.6 Mooring operations

Mooring deployment

Three out of four planned mooring deployments (BCW, BCC, BCE) were successfully deployed in their planned locations and very near their proposed depths (Table 7.8). Mooring NAP-14 was not able to be deployed due to persistent adverse weather conditions (3-4m swell, 30-40 knts Easterly winds). For a full record of the mooring deployment plans see Appendix 1.

Moorings BCW and BCE were able to use the Zodiac for deployment were as BCC recovery was done by grappling from the front deck and BCC deployment was done without the Zodiac, due to adverse weather.

Rough weather throughout the Barrow Canyon and Abyssal Plains (Chukchi and Northwind) waters made for very difficult mooring operations. Mooring operations were further made difficult because the JAMSTEC mooring designs had short inter-instrument spacing (for the Amundsen A-frame), and made tacking very hard and therefore, high line tensions made for sensitive (potentially dangerous) handling maneuvers. With that being said, mooring operations went well and this was a testament to effective planning, information dissemination, organization and experience.

Table 7.8. Mooring deployment summary.

Leg	Mooring ID	Latitude (N)	Longitude (W)	Depth (m)
2b	BCW-14	71°47.742	155°20.750	170
2b	BCC-14	71°42.585	155°11.108	283
2b	BCE-14	71°40.353	154°59.742	106

7.4.7 Mooring deployment procedure

- Instruments programmed and mounted into respective frames / floats;
- Verify Mooring releases function properly;
- Assemble the mooring Top-down on the fore-deck as per mooring design;
- Mooring Equipment attachments confirmed / double checked;
- Toolbox meeting with Mooring and Ship's mooring crew to identify roles and safety considerations (Zodiac® deployed as needed);
- Launch Zodiac® (if needed);
- Date and Time are recorded for the start of mooring operations by a fourth mooring team member, stationed on the bridge;
- Attach a throw-line to top metal loop of the top float and secure the SeaCatch® (connected to the bottom of the frame, using the 500hp winch line), paying attention to the release arm of the SeaCatch® so that it is free to lift up and outward without restriction;
- Throw the throw-line to the Zodiac and have the Zodiac attach the throw-line to the bow horn / tack;
- The mooring line is then tacked / secured and the Zodiac is then instructed to maintain a taught-line (not tight), unless otherwise instructed by the lead mooring professional / chief officer;
- Raise the top float off the deck and extend the A-frame, undoing the mooring line tack before the instrument reaches the deck edge;
- Descend the instrument and release the safety pin of the SeaCatch®, at deck level, then subsequently releasing the SeaCatch® and top float at the water surface. *Depending on wave conditions, timing of SeaCatch® release may need to be timed with a lull in wave period;
- The SeaCatch® is then brought back to the deck level (A-frame brought back in at the same time) and attached to the next solid structure (i.e. cage), pearl link / d-ring (added to the top-side of next device to be lifted);
- Pay-out the mooring line until there is 10-30m remaining (30m is advisable for rough seas). Then put the mooring line on-tack;
- The next instrument is then raised by the 500hp winch wire as the mooring line in-tack is released;
- The same procedure of lowering the device to the water then putting the mooring line on tack, then attaching the SeaCatch® to the top-side of the next device follows until each device is in the water. Meanwhile, the Zodiac continues to maintain a taught-line, so as to not allow for the deployed / in-water equipment to get entangled;
- The final release of the anchor is preceded by the Zodiac releasing its tack of the top float (trying to retain its tack line, or at least a good portion of it) and the chief officer confirms the tagline release from the Zodiac and confirmation that the vessel is at the desired depth / position;

- The SeaCatch® on the Anchor chain shackle (located in the middle of the 2m anchor chain, just above the protective chain cylinder) is then released and the mooring free-falls into position;
- The Zodiac® and 4th team member on the bridge then marks the time and mooring / target location of the last seen vertical position of the top float on-descent;
- The Zodiac® returns to the vessel and the A-frame and 500hp winch are stopped and secured;
- The acoustic releases are interrogated to assure that the mooring is in-place, up-right and releases are functional at-depth;
- The fore deck is cleaned of debris and remaining mooring equipment / cages are secured on the foredeck.

7.4.8 Mooring Deployment Instrumentation Setup/Programming

JAMSTEC mooring team had pre-programmed their instruments during mobilization in Québec city and ArcticNet was not privy to their programming information.

7.4.9 Mooring Recovery

All six moorings (BCW, BCC, BCE, NAP-12, NAP-13, CAP-12) were successfully recovered in their planned locations (Table 7.9).

Moorings BCW and BCE were able to use the Zodiac for recovery were as BCC recovery was done by grappling from the front deck after grappling for the mooring for the better part of an entire day.

Rough weather throughout the Barrow Canyon waters made for very difficult mooring operations. Mooring operations were further made difficult because the JAMSTEC mooring designs had short inter-instrument spacing, this made tacking very hard and therefore, high line tensions made for sensitive (potentially dangerous) handling maneuvers. Line-line junctions are weak-links in mooring designs and made for troublesome handling (shackles would get stuck going through small pulley on cabestan) with a deck-mounted tack. Shackle-ring-shackle junctions within the JAMSTEC designs provided good points of contact for attaching the winch wires. Mooring operations went well, however this was a testament to effective planning, information dissemination, organization and experience.

Table 7.9. Mooring recovery summary.

Leg	Mooring ID	Latitude (N)	Longitude (W)	Depth (m)
2b	BCW-13	71°47.742	155°20.750	170
2b	BCC-13	71°42.585	155°11.108	283
2b	BCE-13	71°40.353	154°59.742	106
2b	NAP-13	74°31.361	161°55.592	1681
2b	NAP-12	75°00.171	162°00.182	1975
2b	CAP-12	75°12.371	172°32.919	447

7.4.10 Mooring recovery procedure

- A multibeam pass over-top the mooring location was performed to verify the presence of the mooring before releasing the mooring (Figure 7.18);
- Acoustic releases are activated once vessel is within a couple hundred meters of the mooring position;
- Toolbox meeting with Mooring and ship's mooring crew to identify roles and safety considerations (Zodiac® deployed if possible);
- Launch Zodiac® (if possible);
- Zodiac® attaches towing line to a buoy or cage on the surface;
- A-frame is payed-out and cabestan cable (with quick release hook) is lowered;
- Cabestan cable is connected to the buoy or frame of a cage;
- Cabestan cable lifts-up equipment just above deck-level and the 2.5T cable hook is connected to another frame or line-line junction (D-ring / Pear link is ideal);
- A-frame pays-in and cabestan cable is lowered to put tension on 2.5T cable and to allow for the first pieces of equipment to be taken off from the mooring line;
- The cabestan cable is then connected to the remaining mooring line at or below the junction of the 2.5T connection;
- The cabestan cable is lifted to remove the tension from the 2.5T cable and the cabestan starts to roll mooring line onto the cabestan;
- When the next equipment comes to deck level, the 2.5T hook is attached to a solid frame / chain / link underneath the hoisted equipment(s);
- The 2.5T cable is lifted to release tension from the cabestan hook and the next set of equipment is removed from the mooring line;
- Steps 7-12 are repeated until releases are onboard;
- The Zodiac® returns to the vessel and the A-frame and 500hp winch are stopped and secured;
- The fore deck is cleaned of debris and remaining mooring equipment / cages are secured on the foredeck;
- CTD profile of the water column is performed using the rosette.

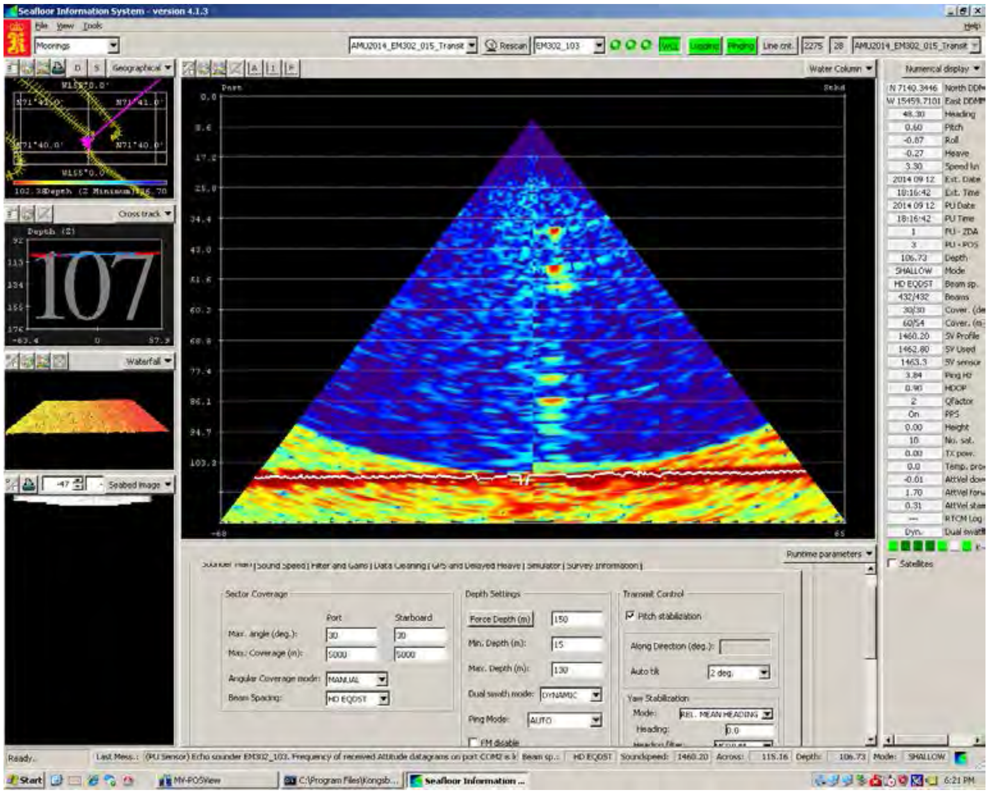


Figure 7.18. BCE-13 Pre-Recovery Multibeam Imagery.

7.5 Comments and recommendations

7.5.1 Hudson Bay mooring operations (BaySys)

Table 7.10. Summary table of lessons learned throughout the mission.

Problem	Solution	Operation
Rough seas	If the Zodiac can't be deployed, then mooring operations are cancelled	Mooring
Mooring design for one vessel makes it difficult to recover or deploy with any other vessel	Design moorings to be deployed or recovered by several different boat types	Mooring
Unsafe line handling in unsafe seas caused by large waves and large swell lead to slack-taught line situations that induce incredibly high tension on the mooring line	Include Chicago / bull grip and open pulley within the tools sent to said-boat, to have an effective method in securing the mooring line to a tack-point or crane	Mooring
Top float not recovered first and hooking into the large instrument hooks was difficult. Thereby, making rope attachments difficult and dangerous (slack and then extreme tension) due to rough seas (taking waves broadside)	Have a crew that is experienced in oceanographic mooring recovery. Have an open pully. Take the top float first. Use a Chicago grip to maintain tension while removing instruments. Have 4 tag line son crane hook. Don't try to recover mooring in rough seas.	Mooring

7.5.2 BREA mooring operations

Table 7.11. Summary table of lessons learned throughout the mission.

Problem	Solution	Operation
Shallow Moorings such as BR-4 and BR-2 are hard to deploy because the bottom instruments are too closely positioned to one another	Changing the 2m sections between the elliptical float and the 300 kHz WHS ADCP to a 5 or 10m section of Kevlar would allow for safer deployments.	Deployment
ArcticNet Mooring Designs from 2013 didn't factor-in the length of the instrument frames and the top float depths were not exactly as expected	Adjusted the lowest most Kevlar section (usually 15m) to be a 5m section.	Deployment
Aural and Technicap batteries were missing due to improper labeling or not enough batteries were brought on-board	Diligence in labeling is needed and one central location of batteries needed for the mission is needed (acoustic well cabinet is the proposed location for 2015).	Preparation
Deckhand needs to help with lowering down of the acoustic release for some moorings and needs to wear a harness	One designated deckhand wears a fall-arrest harness.	Deployment
Forward deck clutter / safety hazards concerning long lengths of rope for moorings	Splay Kevlar rope into Rubbermaid containers to reduce deck clutter and increase deployment safety.	Deployment
Sediment trap safety line that is too long can get tangled-up on the sediment trap and adjoining sensors	Reduce the length of the sediment trap safety line and apply a few wraps of black tape to the surplus safety line and attach it to the main mooring line.	Deployment
SPMDs are very sensitive to petrochemicals, i.e. black tape, and attaching the units to the mooring line can contaminate the gel matrix	Use recommended Hockey sock tape (chemical free) for on-line deployments or use ADCP cage frame (1/2" hole within the attaching clamps will be needed for ADCP frames).	Deployment

Golden Corporation identified several recommendations from work on the *Amundsen* during the 2014 BREA Program that could be applied to the improvement of future mooring deployments and recoveries:

- Sediment traps required extra care during deployment to replace anodes in the sediment trap and remove different metals, which may be in contact. Shackle corrosion may result in mooring line separation and loss of instruments. Safety lines were employed on stainless shackle combinations with all sediment traps in 2014. It is important that the safety line be kept "tidy"; during one mooring deployment the safety line became entangled with the trap complicating the deployment process.
- It is recommended that the Seacatch quick release on the ship should be sent to the manufacturer for inspection and maintenance. Based on IMG-Golder's previous experience the manufacturer recommends sending the quick release for inspection every few years to ensure it is in proper working order and prevent a failure of the device. Failure can occur due to wear of parts.
- The string of floats and cages on the shallow moorings (BR-2, BR-4, and BR-K) was difficult to deploy due to the length relative to the height of the A-frame on the Amundsen. Consider making modifications to the mooring design to space the components so they can be lifted more easily to account for the 5 m height of the A-frame on the Amundsen. For example, a line could be added above the 300 m ellipsoid float; the drawback would be an increased gap in current measurements in the water column.

- Additional improvements that would make the moorings more robust in terms of survival, in terms of corrosion mitigation could be done, as well as modifying sampling strategies and power packs to last 2 years instead of 1 year, if required. Tandem ORE CART releases could be replaced with ORE PORT releases which have a battery life of 2 years and less stainless hardware that is subject to corrosion. Non-similar metal parts can be isolated from one another and high quality marine anodes can continue to be employed in sufficient quantity. This is particularly important for BR-3 and BR-4 moorings that might pose challenges for future recovery operations, as they are located in ice-infested waters of northwest Banks Island.

7.5.3 JAMSTEC mooring operations

Table 7.12. Summary table of lessons learned throughout the mission.

Problem	Solution	Operation
Rough Weather, no Zodiac and short inter-instrument lengths made for difficult mooring operations	Design moorings with the knowledge of ship specific limitations (rarely a viable possibility); place longer inter-instrument rope lengths (allows for inter-instrument tacking (safety concern) in rough weather)	Deployment and Recovery
'Mickey-Mouse' floats getting entangled (safety concern)	Don't use these floats (Eddy Grip or large ORE float solution would be better)	Deployment and Recovery
Rough Weather decreases safety of mooring operations	Be tentative to the sea state (25 Knts-30 Knts winds) for one day is fine, but after several days the swell increases from 1-1.5m (manageable) to ~3m (unsafe). If the conditions are unsafe for a Zodiac, they are borderline-safe for mooring operations on-deck. The decision to always use the Zodiac is the safest option.	Deployment and Recovery
Confusion and miscommunication during mooring operations	Always do a Toolbox before starting any mooring operations	Deployment and Recovery

References

Meredyk, S. 2014. 2014 JAMSTEC Report, ArcticNet Inc. 25 p.

Meredyk, S. 2014. 2014 Mooring Program Report - BaySys, ArcticNet Inc. 11 p.

Meredyk, S. 2014. 2014 Mooring Program Report - BREA, ArcticNet Inc. 19 p.

IMG-Golder. 2014. Beaufort Regional Environmental Assessment Moorings Program, Leg 2a Field Report. Report Number 1404718/6000/6001. 28 pp.

8 Oceanic dimethylsufide (DMS) and related sulfur compounds in melt ponds, ice, surface microlayer and water column – Leg 1

ArcticNet Phase 3 – Carbon Exchange Dynamics in Coastal and Marine Ecosystems.
http://www.arcticnet.ulaval.ca/pdf/phase3/carbon-dynamics.pdf

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8.1 Introduction

Dimethylsulfide (DMS) is an important climate-active gas. Its oxidation products in the atmosphere contribute to the formation of high-albedo clouds that participate to the radiative balance of the Earth. In the Arctic atmosphere, low atmospheric particle content in early summer increases the impact and the occurrence of DMS-derived aerosol formation. Ice covered oceans provide complex and dynamic environments where DMS, its precursor DMSP (dimethylsulfoniopropionate), and DMSO (dimethylsulfoxide) are produced by phytoplankton as well as ice algae. In a context of advanced and increased ice thaw, melt ponds could also become a significant source of DMS in the Arctic during the melting period. Melt ponds are in direct contact with the atmosphere and can cover from 50% to 60%, and up to 90%, of the ice sheet in some regions. Only a small number of DMS measurements in melt ponds already exist. Sharma et al. (1999) have reported DMS concentrations varying from 0.1 to 2.2 nmol l^{-1} in the Arctic. This team previously measured up to 14 nmol l^{-1} in melt ponds offshore Resolute in June 2012. Asher et al. (2011) measured DMS concentrations up to 250 nmol l^{-1} in melt ponds colonized by micro-algae in Antarctica. Micro-algae in melt ponds are exposed to intense sunlight and fresher water conditions which could lead to high DMS production. The production and dynamics of DMS in these environments have yet to be described.

This project will contribute to the building of knowledge about DMS cycling in the Arctic by addressing three main objectives:

- Quantify DMS production in melt ponds and Arctic surface waters in summer;
- Identify the processes leading to DMS production in melt ponds;
- Improve the understanding of the DMS cycle in ice-covered regions by providing much needed records of the DMS distribution in sea ice and the under ice water during the melt season.

8.2 Methodology

8.2.1 Melt pond sampling

Upon arrival on the ice stations, ice thickness was probed using a 2-inch drill. The work could be initiated only if the ice was thicker than 50 cm. First, GPS position, air temperature and weather observations were recorded on site. Then, down welling and upwelling irradiance were measured above the ice and melt pond as well as in the melt pond. Several independent melt ponds were chosen for sampling at each station. In each melt pond, *in situ* temperature, depth at 5 different points, length and width were measured. Melt pond water (19 litres) was pumped in a Coleman cooler jug. For DMS samples, 20 mL glass serum vials were filled by overflow, avoiding bubbles. Vials were then sealed with a butyl cap maintained by an aluminum lid fitted with a hand crimper. The pump (Cyclone pump, Aquameric) was attached to an aluminum arm and plugged to a sealed Lead Acid battery fitted with a LDPE tubing (Figure 8.1).

Figure 8.1. Melt pond water pumping with a cyclone pump attached to an arm.
Photo: Isabelle Courchesne.

Melt pond water was subsampled to obtain the following variables and parameters: fractionated chlorophyll *a*, DMS, DMSO, DMSP, nutrients, HPLC, flow cytometry, taxonomy, DOC/TOC, POC/PON, primary production, MAA, CH_4, salinity, *in situ* temperature and pH.

Melt pond water was incubated for DMS cycling and nitrogen cycling experiments on one and all the melt ponds sampled, respectively. Table 8.1 summarizes the work of the melt ponds team, which included Joannie Charette (PI: Michel Gosselin), Jean-Sebastien Côté (PI: Jean-Éric Tremblay), Margaux Gourdal and Martine Lizotte (PI: Maurice Levasseur), and Tim Papakyriakou. The white boxes refer variables measured in the laboratory. The crosses indicate variables measured by Margaux Gourdal. For other data and analyses, see the carbon and nutrient fluxes report (Section 15), the phytoplankton report (Section 18) and the microbial report (Section 16).

Table 8.1. Set of variables measured in melt ponds, ice and under ice water during Leg 1.

	MP	Pooled DIC	UIW	FC Chla	FC DMS	FC Nuts	FSW
				x	x		
				x	x		x
				x			
	x	x	x	x	x		x
	x						

8.2.2 Ice sampling

After melt ponds sampling, several ice core were drilled using a Kovacs ice corer (9 cm diameter) fitted with an electrical drill. Full cores were taken for Salinity/nutrients; Ice temperature profile; Chlorophyll *a* profile; and ice DMS profile. Four bottom 10 cm of the ice core were collected, pooled and melted in 0.2 µm filtered seawater (FSW) for Chlorophyll *a*, nutrients, taxonomy, pigments (HPLC), POC/PON, DOC/POC and MAA. One other separate bottom ice core was used for DOC/POC and nutrients analysis.

For the DMS ice core, 10 cm sections of the core were individually placed inside Tedlar bags fitted with a tap (Delin Dalian Tedlar bag-China). 1.5 litres of 0.2 µm FSW acidified at pH 1 was added to the ice core to avoid the exposition of ice algae to an osmotic shock during the ice melt. Acidification of the FSW stops bacterial activity, which could modify DMSP and DMS concentrations in the sample while the core is melting. The acidic FSW was a mixture of 5 mL HCL 37% in 3 L of FSW. Once the FSW was added, the bag was closed using a clip and seal device. Air was then removed through the tap of the bag. The tap was then closed and the bag was kept in the dark at room temperature. DMS, DMSP and DMSO concentrations, final volume, pH and salinity of the melted ice-FSW mixture were measured.

8.2.3 Under ice water sampling

On several stations (ice # 1; 3 and 4), water was pumped under the ice cover through an auger-drilled hole (Table 8.2). Water was pumped using a cyclone pump (aquameric) plugged to a sealed Lead Acid battery and fitted with a LDPE tubing. Water samples for the DMSP and DMSO samples were kept in a cooler rinsed 3 times prior filling. For DMS samples, 20 mL glass serum vials were filled by overflow, avoiding bubbles. Vials were then sealed with a butyl cap maintained by an aluminum lid fitted with a hand crimper.

Table 8.2. Summary of melt ponds stations where incubations work was undertaken.

Station	Coordinates	Incubation	Samples collected
Ice # 1	73°31.656 N 080°59.385 W	Melt pond water	Ice - 3 melt ponds- Under ice water
Ice # 2	74°16.774 N 091°37.990 W	No	3 melt ponds
Ice # 3	74°14.274 N 092°11.808 W	Melt pond water	Ice - 3 melt ponds- Under ice water
Ice # 4	74°36.217 N 094°54.611 W	Melt pond water	Ice - 3 melt ponds- Under ice water
115	76°20.087 N 071°12.870 W	Surface water	Surface water bucket
107	76°16.926 N 074°58.885 W	Surface water	Surface water bucket
101	76°23.056 N 077°23.788 W	Surface water	Surface water bucket
Ice island (5/08)	79°03.739 N 071°40.562 W	Surface water	Surface water rosette

8.2.4 Water column sampling

Water samples were taken from the Rosette, at stations located in Lancaster Sound, Baffin Bay, Kennedy Channel, Kane Basin and Peel Sound (Table 8.3). The vertical profiles of DMS concentrations included 7 light depths (i.e. 100%, 50%, 30%, 15%, 5%, 1% and 0.2%), as well as a deep cast (i.e. 60 to 80 m).

Table 8.3. Synthesis of variables sampled (DMS, DMSPt, DMSPd, DMSOt) during Leg 1 according to region, date, time, cast#, depth, latitude and longitude.

Leg	Region	Date	Time	Station Name	Cast number	Depth (m)	Latitude (N)	Longitude (W)	DMS	DMSPp/d	DMSOt
1a	Baffin Bay	15/07/2014	5h12	ROV1	1	734	69°22.026	064°51.965	X	X	
1a	Baffin Bay	16/07/2014	7h11	ROV2	2	612	70°30.500	070°17.623	X	X	
1a	Baffin Bay	16/07/2014	12h00	uLayer 1			71°30.099	070°23.070	no	X	
1a	Lancaster Sound	17/07/2014	17h42	323	3	850	74°09.455	080°28.560	X	X	X
1a	Lancaster Sound	18/07/2014	3h00	300	4	702	74°19.001	080°30.146	X	X	
1a	Lancaster Sound	18/07/2014	5h11	322	6	670	74°29.774	080°32.132	X	X	
1a	Lancaster Sound	18/07/2014	20h22	324	7	774	73°58.969	080°28.412	X	X	
1a	Lancaster Sound	18/07/2014	22h18	325	8	685	73°49.058	080°29.483	X	X	
1a	Lancaster Sound	19/07/2014	9h15	301	9	671	74°06.389	083°24.545	X	X	X
1a	Lancaster Sound	20/07/2014	11h27	346	11	260	74°08.860	091°34.486	X	X	
1a	Lancaster Sound	20/07/2014	13h08	304	12	310	74°14.372	091°32.218	X	X	
1a	Lancaster Sound	22/07/2014	5h32	305	14	188	74°19.104	094°54.385	X	X	X
1a	Lancaster Sound	22/07/2014	19h28	305A	16	171	74°12.990	094°12.902	X	X	
1a	Lancaster Sound	22/07/2014	23h39	305B	17	186	74°13.732	095°54.469	X	X	
1a	Lancaster Sound	23/07/2014	1h07	305C	18	181	74°21.575	095°48.608	X	X	
1a	Lancaster Sound	23/07/2014	2h28	305D	19	195	74°27.378	095°42.168	X	X	
1a	Lancaster Sound	23/07/2014	4h13	305E	20	128	74°35.323	095°03.718	X	X	
1a	Lancaster Sound	23/07/2014	13h00	uLayer 2			74°36.935	094°43.663	X	X	?
1b	Lancaster Sound	25/07/2014	11h00	Transect Lancaster Sound			74°27.185	090°23.626	X	X	X
1b	Lancaster Sound	25/07/2014	13h05	TLS			74°26.955	089°09.050	X	X	X
1b	Lancaster Sound	25/07/2014	15h03	TLS			74°24.780	087°33.858	X	X	X
1b	Lancaster Sound	25/07/2014	17h15	TLS			74°27.390	085°50.747	X	X	X
1b	Lancaster Sound	25/07/2014	19h11	TLS			74°26.764	084°16.103	X	X	X
1b	Lancaster Sound	25/07/2014	21h11	TLS			74°27.967	082°45.609	X	X	X
1b	Ice Island (near Greenland)	26/07/2014	8h45	uLayer 3			74°00.067	075°47.318	X	X	?
1b	Baffin Bay	27/07/2014	7h37	200	21	1461	73° 16.753	063° 38.208	X	X	X

Leg	Region	Date	Time	Station Name	Cast number	Depth (m)	Latitude (N)	Longitude (W)	DMS	DMSPp/d	DMSOt
1b	Baffin Bay	28/07/2014	10h08	204	24	998	73° 15.750	057° 52.850	X	X	X
1b	Northern Baffin Bay	29/07/2014	13h54	210	28	1138	75° 24.445	061°38.957	X	X	X
1b	Northern Baffin Bay	30/07/2014	14h44	115	32	676	76° 20.087	071°12.870	X	X	X
1b	Northern Baffin Bay	30/07/2014	18h10	uLayer 4			76°19.882	071°10.329			
1b	Northern Baffin Bay	31/07/2014	7h32	111	38	592	76° 18.384	073°13.361	X	X	X
1b	Northern Baffin Bay	31/07/2014	17h00	uLayer 5			76°16.568	074°36.063			
1b	Northern Baffin Bay	01/08/2014	2h15	108	43	445	76° 16.301	074°35.992	X	X	X
1b	Northern Baffin Bay	01/08/2014	9h52	105	47	334	76° 19.444	075°46.939	X	X	X
1b	Northern Baffin Bay	02/08/2014	2h07	101	52	350	76° 26.056	077°23.788	X	X	X
1b	Kennedy Channel	03/08/2014	9h28	KEN1	53	497	81° 22.022	064°10.619	X	X	X
1b	Kennedy Channel	03/08/2014	8h15	uLayer 6			81°21.743	064°11.399	X	X	?
1b	Kennedy Channel	04/08/2014	2h09	KEN 3	56	403	80° 47.539	067°18.023	X	X	X
1b	Kane Basin	04/08/2014	13h10	KANE 1	59	245	79° 59.037	069°46.830	X	X	X
1b	Kane Basin	04/08/2014	14h40	uLayer 7			79°58.672	069°56.051	X	X	?
1b	Kane Basin	05/08/2014	3h48	KANE 3	62	223	79° 21.637	071°51.670	X	X	X
1b	Kane Basin	05/08/2014	22h47	KANE 5	72	244	79° 00.400	073°12.404	X	X	X
1b		05/08/2014	15h15	uLayer 8			79°04.673	071°39.205	X	X	?
1b	Smith Sound	06/08/2014	13h02	120	75	562	77° 19.438	075°41.608	X	X	X
1b	Lancaster Sound	08/08/2014	21h12	335	77	129	74°25.678	098°49.444	X	X	X
1b	Peel Sound	10/08/2014	5h56	309	79	338	72°57.125	096°09.313	X	X	X
1b	Peel Sound	11/08/2014	10h30	310	81	137	71°17.850	097°41.340	X	X	X
1b		11/08/2014	16h05	uLayer 9			69°10.009	100°44.018	X	X	?
1b		12/08/2014	9h36	312	83	60	69°10.604	100°40.139	X	X	X
1b	Cambridge Bay	12/08/2014	13h13	314	85	80	68°58.223	105°28.249	X	X	X
1b		12/08/2014	14h55	uLayer 10			68°55.897	105°19.809	X	X	X

Over 1200 manual injections were operated on the GC during the course of Legs 1a and 1b. The following stations were successfully sampled: ROV1, 323, 300, 322, 325, 324, 301, 346, 304, 305A, 305B, 305C, 305D, 305E, 305F, 200, 204, 210, 115, 111, 108, 105, 101, Ken1, Ken3, Kane1, Kane3, Kane5, 120, 335, 309, 310 (Peel Sound), 312, 314, 6 stations along a West-to-East transect in Lancaster Sound (from the ice edge to the entrance of Baffin Bay), as well as 8 impromptu stations around the Ice Island Kane II.

8.2.5 Samples measurement and conservation

DMS samples. DMS samples were measured on board using a gas chromatograph (GC). Please see DMS Team Report in Section 16 for more detailed information.

DMSP conservation of seawater, melt ponds and melted ice samples. Total DMSP (DMSPt) samples were preserved by adding of 50 µl of H2SO4 50% in 5 mL polypropylene tubes. To obtain dissolved DMSP (DMSPd) samples, water was gravity-filtered through a GF/F filter placed on a magnetic funnel. This method avoids cell bursting during the filtration. The first drops of filtered sample were discarded and 4 mL were then collected in a 5 mL polypropylene tube.

DMSO conservation of seawater, melt ponds and melted ice samples. Total DMSO (DMSOt) samples were preserved by adding a pellet of NaOH to the sample collected in a 20 mL glass serum vial. Vials were then sealed with a butyl cap maintained by an aluminium lid. For dissolved DMSO (DMSOd) and particulate DMSO (DMSOp) samples, water was filtered through a sweenex on a GF/F filter. The first drops of filtrate were discarded. 20 mL glass serum vial were filled for DMSOd samples. After adding a NaOH pellet, vials were sealed with a butyl cap maintained by an aluminium lid. DMSO samples are kept in the dark at 4°C.The filter was kept in a dark polypropylene tube at -20°C for DMSOp samples.

8.2.6 Melt ponds and surface water incubations

The following diagram (Figure 8.2) shows the potential sources and sinks of DMS production and removal in a melt pond, ignoring ventilation.

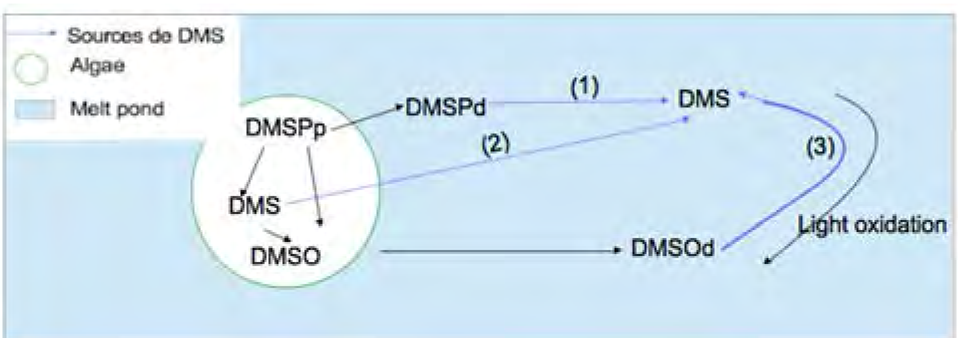

Figure 8.2. Schematic of the potential sources and sinks of DMS in a melt pond, where (1) DMS yield from DMSP, (2) DMS production by the algae, (3) DMSO reduction, (1)+(2)+(3) Gross DMS production.

To quantify these processes, melt ponds water was incubated on the foredeck during 24-h experiments using stable isotopes compounds ^{6}H-DMSP and ^{13}C-DMSO. The final concentration of ^{6}H-DMSP and ^{13}C-DMSO was 100 nmol l^{-1} for each compound. The experimental setup included 8 tedlar bags filled with 2 litres of melt pond water. Two bags were kept as controls; 2 bags were added with the stables isotopes of DMSP and DMSO, 2 bags were added with the stables isotopes of DMSP and DMSO in the dark, and 2 bags were added with methyl butyl ether (MBE), an inhibitor of bacterial consumption of DMS (Figure 8.3).

Figure 8.3. Experimental setup for DMS incubations.

Tedlar bags were chosen for their gas-tight properties. The bags also have high transmittance values from the UV (300 nm) to the end of the visible spectrum (Figure 8.4). This characteristic provides a good simulation of the natural light condition in melt ponds and surface waters during the incubation.

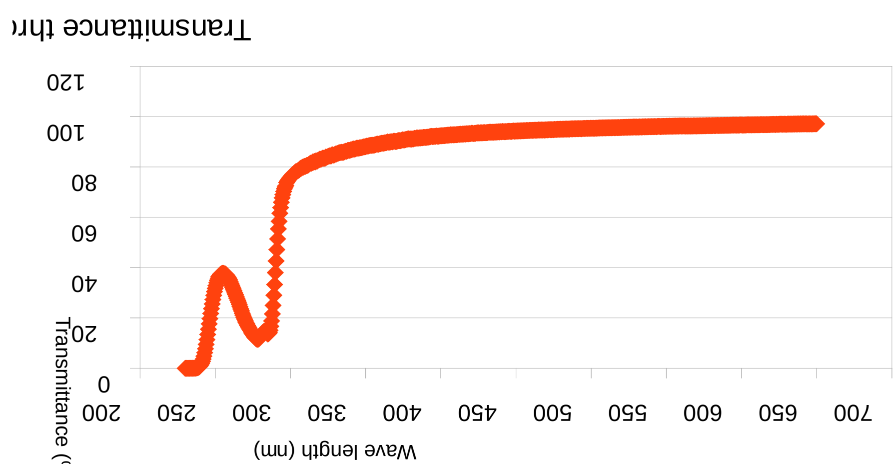

Figure 8.4. Light transmittance through a Tedlar bag.

The yield of DMS from DMSP (process (1) in Figure 8.2) was obtained by measuring 6H-DMS concentrations with a GC-MS. The final DMS concentration in the MBE bags after 24 h of incubation represented the total DMS production undiminished by the bacterial consumption of DMS (i.e. the gross DMS production ((1) + (2) + (3)). DMS production from DMSO was obtained by measuring 13C-DMS with a GC-MS. The process (2) was deduced from the gross DMS production, DMS yield from DMSP and DMS yield from DMSO ((2) = gross DMS production – (1) + (3)).

DMS, total and dissolved DMSP, as well as total, dissolved and particulate DMSO were subsampled from the tedlar bags every 6 hours during 24 h. Nutrients and chlorophyll *a* were measured at T0, T12 and T24. Samples for pico and nanoplancton taxonomy were taken at T0. To measure the isotopic signature of DMS (13C-DMS and 6H-DMS), DMS samples were also preserved at T0 and T24 on a cold trap. The DMS traps consisted in gas chromatography (GC) liners packed with Tenax TA. The use of this polymer as a tool for sulphured gases measurements is documented (e.g. Pandey & Ki-hyun 2009, Zemmelink et al. 2002, Pio et al. 1996). Shooter et al. (1992) described TENAX as "*an appropriate adsorbent for sulfur compounds, especially DMS*". DMS was stripped from seawater using Helium (99.999%) bubbling in a glass chamber at 70°C for 4.5 minutes at 45 mL/min. The sample flow was dried by condensation and using a counter-flow (Nafion) (see Scarratt et al. 2000 for the method details). Samples were maintained at -80°C until their analysis on a GC-MS at Laval University.

Four surface seawater incubations were also carried out at Stations 115, 107, 101 and around the ice island on the 5 August. The incubation setup was the same as described for the melt ponds incubations. Those allowed for comparison with the melt pond environment.

8.3 Preliminary results

Among all the variables sampled in the water column during the cruise, the only ones that could be analyzed onboard were DMS analysis by Gas Chromatography and Chl *a* analysis by fluorometry. Overall, levels of oceanic DMS were found to be high, with >12 nmol L^{-1} at stations 300-301-115-Kane3 and as much as 35 nmol L^{-1} at microlayer Station #4, near Station 115. The typical water column profile featured high DMS concentrations in the upper waters of the mixed layer with a characteristic tailing off at depth (Figure 8.5). A strong North to South gradient in concentrations of DMS was observed during the Kennedy Channel-Kane Basin investigations (Figure 8.5) that, at first glance, seems to strongly correlate with concentrations of Chl *a*.

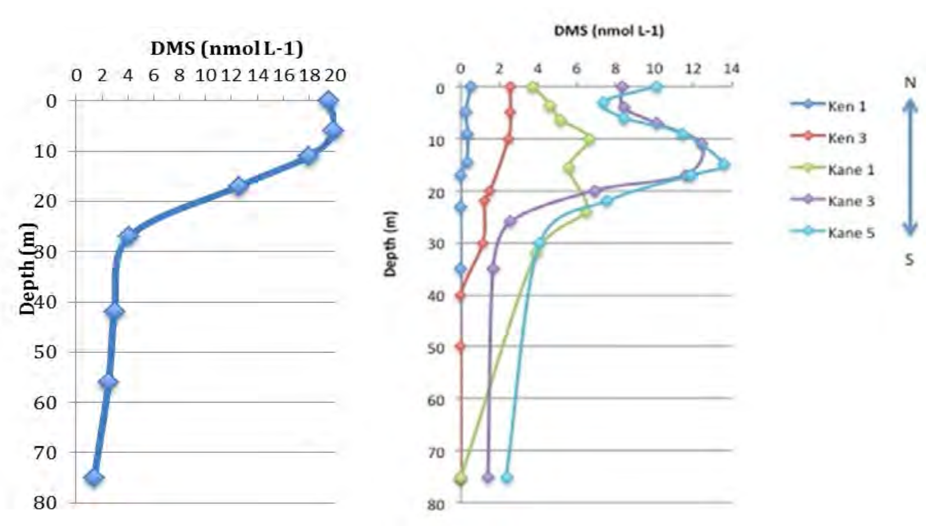

Figure 8.5. Vertical profile of oceanic concentrations of DMS (nmol L^{-1}) at Station 115 sampled on 30 July 2014 during Leg 1b (left). Vertical profiles of DMS concentrations (nmol L^{-1}) along a North to South transect from Kennedy Channel to Kane Basin during Leg 1b (right).

8.4 Comments and recommendations

After troubleshooting the main instrument (Gas Chromatograph – GC) during transit in Leg 1a, the system up and running just in time for the start of the Rosette stations in Lancaster Sound (Station 323, 17 July). Acknowledgements are due here to Maxime Mercier (*Amundsen* electronic technician) for providing tireless IT support, Rémi Bisaillon (electrical officer) for installing an extra UPS electrical outlet in the Paleoceanography Laboratory (#651), as well as to Sonia Michaud (MPO Maurice-Lamontagne Institute) for on-land GC expertise and advice.

The reliability of the equipment was put to the test during heavy ice breaking periods during Leg 1a and the start of Leg 1b. It quickly became obvious during the cruise that the Varian 3800 GC is very sensitive to the ship's motion as well as to ice breaking. The use of a gyroscopic table (gimbal support) or another solution needs to be found and applied for future cruises on the CCGS *Amundsen*.

Unfortunately, our newly purchased Hydrogen Generator did not withstand the shaking and a central piece of the H_2 catalyst module broke on 25 July. We would like to acknowledge the help of Erick Dubé (Senior Engineer) and Thomas Linkowski (ArcticNet technician) who both provided advice and technical support during troubleshooting. While it was not possible to get the H_2 generator back up and running, a plan B was put into place through Ann-Lise Norman's team (U. of Calgary) who generously gave us a Hydrogen cylinder tank.

9 Surface microlayer sampling – Leg 1

ArcticNet Phase 3 – Carbon Exchange Dynamics in Coastal and Marine Ecosystems, http://www.arcticnet.ulaval.ca/pdf/phase3/carbon-dynamics.pdf

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9.1 Methodology

Surface microlayer (SML or uL) and bulk water (BW) samples were taken on 8 different days during Leg 1 (Table 9.1). A full description of each station can be found below.

Table 9.1. Location of stations where surface microlayer (SML or uL) sampling was conducted during Leg 1.

Station	Date (dd/mm/yr)	Depth (m)	Latitude (N)	Longitude (W)
uL Sta.1 uL	16/07/2014	0.5	71°31.650	070°24.168
uL Sta.1 BW	16/07/2014	0.0	71°31.650	070°24.168
uL Sta.2 uL	23/07/2014	0.0	74°51.582	094°54.048
uL Sta.2 BW	23/07/2014	0.5	74°51.582	094°54.048
uL Sta.3 uL	29/07/2014	0.0	74°01.116	075°52.302
uL Sta.3 BW	29/07/2014	0.5	74°01.116	075°52.302
uL Sta.4 uL	30/07/2014	0.0	76°33.702	071°15.486
uL Sta.4 BW	30/07/2014	0.5	76°33.702	071°15.486
uL Sta.5 uL	31/07/2014	0.0	76°25.464	074°37.050
uL Sta.5 BW	31/07/2014	0.5	76°25.464	074°37.050
uL Sta.6 uL	03/08/2014	0.0	81°33.384	064°17.652
uL Sta.6 BW	03/08/2014	0.5	81°33.384	064°17.652
uL Sta.7 uL	04/08/2014	0.0	80°09.198	069°56.850
uL Sta.7 BW	04/08/2014	0.5	80°09.198	069°56.850
uL Sta.8 uL	05/08/2014	0.0	79°15.216	071°42.414
uL Sta.8 BW	05/08/2014	0.5	79°15.216	071°42.414
uL Sta.9 uL	11/08/2014	0.0	69°10.152	100°44.298
uL Sta.9 BW	11/08/2014	0.5	69°10.152	100°44.298
uL Sta.10 uL	12/08/2014	0.0	69°09.948	105°32.484
uL Sta.10 BW	12/08/2014	0.5	69°09.948	105°32.484

Microlayer samples were collected using a glass plate and squeegee. After returning to the ship each day, samples were divided and treated according to different protocols for other groups to analyse (Table 9.2). The SML sub samples were for TEP, DOC/TOC, bacteria, sulfur compounds (including DMS, $DMSP_t$, $DMSP_d$), ice nuclei (IN), ammonia, surfactants and single cell genomes.

- The IN SML samples for the UBC and Toronto groups were sub sampled into duplicate 30 mL HCl-rinsed bottles, promptly put into a -80°C freezer and left onboard until demobilisation.
- SML samples for TEP were subsampled into HCl-rinsed 60mL bottles, spiked with 2% formalin and kept at 4°C in the dark. The samples were transported back on the charter flight from Kugluktuk on 14 August and shipped to Germany on the 18 August.
- SML samples for DOC/TOC and bacteria were taken by the Gosselin group for direct analysis after sampling took place (Section 17).
- SML samples for sulphur compounds were taken by the DMS group for direct analysis after sampling took place (Section 8).
- SML samples for ammonia compounds were taken by the Murphy group for direct analysis after sampling took place (this only happened for the first two stations).
- SML samples for surfactants were subsampled into 40 mL glass vials and stored immediately in a -80°C freezer, they were transported back on the charter flight from Kugluktuk on 14 August and shipped to UBC on 18 August.
- SML samples for single cell genomes were taken by the Lovejoy group for direct analysis after sampling took place (Leg 1b only) (Section 16).

Table 9.2. Subsamples of surface microlayer (SML) seawater divided among the different teams.

Station	**Volume**	**16 July**	**23 July**	**26 July**	**30 July**	**31 July**	**3 Aug**	**4 Aug**	**5 Aug**	**11 Aug**	**12 Aug**
IN	2 x 30 mL	X	X	X	X	X	X	X	X	X	X
IN - TIC	2 x 30 mL	X	X	X	X	X	X	X	X	X	X
DMS	25 mL		X	X	X	X	X	X	X	X	X
DMSP(t)	5 mL	X	X	X	X	X	X	X	X	X	X
DMSP(d)	20 mL		X	X	X	X	X	X	X	X	X
DOC/TOC and bacteria (Phyto)	100 mL	X		X	X	X	X	X	NO DOC (only bacteria)	NO DOC (only bacteria)	NO DOC (only bacteria)
TEP	60 mL	X	X	X	X	X	X	X	X	X	X
Surfactants	30 mL	X	X	X	X	X	X	X	X	X	X
Ammonia (Trace gases, Nutrients)	50 mL	X	X								
DMSO(t)				X	X	X	X	X	X	X	X
Single cell genome/ other (Microbes)	the rest			X	X	X	X	X	X	X	X
TOTAL	**410 mL**										

Bulk water (BW) samples were subsampled in the same way for all previously mentioned variables (Table 9.3). Additional samples were taken for TIC/Alk, salinity and O18. The bulk water for TIC/Alk was taken directly from the Niskin bottle and stored in glass bottles using the gas-clean technique, then poisoned on the Zodiac with $HgCl_2$ and stored in a cooler until back at the ship where they were stored at 4°C. The O18 samples were taken directly after and stored in 2 mL glass vials. Salinity was taken in 250 mL glass bottles using the same sampling tube from the Niskin and stored at 4°C. All other variables were sub sampled from one bottle of bulk water after homogenising the sample.

Table 9.3. Subsamples of bulk water (BW) divided among the different teams.

Station	Volume	16 July	23 July	26 July	30 July	31 July	3 Aug	4 Aug	5 Aug	11 Aug	12 Aug
Salinity	1 x 250 mL	X	X	X	X	X	X	X	X	X	X
TIC/Alk	3 x 250 mL	X	X	X	X	X	X	X	X	X	X
O18	2 mL	X	X	X	X	X	X	X	X	X	X
IN - Luis	2 x 30 mL	X	X	X	X	X	X	X	X	X	X
IN - Vickie	2 x 30 mL	X	X	X	X	X	X	X	X	X	X
DMS - Martine	25 mL		X	X	X	X	X	X	X	X	X
DMSP(t) - Martine	5 mL	X	X	X	X	X	X	X	X	X	X
DMSP(d) - Martine	20 mL		X	X	X	X	X	X	X	X	X
DOC/TOC and bacteria – Michel/ Joannie/ Marjo	100 mL	X	X	X	X	X	X	X	NO DOC (only bacteria)	NO DOC (only bacteria)	NO DOC (only bacteria)
TEP - Oliver	60 mL	X	X	X	X	X	X	X	X	X	X
Surfactants – Ania	30 mL	X	X	X	X	X	X	X	X	X	X
Ammonia – Greg	50 mL	X	X								
DMSO(t) - Virginie				X	X	X	X	X	X	X	X
Single cell genome/ other - Connie	the rest			X	X	X	X	X	X	X	X
TOTAL	**1412 mL**										

9.1.1 Station 1

The sky was overcast with occasional spots of sunlight, there was hardly any wind to start with but then picked up during the time taken to sample. The Zodiac was launched at approximately 11:00 am and arrived back at the ship at approximately 2:30 pm. To begin with, the Zodiac made its way west towards land and ice. Slick and non-slick areas were observed, a non-slick area was chosen as the place of interest. The engine was cut and approximately ten minutes went by before sampling took place to ensure no movement in the water was due to the Zodiac.

Microlayer

	Time	Position	Conditions
Start	12:08pm	71°30.099 N 070°23.070W	Perfectly calm, no wind, non-slick area.
Finish	12:42pm	71°29.962 N 070°22.723W	Wind had picked up, boat was rocking quite a bit, was difficult to lower the GP slowly and at a continuous rate for SML. Had moved into a slick area.

Salinity: 28.6
Temperature: 7.7°C
pH: 7.4

no. of swipes: 185
Secchi disk: 16 m (there was an underwater current that put it at an angle)

CTD cast at 1:20pm

Bulk (0.5 m)
Time end of casts: 1:35pm
End position: 71°29.764N, 070°21.555W
Salinity: 28.1
Temperature: 7.9°C
pH: 8.1
Three casts were done. TIC/Alk a + b bottles were taken from first cast, TIC/Alk c bottle and salinity were taken from second cast. All other variables were taken from third cast. O18 and DMS were not subsampled at this station.

9.1.2 Station 2

It was a gloriously sunny day after a week of overcast skies; the sea was a little wavy however we spotted an iceberg with a potential sheltered area. We drove downwind of the iceberg, cut the engine and started sampling. After sampling we explored further around the iceberg and saw bits of green algae in the water (this was approx. 75m away from our original sampling area).

Microlayer

	Time	Position	Conditions
Start	13:10	74°36.935 N 094°43.663W	Behind iceberg to be sheltered from wind. Sunny day, a bit wavy. Slick area.
Finish	13:30	74°36.966 N 094°42.852W	Had drifted downwind and were near ice edge rather than iceberg.

Salinity: 25.9
Temp: 2.3°C
pH: 7.7
no. of swipes: 150

Secchi disk: 13m (there was an underwater current that put it at an angle)

Bulk (0.5m)
Time end of casts: 1:35pm
Cast 1 position: 74°36.966N, 094°42.852W
Cast 2 position: 74°36.962N, 094°42.781W
Cast 3 position: 74°36.947N, 094°42.542W
Salinity: 24.4
Temperature: 4.0°C
pH – not taken
Three casts were done. TIC/Alk a + b bottles were taken from first cast, TIC/Alk c bottle and salinity were taken from second cast. All other variables were taken from third cast.
O18 labelled – Z01

Time finish all sampling: 14:00

9.1.3 Station 3

Conditions were a little rougher than previous stations; the sea was uniform. We sampled where what we thought looked to be a more sheltered area in an opening into the ice island. Sampling took place relatively quickly as seasickness had set in. Salinity was taken from the bulk water bottle rather than the Niskin bottle as we forgot to do this in the Zodiac.

Microlayer

	Time	Position	Conditions
Start	08:45	74°00.067 N 075°47.318W	In a cove next to the ice island, conditions bumpy but this looks to be the only "sheltered" area. Overcast skies. Neither slick nor non-slick, sea was uniform.
Finish	09:00	74°00.229 N 075°47.396W	Same as start except a lot of ice had fallen from the ice island during sampling therefore more waves had been generated.

Salinity: 23.7
Temperature: 4.4°C
pH: 8.0
no. of swipes: 133 (to get almost 1 L, Jean was efficiently swooping down to catch most of the microlayer that dripped)

Secchi disk: 16m

Bulk (0.5m)
Time end of casts:
Cast 1 position: 74°00.229N, 075°47.396W
Cast 2 position: 74°00.399N, 075°47.411W
Salinity: 26.9
Temperature: 5.5°C
pH: 8.1
Two casts were done. TIC/Alk a + b bottles were taken from first cast, TIC/Alk c bottle, O18, salinity and other variables were taken from second cast.
O18 labelled – Z02
Time finish all sampling – 09:30

9.1.4 Station 4

Conditions were as good as they can get for microlayer sampling in Baffin Bay. The whole area was one big slick of glassy looking microlayer. The fog had just dissipated and some sun was trying to break through remaining cloud (95% cover altostratus). We tried to shake off the puffins around us but they were interested in our manoeuvres so we had to make do with them hanging around.

Microlayer

	Time	Position	Conditions
Start	18:10	76°19.882 N 071°10.329W	Slick, calm, open water. No icebergs in close proximity.

Finish	18:26	76°10'276 N 076°20.114W	Same as start.

Salinity: 29.1
Temperature: 3.7°C
pH: 7.7
no. of swipes: 135

Secchi disk: 8m

Bulk (0.5m)
Cast 1 position: 76°20.158N, 071°10.103W Time: 18:16
Cast 2 position: 76°20.154N, 071°10.204W Time: 18:21
Cast 3 position: 76°20.110N, 071°10.886W Time: 18:27
Salinity: 27.5
Temperature: 4.1°C
pH: 7.7
Three casts were done. TIC/Alk a + b bottles were taken from first cast, TIC/Alk c bottle, O18, salinity were taken from cast 2 and all other variables were taken from cast 3.
O18 labelled – Z03
Time finish all sampling: 18:35

9.1.5 Station 5

Conditions were not as good as yesterday (Station 4) but still fairly good for microlayer sampling. The whole microlayer area was uniform (i.e. no slick vs non-slick). It was foggy and a little wavy. A couple of boat splashes (spooshes) got into the microlayer samples due to the waves.

Microlayer

	Time	Position	Conditions
Start	17:02	76°16.568 N 074°36.063W	Uniform, a little wavy, open water. No icebergs in close proximity.
Finish	17:15	76°16.480 N 074°35.887W	Same as start. A little sunnier.

Salinity: 27.0
Temperature: 8.1°C
pH: 8.0
no. of swipes: 141

Secchi disk: 18m

Bulk (0.5m)
Cast 1 position: 76°16.596N, 074°36.112W Time: 16:58
Cast 2 position: 76°16.510N, 074°35.955W Time: 17:10
Cast 3 position: 76°16.467N, 074°35.874W Time: 17:16
Salinity: 28.8
Temperature: 5.8°C

pH: 8.0
Three casts were done. TIC/Alk a + b bottles were taken from first cast, TIC/Alk c bottle, O18, salinity were taken from cast 2 and all other variables were taken from cast 3.
O18 labelled – Z04
Time finish all sampling: 17.30

CTD cast
Time: 17:26 Position: 76°16.389N 074°35.718W

9.1.6 Station 6

This was done at the furthest point north of our journey. The wind was at 20 knots but we decided to try anyway. A calmer area of water was found near a large piece of floating ice. There was a large drift but the Zodiac managed to stay in calm waters. The skies were overcast; we were near to Ellesmere Island and the bay where the Peterman glacier exits could be seen across the channel.

Microlayer

	Time	Position	Conditions
Start	08:15	81°21.743 N 064°11.399W	Uniform, near floating piece of ice. Strong winds. Overcast
Finish	08:25	81°21.777 N 064°10.269W	Drifted quite a way. Winds still strong. Weather same.

Salinity: 26.1
Temperature: 0.9°C
pH: 7.7
no. of swipes: 115

Secchi disk: 17m

Bulk (0.5m)
Cast 1 position: 81°21.764N, 064°10.817W Time: 08:20
Cast 2 position: 81°21.184N, 064°09.992W Time: 08:28
Cast 3 position: 81°21.822N, 076°09.097W Time: 08:35
Salinity: 26.7ppt
Temperature: 0.7°C
pH: 7.8
Three casts were done. TIC/Alk a + b bottles were taken from first cast, TIC/Alk c bottle, O18, salinity were taken from cast 2 and all other variables were taken from cast 3.
O18 labelled – Z05a Z05b
Time finish all sampling: 08:45

CTD cast
Time: 08:45 Position: 81°21.064N, 064°08.045W

9.1.7 Station 7

At the north of Kane Basin, the Zodiac went near some ice to anchor itself so there was no drift and to position into calmer waters. It was overcast.

Microlayer

	Time	Position	Conditions
Start	14:40	79°58.672 N 069°56.051W	Uniform, a little wavy, close to ice.
Finish	14:52	79°58.640 N 069°56.086W	Same as start.

Salinity: 24.3 ppt
Temperature: 0.6°C
pH: 7.8
no. of swipes: 125

Secchi disk: 8m

Bulk (0.5m)
Cast 1 position: 79°58.850N, 069°55.842W Time: 14:41
Cast 2 position: 79°58.640N, 069°56.086W Time: 14:53
Cast 3 position: 79°58.486N, 069°56.286W Time: 14:58
Salinity: 23.8 ppt
Temperature: 2.5°C
pH: 7.8
Three casts were done. TIC/Alk a + b bottles were taken from first cast, TIC/Alk c bottle, O18, salinity were taken from cast 2 and all other variables were taken from cast 3.
O18 labelled – Z06a Z06b
Time finish all sampling – 15:10

CTD cast
Time: 15:06 Position: 79°58.343N, 069°56.440W

9.1.8 Station 8

Partly cloudy day. Slick area. Anchored to ice about 200m away from ice island.

Microlayer

	Time	Position	Conditions
Start	15:16	79°04.673 N 071°39.205W	Slick.
Finish	15:30	79°04.708 N 071°38.978W	Same as start.

Salinity: 25.6
Temperature: 3.9°C
pH: 7.7
no. of swipes: 115

Secchi disk: 9m

Bulk (0.5m)
Cast 1 position: 79°04.684N, 071°39.144W Time: 15:21
Cast 2 position: 79°04.703N, 071°39.020W Time: 15:28
Cast 3 position: 79°04.712N, 071°38.933W Time: 15:32
Salinity: 22.7
Temperature: 6.0°C
pH: 7.8
Three casts were done. TIC/Alk a + b bottles were taken from first cast, TIC/Alk c bottle, salinity were taken from cast 2 and all other variables (including O18 as bottles were not on the Zodiac) were taken from cast 3. NOTE – A small clean bottle cap was lost in the bulk water before sub sampling for Oliver's TEP samples, Connie Lovejoy's samples and Vickie's IN samples.
O18 labelled – Z07a Z07b
Time finish all sampling: 15:50

CTD cast
Time: 15:45 Position: 79°04.740N, 071°38.673W

9.1.9 Station 9

Raining and overcast skies. Sampled near some old dirty ice (seal poop). Saw a seal close by. Mucus and birds feathers were spotted on the surface.

Microlayer

	Time	Position	Conditions
Start	16:04	69°10.009 N 100°44.018W	Slick. Raining.
Finish	16:12	69°10.164 N 100°43.496W	Rain had stopped. Still slick.

Salinity: 23.5
Temperature: 3.6°C
pH: 7.7
no. of swipes: 120

Secchi disk: 16m

Bulk (0.5m)
Cast 1 position: 69°10.057N, 100°43.840W Time: 16:04
Cast 2 position: 69°10.118N, 100°43.632W Time: 16:09
Cast 3 position: 69°10.222N, 100°43.301W Time: 16:17
Salinity: 22.0
Temperature: 3.6°C
pH: 7.7
Three casts were done. TIC/Alk a + b bottles were taken from first cast, TIC/Alk c bottle, salinity and O18 were taken from cast 2 and all other variables were taken from cast 3. NOTE – the TIC/Alk bottle bopper was forgotten so an estimation of head space was made.

O18 labelled – Z08a Z08b
Time finish all sampling: 16:30

CTD cast
Time: 16:24 Position: 69°10.307N, 100°43.050W
CTD did not go down full length as depth was shallow.

9.1.10 Station 10 (Cambridge Bay)

Cambridge Bay area: a little windy, some sun, generally calm. Slick area with some bubbles/green gloop/biological stuff in it. Splashes into the microlayer were unavoidable due to Zodiac bobbing around a lot.

Microlayer

	Time	Position	Conditions
Start	14:54	68°55.897 N 105°19.809W	Slick. Gloopy stuff floating around (not from the ship though).
Finish	15:03	68°55.983 N 105°19.957W	Still slick. Still gloop.

Salinity: 24.5
Temperature: 3.3°C
pH: 7.8
no. of swipes: 115

Secchi disk: 17m

Bulk (0.5m)
Cast 1 position: 68°55.932N, 105°19.870W Time: 14:58
Cast 2 position: 68°56.020N, 105°20.014W Time: 15:07
Cast 3 position: 68°56.109N, 105°20.145W Time: 15:16
Salinity: 21.6
Temperature: 5.8°C
pH: 7.8
Three casts were done. TIC/Alk a + b bottles were taken from first cast, TIC/Alk c bottle, salinity and O18 were taken from cast 2 and all other variables were taken from cast 3.
O18 labelled – Z09a Z09b
Time finish all sampling: 15:30

CTD cast
Time: 15:24 Position: 68°56.199N, 105°20.277W
CTD did not go down full length as depth was shallow.

10 Sea surface properties and remote sensing – Leg 1

ArcticNet Phase 3 – Remote Sensing of Canada's New Arctic Frontier.
http://www.arcticnet.ulaval.ca/pdf/phase3/remote-sensing.pdf

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10.1 Introduction

Light drives primary production and biogeochemical cycles. During summer, there's more daily light in the Arctic than anywhere else on the planet while, during winter, there is very little light. Light is dimmed by clouds and barely gets through ice. Cloud cover has increased in the past decade. Sea ice coverage and sea ice thickness are changing fast. There's less snow on the ice, less ice and more water. Global albedo of the arctic surface decreases, thus temperature rises faster and faster (twice faster in the Arctic than anywhere else). Permafrost is thawing and releasing organic matter (which light and bacteria transform in CO_2). Amount of fresh water from river discharge and ice melting is increasing, reinforcing stratification in the system, as more light is available for the water column without ice. In these conditions, it isn't easy to predict carbon fixation rates. Such changes stressed the need for accurate data through field campaigns.

10.2 Methodology

Light was measured using several instruments in order to quantify its effect on photochemistry and biological production. Measurements of apparent optical properties and inherent optical properties obtained in the field were compared with satellite-based measurements.

10.2.1 Atmospheric measurements

The atmosphere causes light to vary in magnitude and spectral shape. A sunphotometer was used to derive the aerosol optical thickness and ozone concentration, radiometer was mounted on the wheelhouse to record the down welling light and two radiometers were attached on the bow of the ship (Figure 10.1) to measure the water reflectance (HYPERSAS) and quantify how the water surface modifies the geometry of the light field.

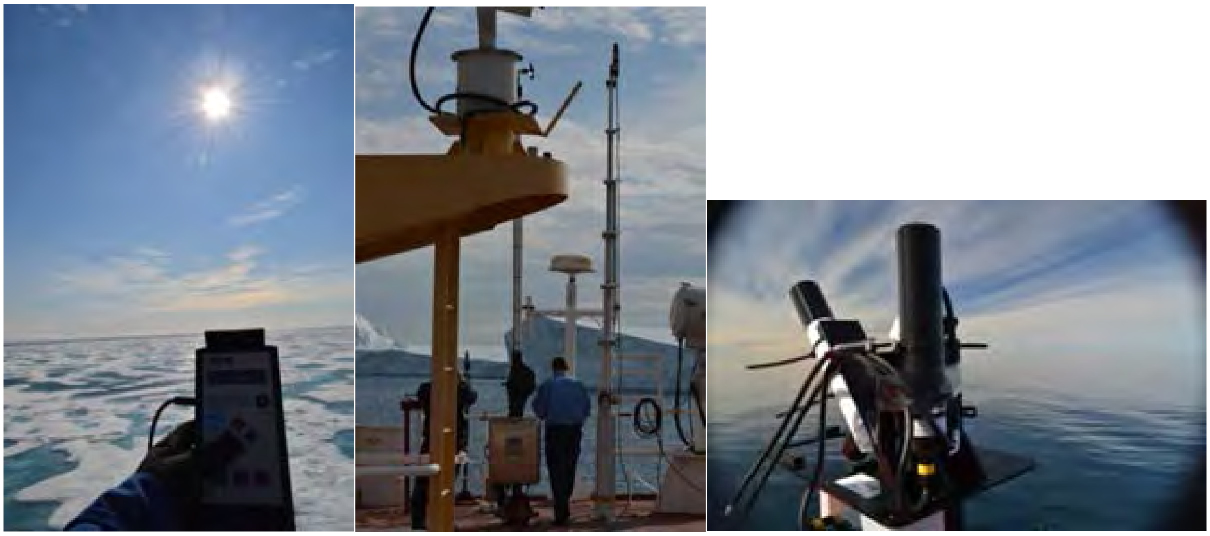

Figure 10.1. Instruments measuring atmospheric parameters: Sunphotometer (left), Radiometer located on the wheelhouse (centre), and Radiometers at the bow of the ship (right).

10.2.2 Water column measurements

Radiometers (15 wavelengths) were deployed to characterize the distribution of light (upwelling and down welling irradiance) as a function of depth in the photic layer (COPS). The reference radiometer, GPS and Bioshade were mounted on a telescopic mast on the barge. An optical package was also deployed to measure CTD and scattering, either from the barge or from the foredeck using the A-frame (Figure 10.2).

Figure 10.2. Instruments measuring water column parameters: Radiometer (left), Reference radiometer, GPS and Bioshade used on the barge (centre), and Optical instruments (right).

10.2.3 Water samples processing

Surface seawater was sampled from the barge while the Rosette was used to sample surface and maximum chlorophyll at Full and Basic stations. During transit along the Labrador and Baffin Island coasts, the seawater coming from the thermosalinograph (TGS; water pumped continuously from a 5 m depth underneath the ship) was sampled at regular intervals. Melt pond water was also analysed.

Seawater samples were filtered using different systems previous to analyses of absorption by particles and colored dissolved organic matter (CDOM) (Figure 10.3).

Figure 10.3. Filtration systems used for: Absorption of particulates (left), and absorption of colored dissolved matter (right).

To measure the *in vivo* light, absorption by particles and colored dissolve organic matter (CDOM), analyses were performed according to the Tassan and Ferrari methods. This method combines light transmission and light reflection measurements before and after extraction of the pigments with methanol. Spectrum readings were made using a spectrophotometer Cary UV 100.

Pigments concentration and type were assessed using HPLC techniques. Particulate Organic Carbon (POC) and Nitrate (PON) were also sampled and preserved, and will be analyzed at the lab.

10.3 Preliminary results

Results from the COPS instrument were processed on the ship and provide data on the rate at which light is attenuated (K0Edz) in the water column (m) (Figure 10.4).

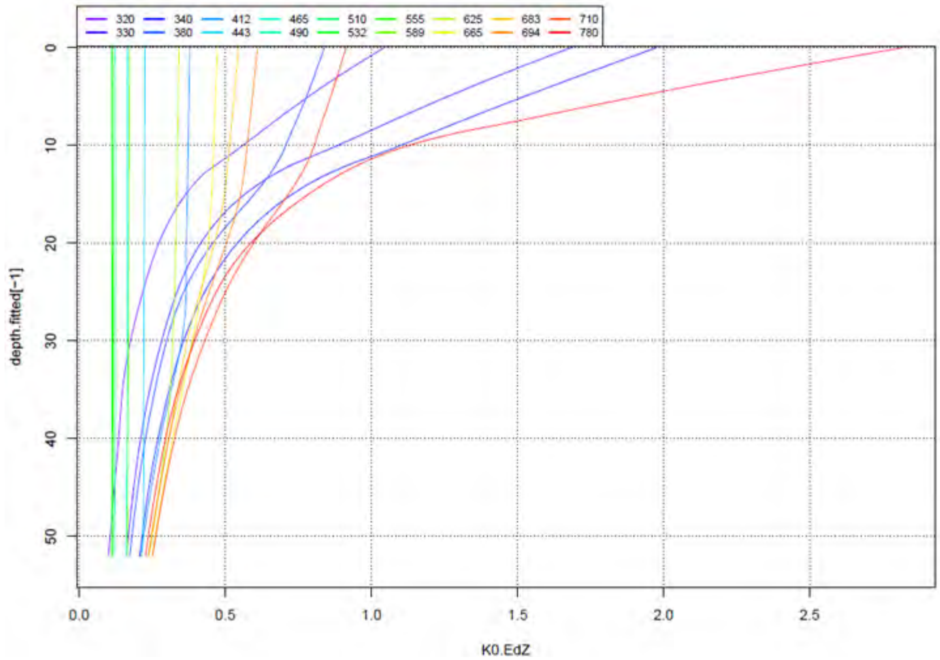

Figure 10.4. Example of light attenuation curves at the Kane1 station sampled on 03 August 2014 during Leg 1.

Results from CTD casts obtained with the Optical (IOP) package were also processed onboard for comparison with the Hydroscat data (data not shown).

10.4 Comments and recommendations

Many technical issues were encountered during Leg 1. The BioShade was mounted on a mast as part of the COPS reference to normalize the underwater light measurements. Even though it was calibrated in April, the shadow band, which informs on the direct to diffuse light ratio, wasn't working. It should be sent back to Biospherical to resolve this issue and tested prior to the cruise.

There was a slight offset with the pressure gauge on the CTD, which was solved by creating a new calfile integrating this pressure offset based on the previous offset values. Sending the instrument for calibration should solve the problem for next year.

The spectrophotometer stopped working halfway through the cruise and it was impossible to resolve the problem despite several attempts. The samples were frozen after filtration and stored at -80°C for the absorption particulate analyses and at 4 °C for CDOM analyses.

The TSG line during Leg 1a did not produce very good samples due to rust contamination. The line needed to be flushed several times to avoid rust particles that could potentially contaminate the absorption measurements.

All equipment deployed from the barge was autonomous, but equipment or a laptop may need to recharge while on the barge (loss of battery because of cold temperatures, for instance). The 120VAC power supply on the barge was too weak (0,5A) and the power delivering limits should be upgraded. The electrician on board was asked to order the necessary equipment to get 30A at 120VAC independent power on the barge.

11 CTD-Rosette, LADCP and UVP operations – Legs 1, 2 and 3

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Cruise participants Leg 2: Lou Tisné[2] and Pascal Guillot[3]
Cruise participants Leg 3: Sylvain Blondeau[3] and Line Bourdages[4]
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11.1 Introduction

The objective of this shipboard fieldwork was to characterize the water column physical and chemical properties: temperature, salinity, fluorescence, CDOM, dissolved oxygen concentration, nitrate concentration, light penetration and turbidity. A SBE 911 CTD was used in conjunction with various other sensors mounted on a cylindrical frame known as a Rosette. A 300 kHz Lowered Acoustic Doppler Current Profiler (LADCP) was attached to the frame to provide vertical profiles of the velocities on station. The Rosette was also equipped with Niskin bottles, which were used to supply water samples for biologists and chemists.

11.2 Methodology – CTD-Rosette

The Rosette frame was equipped with twenty-four (24) 12-litre bottles and the sensors described in Table 11.1 and 11.2.

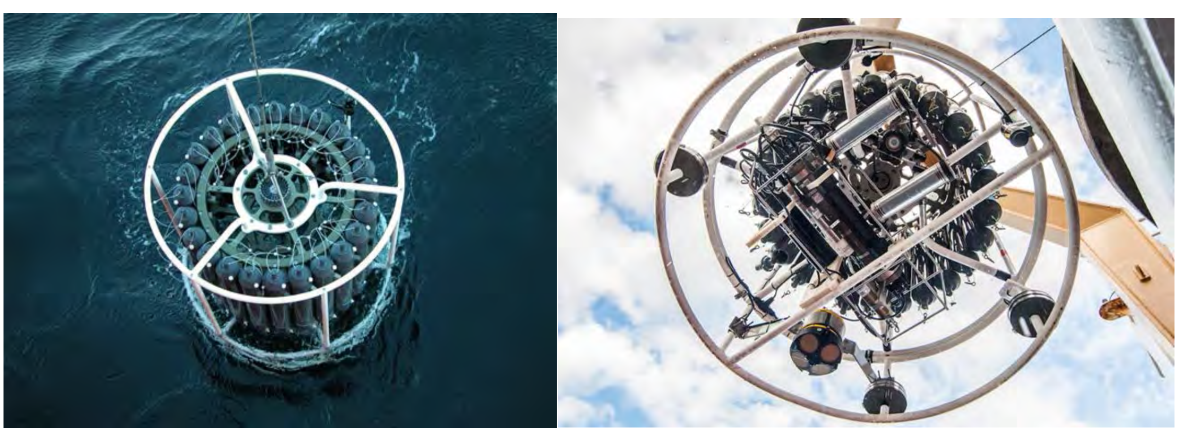


Figure 11.1. Photos of the Rosette used on the CCGS *Amundsen*. Photo: Jessy Barrette.

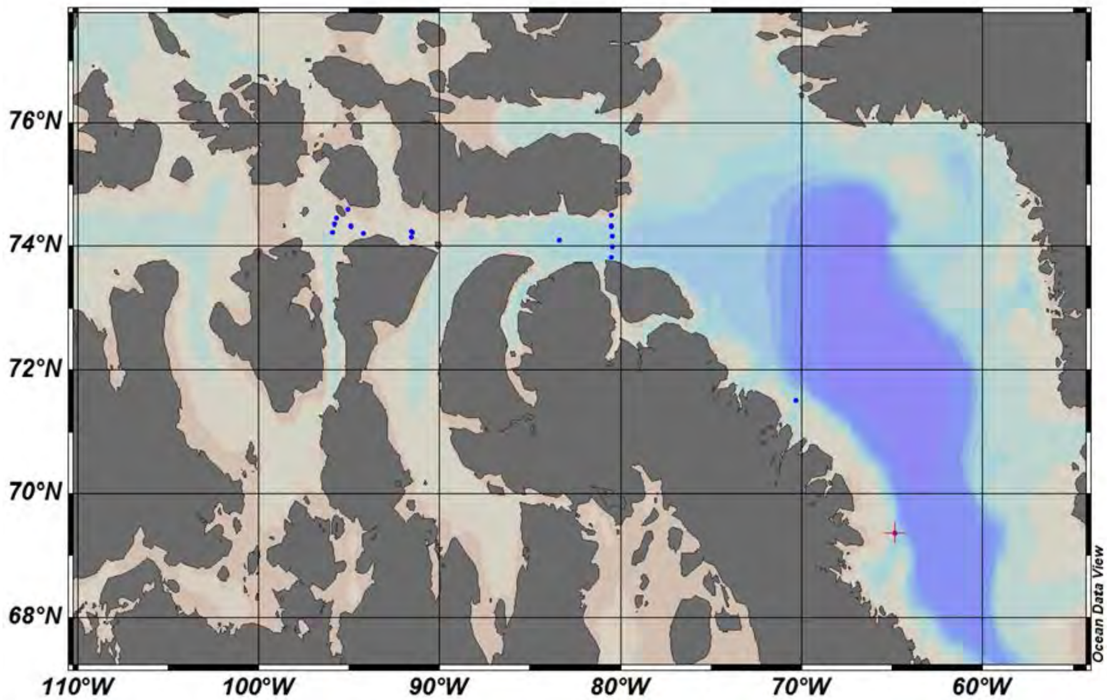


Figure 11.2. Rosette casts locations for Leg 1a.

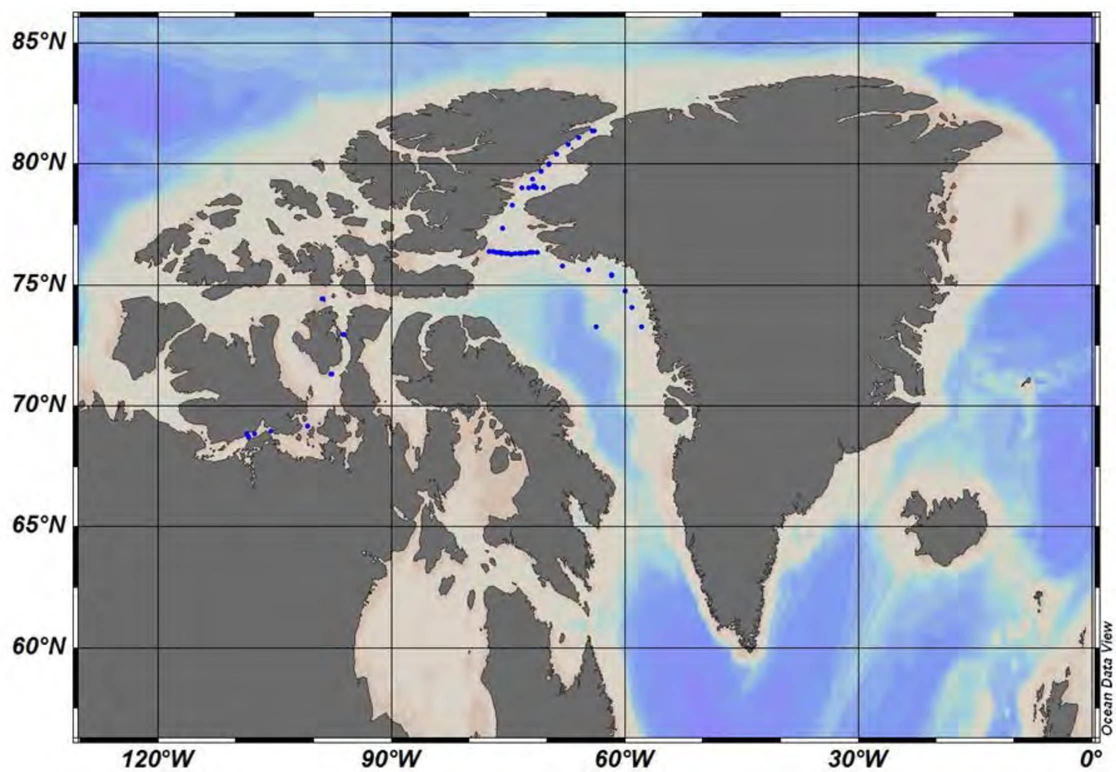


Figure 11.3. Rosette casts location for Leg 1b.

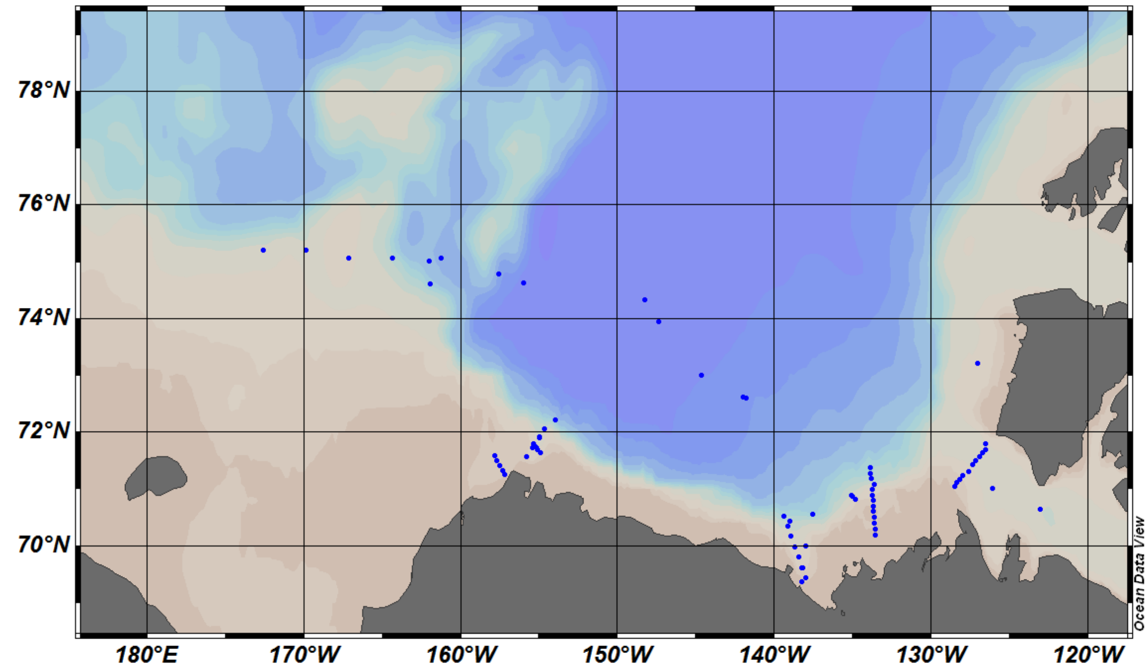


Figure 11.4. Rosette casts location for Leg 2.

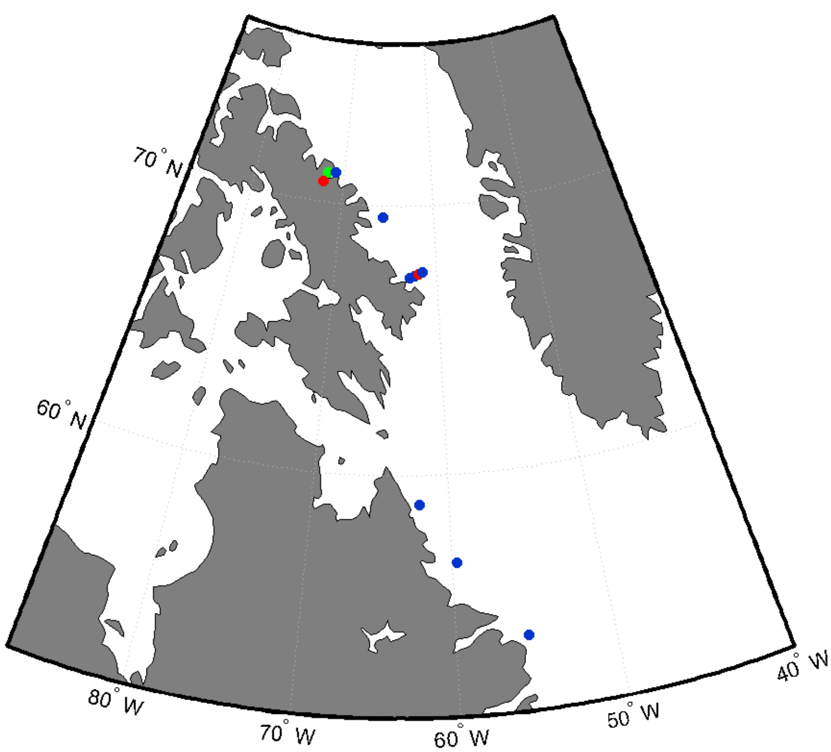


Figure 11.5. Rosette casts location for Leg 3.

11.2.1 Rosette sensors

Table 11.1. Description of sensors equipped on the Rosette.

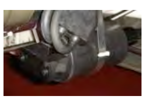
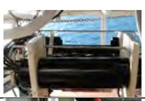
Photo	Instrument	Manufacturer	Type & Properties	Serial Number
	Data Logger	SeaBird	SBE-9plus Sampling rate: 24 Hz	0679
	Temperature	SeaBird	SBE 3plus Range: -5ºC to + 35ºC Accuracy: 0.001	4318
	Pressure	SeaBird	Accuracy: 0.015% of full range	0679
	Conductivity	SeaBird	SBE 4C Range: 0 to 7 S/m Accuracy: 0.0003	042696
	Oxygen	SeaBird	SBE-43 Range: 120% of saturation Accuracy: 2% of saturation	0240
	Nitrates	Satlantic	MBARI ISUS Range: 0.5 to 200 μM Accuracy: ± 2 μM	132
	PAR	LICOR	PAR Dynamic Range: 1.4x10^{-5} to 0.5 μE/(cm^2 sec)	4664
	SPAR	LICOR	PAR Spectral Response: Equal (better than ±10%) quantum response from 400 to 700nm	20123
	Fluorometer	Sea Point	Minimum Detectable Level 0.02 µg/l Gain Sens, V/(µg/l) Range/(µg/l), 30x 1.0 5 10x 0.33 15 3x 0.1 50 1x 0.033 150	3114
	Transmissometer	WetLab	Path length: 25 cm Sensitivity: 1.25 mV	CST-558DR
	Altimeter	Benthos	Range: 50 m from bottom	1065
	ECO fluorometer (CDOM)	Wet Labs	FL(RT)D Digital output resolution: 14 bit Analog output signal: 0-5V Range: 0.09-500ppb Ex/Em: 370/460nm	2344
	Underwater Vision Profiler (UVP)	Hydroptic		008

Table 11.2. Specifications for the sensors equipped on the Rosette.

Parameter	Sensor		Range	Accuracy	Resolution
	Company	Instrument Type			
Data Logger	SeaBird	SBE-9plus [1]			
Temperature	SeaBird	SBE-03 [1]	-5°C to +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)

Parameter	Sensor		Range	Accuracy	Resolution
	Company	Instrument Type			
Pressure	Paroscientific	410K-105	up to 10 500m (15 000 psia)[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
Nitrates concentration	Satlantic	MBARI-ISUS 5T [6]	0.5 to 2000 µM	±2 □M	±0.5 µM
Light intensity (PAR)	LICOR			□	□
sPAR	LICOR			□	
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
CDOM fluorescence	Wet Labs	FL(RT)D [7]	0.09-500 ppb	unknown	14 bit
UVP	Hydroptic	UVP	150µm – 3cm		

Notes: [1] Maximum depth of 6800m; [2] Depending on the configuration; [3] Maximum depth of 7,000m; [4] In all natural waters, fresh and marine; [5] Maximum depth of 1200m; [6] Maximum depth of 1000m; [7] Maximum depth of 6000m.

11.2.2 Probe calibration

Salinity – Seabird CTD. Water samples were taken on several casts with 200 mL bottles (Figure 11.6). They were analyzed with a GuildLine, Autosal model 8400B. Its range goes from 0.005 to 42 PSU with accuracy better than 0.002.

Salinity – Seabird TSG. Water samples were taken at different times during the transits from the surface thermosalinograph. The probe was located in the engine room. The samples were analyzed with a GuildLine.

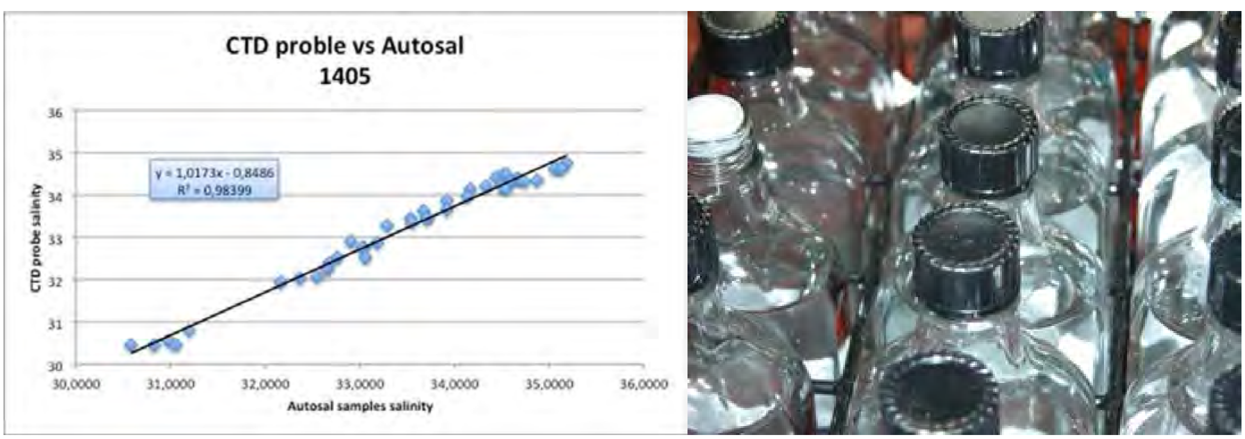


Figure 11.6. Example of a calibration curve (left) and photo of the bottles used to collect water samples to measure salinity (right).

Oxygen. Oxygen sensor calibration was performed based on dissolved oxygen concentration measured in water samples using Winkler's method and a Mettler Toledo titration machine (Figure 11.7). Reagent blanks were performed once, results show that chemicals are still good (m<1). Oxygen was sampled on three casts (1405007, 1405031 and 1405054). Five depths were selected with different oxygen concentrations and three samples were collected at each depth.

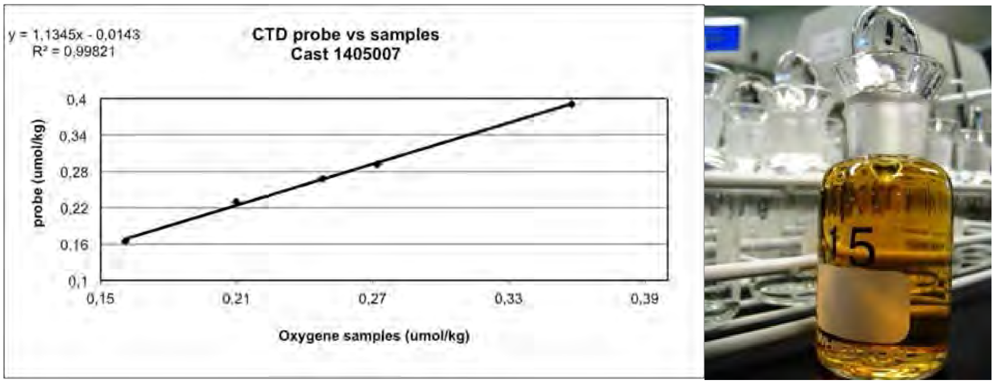


Figure 11.7. Example of oxygen calibration curve (left) and photo of the bottles used to collect water samples to measure oxygen (bottom right).

11.2.3 Water sampling

Water was sampled with the Rosette according to each team's requests. To identify each water sample, the term "Rosette cast" was used to describe one CTD-Rosette operation. A different cast number was associated with each cast. The cast number was incremented every time the Rosette was lowered in the water. The cast number was a seven-digit number: **xxyyzzz,** where:

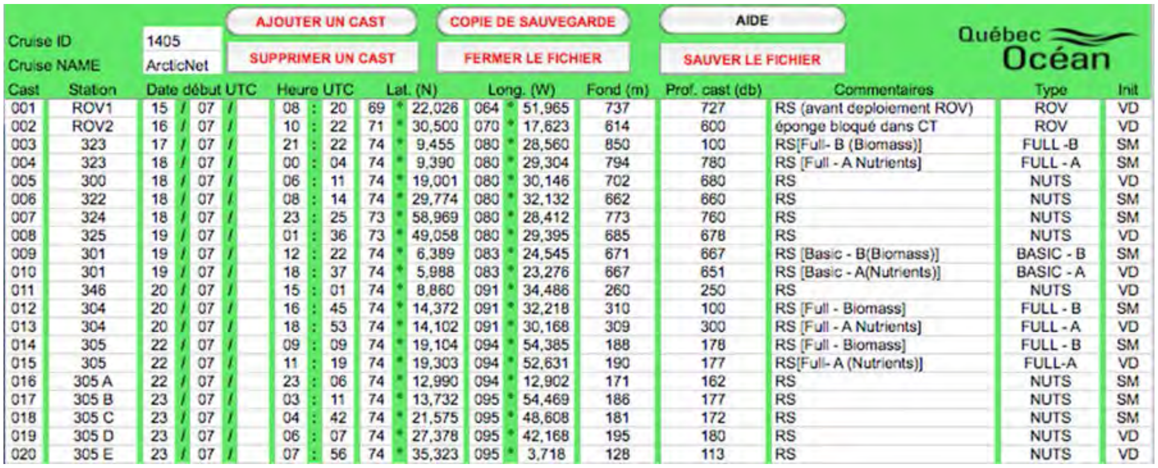
xx: the last two digits of the current year
yy : a sequential (Québec-Océan) cruise number
zzz : the sequential cast number

The first cast numbers for the Legs 1, 2 and 3 were respectively **1405001**, **1406001** and **1407001**. To identify the twenty-four Rosette bottles on each cast, the bottle number was simply appended: **1405001nn**, where "nn" is the bottle number (01 to 24).

Four types of CTD-Rosette casts were defined:

CTD casts: CTD profiles are only for sound speed and mooring calibration.
Nutrients casts: Samples are obtained for Nutrients studies.
Basic and Full casts: Samples are obtained for Mercury, Diversity, Dissolved Oxygen, CDOM, DNA, CH4, Salinity, etc.

All the information concerning the Rosette casts is summarized in the *CTD Logbook* (one line per cast, Appendix 3). The information includes the cast number and station id, date and time of sampling in UTC, latitude and longitude, bottom and cast depths, and minimalist comments concerning the casts (Figure 11.8).


Cruise ID 1405
Cruise NAME ArcticNet
AJOUTER UN CAST | COPIE DE SAUVEGARDE | AIDE
SUPPRIMER UN CAST | FERMER LE FICHIER | SAUVER LE FICHIER
Québec Océan

Cast	Station	Date début UTC	Heure UTC	Lat. (N)	Long. (W)	Fond (m)	Prof. cast (db)	Commentaires	Type	Init
001	ROV1	15 / 07 /	08 : 20	69 ° 22,026	064 ° 51,965	737	727	RS (avant deploiement ROV)	ROV	VD
002	ROV2	16 / 07 /	10 : 22	71 ° 30,500	070 ° 17,623	614	600	éponge bloqué dans CT	ROV	VD
003	323	17 / 07 /	21 : 22	74 ° 9,455	080 ° 28,560	850	100	RS[Full- B (Biomass)]	FULL -B	SM
004	323	18 / 07 /	00 : 04	74 ° 9,390	080 ° 29,304	794	780	RS [Full - A Nutrients]	FULL - A	SM
005	300	18 / 07 /	06 : 11	74 ° 19,001	080 ° 30,146	702	680	RS	NUTS	VD
006	322	18 / 07 /	08 : 14	74 ° 29,774	080 ° 32,132	662	660	RS	NUTS	SM
007	324	18 / 07 /	23 : 25	73 ° 58,969	080 ° 28,412	773	760	RS	NUTS	SM
008	325	19 / 07 /	01 : 36	73 ° 49,058	080 ° 29,395	685	678	RS	NUTS	VD
009	301	19 / 07 /	12 : 22	74 ° 6,389	083 ° 24,545	671	667	RS [Basic - B(Biomass)]	BASIC - B	SM
010	301	19 / 07 /	18 : 37	74 ° 5,988	083 ° 23,276	667	651	RS [Basic - A(Nutrients)]	BASIC - A	VD
011	346	20 / 07 /	15 : 01	74 ° 8,860	091 ° 34,486	260	250	RS	NUTS	VD
012	304	20 / 07 /	16 : 45	74 ° 14,372	091 ° 32,218	310	100	RS [Full - Biomass]	FULL - B	SM
013	304	20 / 07 /	18 : 53	74 ° 14,102	091 ° 30,168	309	300	RS [Full - A Nutrients]	FULL - A	VD
014	305	22 / 07 /	09 : 09	74 ° 19,104	094 ° 54,385	188	178	RS [Full - Biomass]	FULL - B	SM
015	305	22 / 07 /	11 : 19	74 ° 19,303	094 ° 52,631	190	177	RS[Full- A (Nutrients)]	FULL-A	VD
016	305 A	22 / 07 /	23 : 06	74 ° 12,990	094 ° 12,902	171	162	RS	NUTS	SM
017	305 B	23 / 07 /	03 : 11	74 ° 13,732	095 ° 54,469	186	177	RS	NUTS	SM
018	305 C	23 / 07 /	04 : 42	74 ° 21,575	095 ° 48,608	181	172	RS	NUTS	SM
019	305 D	23 / 07 /	06 : 07	74 ° 27,378	095 ° 42,168	195	180	RS	NUTS	VD
020	305 E	23 / 07 /	07 : 56	74 ° 35,323	095 ° 3,718	128	113	RS	NUTS	VD

Figure 11.8. Example of CTD logbook created for each station and cast.

An Excel® *Rosette Sheet* was also created for every single cast. It includes the same information as the CTD Logbook plus a table of what was actually sampled and at what depth. Weather information at the sampling time is included in each Rosette Sheet and is summarized as well in a *Meteorological Logbook* (one line per cast). For every cast, data from three seconds after a bottle is closed to seven seconds later is averaged and recorded in the ascii '*bottle files'* (files with a *btl* extension). The information includes the bottle number, time and date, trip pressure, temperature, salinity, light transmission, fluorescence, dissolved oxygen, irradiance and CDOM measurements.

All those files are available in the directory "Data\Rosette" on the 'Shares' folder on the *Amundsen* server. There are six sub-directories in the rosette folder.

\Rosette\log\: Rosette sheets, Meteorological and CTD logbooks.
\Rosette\plots\: plots of every cast (Png® and Pdf® files) including salinity, temperature, oxygen, light transmission, nitrate, fluorescence and irradiance data.
\Rosette\odv\: Ocean Data Viewer file that include .cnv cast files.
\Rosette\svp\: bin average files to help multibeam team to create a salinity velocity profile.
\Rosette\avg\: bin average files of every cast.
\Rosette\LADCP\: LADCP post-process data results.

11.3 Methodology – Lowered Acoustic Doppler Current Profiler (LADCP)

A 300 kHz LADCP (a RD-Instrument Workhorse®) was mounted on the Rosette frame (Figure 11.9). The LADCP gets its power through the rosette cable and the data is uploaded on a portable computer connected to the instrument through a RS-232 interface after each cast. 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. The settings were 57600 bauds, with no parity and one stop bit. Since the LADCP is lowered with the rosette, there were several measurements for each depth interval. The processing was done in Matlab® according to Visbek (2002).

Figure 11.9. The 300 kHz LADCP mounted on the Rosette frame.

Sometimes, the BBtalk software didn’t recognize the LADCP. When this occurred, it was impossible to download data. In order to reactivate the communication, the software had be turned off and reopened. The baud rate was changed from 9700 to 57600 to facilitate the recovery of the recorder tool. During Leg 2, interferences were detected, possibly because of other scientific probes. Several tests were conducted and revealed that the altimeter connected to the CTD created noise. Moreover, during Legs 2 and 3, warnings during data download indicated that LADCP’s beam 4 was malfunctioning and that the instrument voltage was low.

11.4 Methodology – Underwater Vision Profiler (UVP)

The UVP5 is an instrument designed to take pictures of a slice of water illuminated by 2 rows of flashing LEDs while profiling or while being moored (Figure 11.10). Image processing can be performed either onboard while profiling, or in delayed mode after data recovery (at the user's convenience). The image processing provides estimates of particle size distribution and stores vignettes of the particles found in the images. The pixel size of the camera is approximately 150 microns, so that the particles detected by the UVP range from 150 microns up to a few centimeters.

The UVP main cylindrical case includes a camera, containing itself a hard drive (HD) and a flash drive (FD). There are 2 modes that can be used to record the images and process them. In clear waters, the "mixfd" mode is given preference; it processes the images while acquiring data, and stores only vignettes taken from the entire images. In more turbid waters, the "fullhd" mode is preferred; it stores the entire image on the camera hard drive (64Go USB drive).

Figure 11.10. Photo of the UVP mounted on the Rosette.

A complete training concerning the UVP was given by Marc Picheral by videoconference on April 2013 and was attended by P. Guillot, T. Linkovsky, A. Forest, G. Becu and C. Marec.

The UVP was shipped back from a cruise onboard the icebreaker USGS *Healy*, presenting a problem on the HD storage unit. Due to the late arrival of the equipment this problem could not be fixed on time before the departure of CCGS *Amundsen* from Quebec, so that he UVP could only be installed for Leg 1b. During Leg 1b, casts were performed in the mixtfd mode, in depth sequence operating mode. UVP voltage output was acquired as a voltage channel (Userpoly) by the SBE9+ (Y cable with ISUS channel). This is mainly a monitoring of the functioning of the UVP, which is self-logging equipment.

All the Leg 1 casts were successfully acquired, except six, when the battery was discharged (corresponding to CTD casts 37, 38, 39, 40, 41 and 50). The power shunt was suspected as the reason for a power leakage and a new one was made onboard. The internal limit of power to put the equipment in sleep mode was set to 23.3v (instead of the default value 25.5v).

At the beginning of Leg 3, one of the UVP lamps needed to be replaced because it was cracked. The UVP then performed without issue until the last three casts (1407009, 1407010 and 1407011), during which no data could be retrieved. At the end of the leg, the reason for this data acquisition issue remained unknown, as the battery was charged (above 27.5) on all three casts and the methodology did not change between casts 008 and 009.

11.5 Preliminary results

All of the preliminary results are based on raw data (i.e. not processed or validated) and figures must not be used.

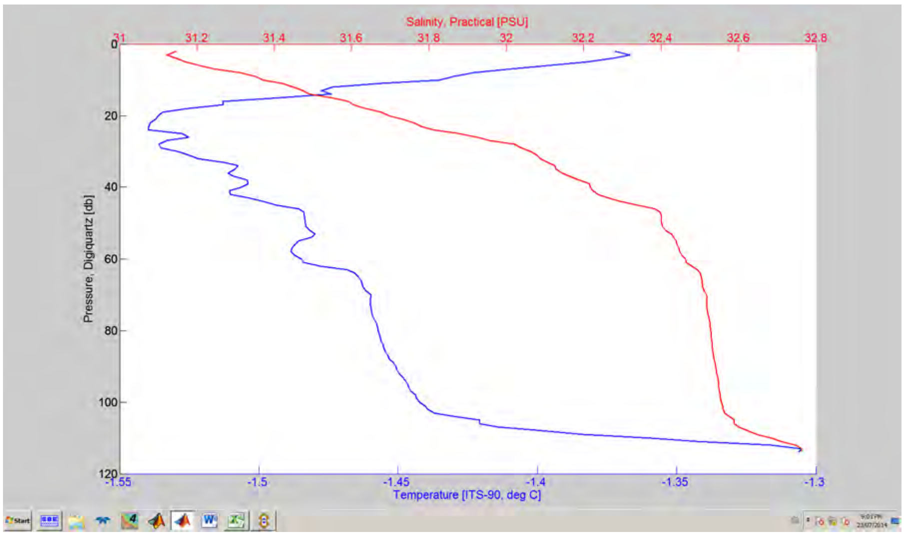


Figure 11.11. Example of temperature and salinity profiles during Leg 1 (cast 1405020).

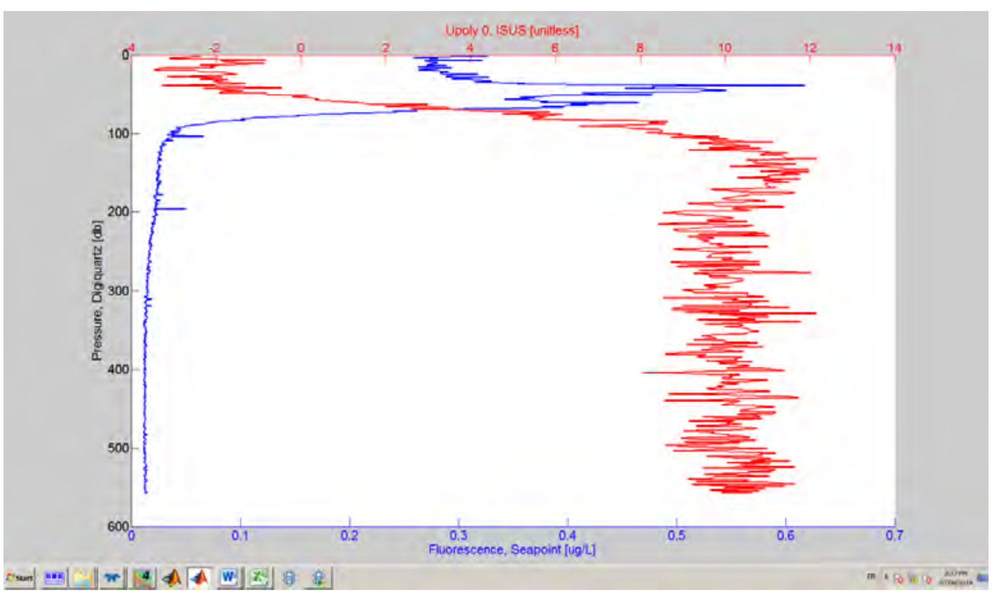


Figure 11.12. Example of nitrate and fluorescence profiles during Leg 1 (cast 1405020).

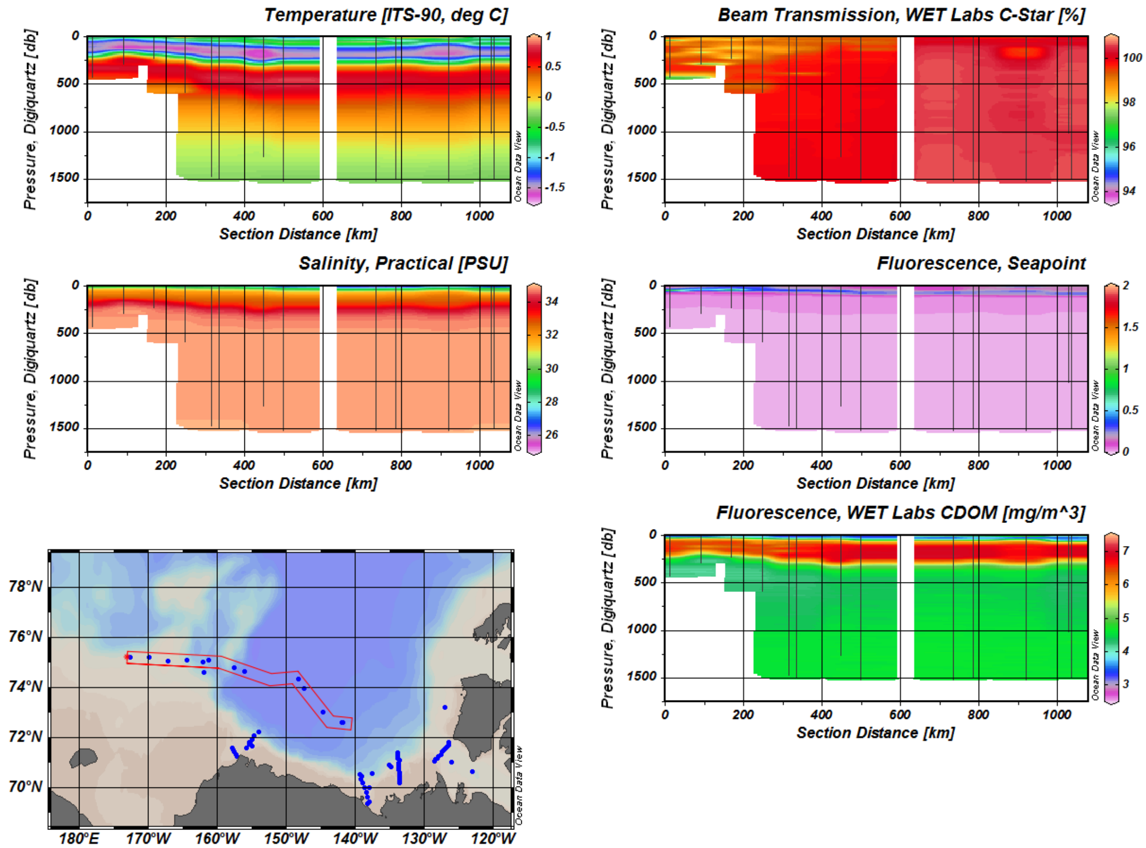


Figure 11.13. Example of the evolution of the main parameters along a West-East transect during Leg 2.

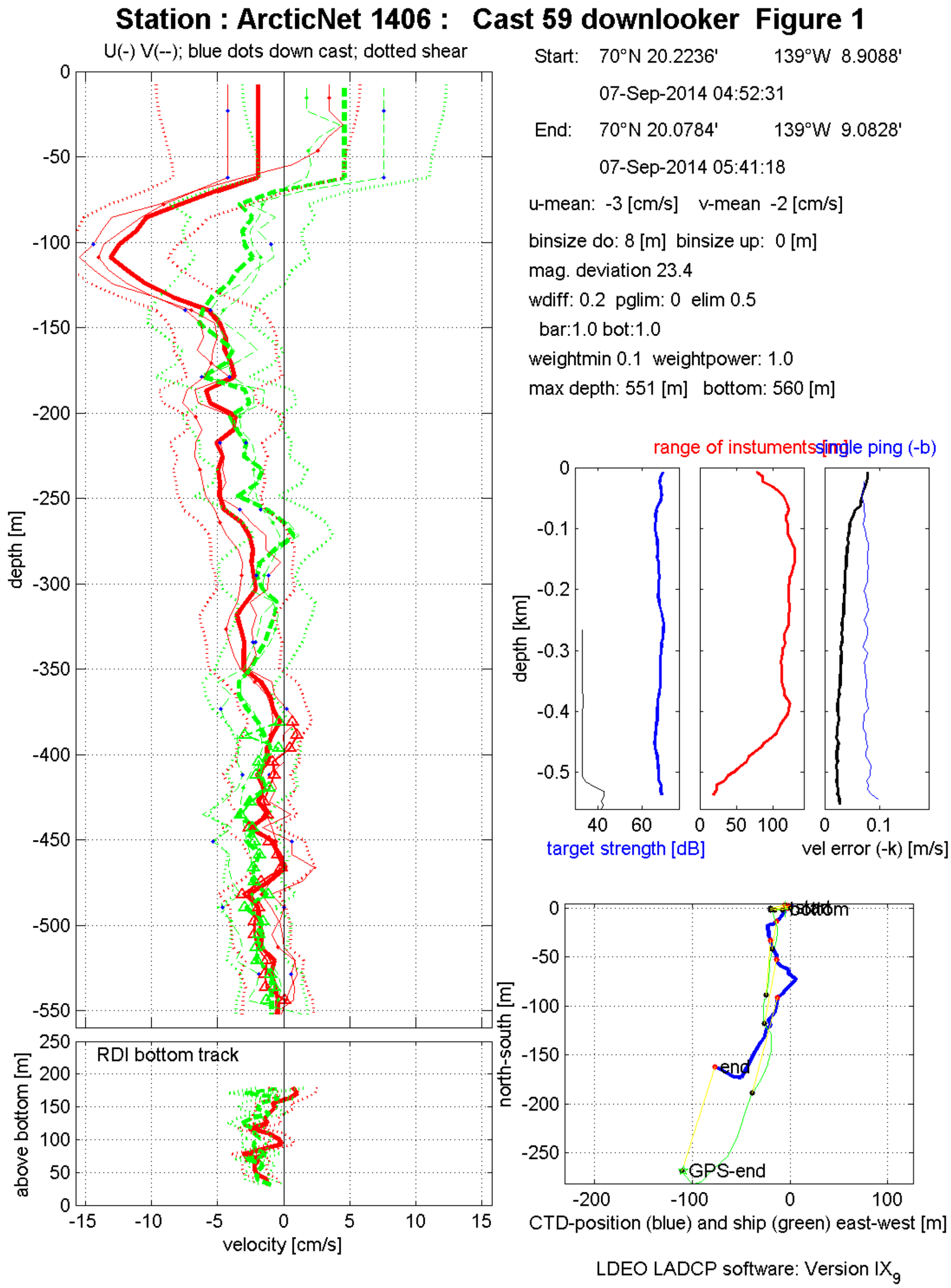


Figure 11.14. Example of current velocities recorded by the LADCP during Leg 2 (cast 1406059).

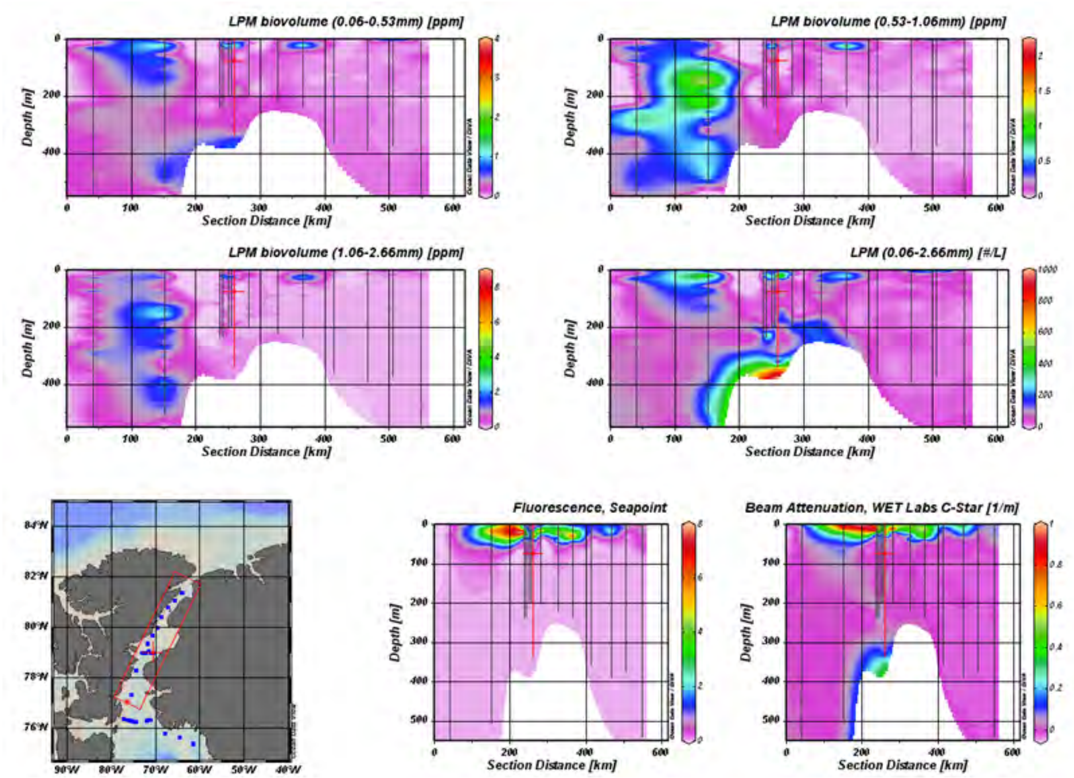


Figure 11.15. Example of UVP data that were processed onboard by C. Marec during Leg 1 (UVP data merged to CTD data). See above for an example of preliminary results of a section showing biovolume and particle abundance, as well as data from the Chl*a* fluorometer and C-star transmissiometer.

Figure 11.16. Example of picture recorded by the UVP5.

11.6 Comments and recommendations

Rosette bottles. Several elastic bands should be replaced inside the bottles.

Rosette sensors. On three casts during Leg 1a, some sensors showed out of range peak values when the CTD was stopped for bottle closing.

Pump. At the end of Sea Trials, the pump was changed. Pump number 53667 stopped and started intermittently and was replaced by pump number 53382. No problem during Leg 1.

Carousel. No known problem.

CTD. No known problem.

Deck Unit. No known problem.

Deck material (winch, A-frame, etc.). No Problem. The new winch performed well.

Server ADAS data Backup. During Leg 1a, the software used to backup data to the ADAS was changed from NetBak Replicator to SyncBack.

Data processing. Several changes were made for the arborescence of data on the CTD-process computer. The "Revisions 2014" text file can be found in Data2014/Rosette/Protocole.

Conductivity probe "SBE4C. Results from the SBE4C probe calibration showed a significant drift. The salinity bottle sampling needs to be continued at regular frequency during the next leg in order to assess the evolution of this drift.

Oxygen sensor. During Legs 2 and 3, the Toledo analyzer stopped working properly and the calibration could not be performed. Results from Leg 1 will be used to post-calibrate the SBE43 oxygen sensor. The electrode should probably be changed.

Salinometer Autosal. At the beginning of the Leg 1, it was impossible to standardize the salinometer with a fixed range. This problem was due to the room's temperature: as the temperature could not be regulated and kept stable, the GuildLine would not work properly. It would be important for the next expedition to install a thermometer in this room. During Leg 2, special attention has been paid to maintain the autosal room at an appropriate temperature. Salinity bottles have also been cleaned with HCL 10% in order to improve accuracy.

LADCP. The instrument must be sent to RDI for a complete check up. A solution must be found to stop the altimeter from creating interference with the ADCP. The beam 4 should be repaired and the voltage issue should be troubleshot.

UVP. The data acquisition issue during the last three casts of the Leg 3 should be investigated.

Stations. Bad weather interfered with sampling at several stations that were initially planned for Leg 3. In fact, 10 stations out of 13 were skipped in the Baffin Bay region (i.e. 166, 172, 171, 170, 169, SI, 173, 178, 181 and 180) as well as 3 out of 3 in the Hudson

Strait (i.e. 353, 354 and 355). Additional unplanned stations have been sampled in Clarke and Gibbs Fjords (i.e. PCBC2, PCBC3 and Gibbs N).

References

Visbeck, M. 2002. Deep Velocity Profiling Using Lowered Acoustic Doppler Current Profilers: Bottom Track and inverse Solutions. Journal of Atmospheric and Oceanic Technology. 19: 794-807.

12 The intra-seasonal variability of the Beaufort Gyre and the pathway of the Pacific Summer Water – Leg 2b

ArcticNet Phase 3 – Long-Term Observatories in Canadian Arctic Waters.
http://www.arcticnet.ulaval.ca/pdf/phase3/marine-observatories.pdf
ArcticNet Phase 3 – Remote Sensing of Canada's New Arctic Frontier.
http://www.arcticnet.ulaval.ca/pdf/phase3/remote-sensing.pdf

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12.1 Introduction

In the Pacific sector of the Arctic Ocean, drastic reduction of sea ice during summer has been observed, especially since 2007. Causes for the reduction of sea ice are thought to be 1) the ocean heat content in the surface mixed layer (Steel et al. 2008), 2) Pacific Summer Water (hereafter, PSW) usually found in the subsurface (~50 m water depth) layer (Shimada et al. 2006) and 3) the low pressure system carrying ice pack away from main ice pack resulting in efficient melt of sea ice (Parkinson and Comiso 2013). All of them may have an impact on the suppression of sea ice growth, but it is hard to identify the contribution of each to sea ice reduction, simultaneously. However, based on the time series of sea ice concentration measured by the satellite microwave remote sensing and results from the hydrographic surveys, the PSW is a primary suspect for sea ice reduction. Moreover, from the viewpoint of specific of heat, the PSW contains large amount of heat, so that it must be well understood where and when the PSW is delivered in the Arctic Ocean.

The PSW is coming through the Bering Strait (July) and the Barrow Canyon (September to October), and then enters in the Canada Basin (during winter). In the Canada Basin, there is the clockwise Beaufort Gyre driven by the sea surface stress. Due to the clockwise circulation of the Beaufort Gyre, the PSW is delivered to the Chukchi Border Land. Hence the spatial distribution and strength of the Beaufort Gyre is the key to understand where and when the PSW is delivered.

Before this cruise, the team has investigated the Dynamic Ocean Topography (DOT) derived from the Cryosat-2/SIRAL (Synthetic Interferometric Radar ALtimeter). Monthly DOT and sea surface stress field (wind and sea ice motion) suggest that the spatial distribution and strength of the Beaufort Gyre are quickly changed responding to sea surface stress (intra-seasonal variability).

Based on the background described above, the specific objectives were as follows:

- Validate the DOTs derived from the Cryosat-2/SIRAL data in the sea ice-covered area;
- Improve the method of the spatial interpolation (the optimum interpolation) for obtaining more realistic DOTs;
- Elucidate what kind of phenomena (e.g., eddies, heat contents of PSW, local warming, etc.) affect the DOTs;
- Investigate the location where the Pacific Summer Water was delivered during last winter → to validate the speculation based on the variability of the DOTs (or the Beaufort Gyre);
- Investigate the spatial distribution of ocean heat content.

12.2 Methodology

The dynamic ocean topography is a function of the density, which is calculated from vertical profiles of temperature and salinity. Hence, the CTD data (pressure, temperature and salinity) is needed to calculate the DOTs. However, the number of CTD casts depends on sea state and sea ice condition in the Arctic Ocean. As the hydrographic observation (and other samplings like net sampling) was sometimes cancelled, the following instruments were used to obtain temperature and salinity in the area where the Rosette + Seabird-911 could not be deployed. These allowed the increase of the CTD data spatial coverage during this cruise.

12.2.1 eXpendable Conductivity, Temperature and Depth (XCTD-1)

Temperature and salinity profiles were obtained by eXpendable CTD (XCTD) casts (Table 12.1). XCTD system, manufactured by the Tsurumi-Seiki Co. Ltd. (Yokohama, Japan), allows to measure ocean temperature and conductivity, (i.e. salinity), from sea surface down to 1100 m depth. It mainly consists of XCTD probe, launcher, digital converter and personal computer for data processing. The XCTD probes were launched from the after deck of the ship into water and sinked down with constant velocity, measuring temperature and conductivity. During this cruise, 36 probes were deployed, and 2 casts failed. One failure was due to a cut wire between a probe and a launcher, and the other one resulted from a bug of the software MK-130. 34 measurements of XCTD provided data from the Chukchi Plateau to the Canada Basin as well as some shorter sections from the shelf break along the Chuckchi Sea. Additional stations were measured in between the CTD stations to increase horizontal resolution.

Table 12.1. Locations of XCTD casts.

Cast number	Latitude (N)	Longitude (W)
XCTD01	73°03.972	159°15.300
XCTD02	73°45.114	161°10.734
XCTD03	74°40.500	162°56.700

Cast number	Latitude (N)	Longitude (W)
XCTD04	74°43.500	163°51.198
XCTD05	74°44.502	164°15.102
XCTD06	74°44.952	164°24.288
XCTD07	74°45.900	164°43.098
XCTD08	75°11.442	171°05.010
XCTD09	75°06.978	168°18.420
XCTD10	74°59.760	163°54.360
XCTD11	74°58.860	163°49.980
XCTD12	74°54.720	163°29.400
XCTD13	74°53.100	158°57.084
XCTD14	74°51.168	158°16.050
XCTD15	74°48.000	157°36.432
XCTD16	74°45.942	157°26.814
XCTD17	74°39.438	156°39.414
XCTD18	74°37.266	155°51.666
XCTD19	74°26.592	154°08.304
XCTD20	74°20.148	152°18.060
XCTD21	74°20.322	149°56.346
XCTD22	73°27.618	145°53.238
XCTD23	72°54.552	144°05.526
XCTD24	72°44.934	143°48.330
XCTD25	72°39.840	143°24.078
XCTD26	72°30.342	142°56.100
XCTD27	72°32.196	142°9.924
XCTD28	72°35.208	141°26.940
XCTD29	72°24.558	140°03.900
XCTD30	71°55.758	139°29.0160
XCTD30	71°55.758	139°29.0160
XCTD31	71°38.670	137°53.610
XCTD32	71°21.834	135°48.150
XCTD33	71°16.044	135°03.882
XCTD34	71°07.986	134°02.604

- Deployment @ the after deck (port side), 1 cast took 5-10 min;
- Measurements of vertical profiles of temperature and conductivity from sea surface to 1100m water depth;
- 34 casts were done from the Chukchi Border Land to eastern side of the Canada Basin.

Figure 12.1. The XCTD system at the after deck. (Upper) the digital converter MK-130, the launcher and a PC for operation, (Lower) a XCTD-1 probe. XCTD-1 probe can measure temperature and conductivity from ocean surface to 1100 m water depth. Depth (m) is calculated from the time started from when a XCTD probe enters the ocean.

12.2.2 Moving Vessel Profiler (MVP)

- Deployment @ the after deck;
- Measurements of vertical profiles of temperature and conductivity from ~20m to bottom (20m above sea floor);
- 50 casts were done in the Chukchi Plateau.

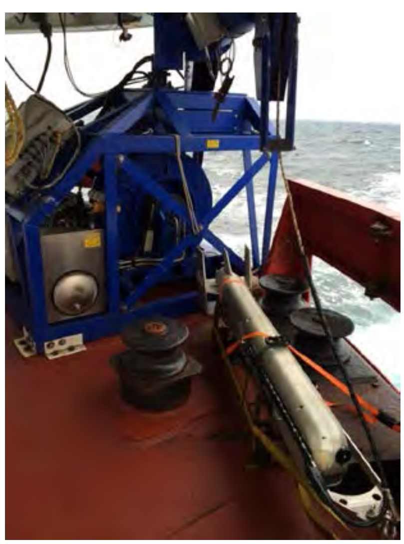

Figure 12.2. Moving Vessel Profiler and the winch mounted at the after deck.

12.3 Preliminary results

Only XCTD data are presented in this section, since the MVP measurements are ongoing, and CTD data need correction.

12.3.1 Locations of CTD/XCTD/MVP measurements

Figure 12.3 shows locations of CTD measurements during this cruise (Leg 2b). Black bullets and red circle with black cross indicate deployments of XCTD and Rosette+Seabird CTD, respectively. During this cruise, 36 probes of XCTD were deployed. Basic idea of XCTD cast is to increase the spatial resolution and to capture the ocean circulation, so that XCTD cast was made (1) between the Basic (or Nutrient/Full) stations, and (2) at the specific isobaths (500m, 750m, 1000m, 1250m and 1500m). Also we deployed XCTD at the station for the NORPAC net (except for Station NORPAC-1) to obtain profiles of temperature and salinity and to save ship time.

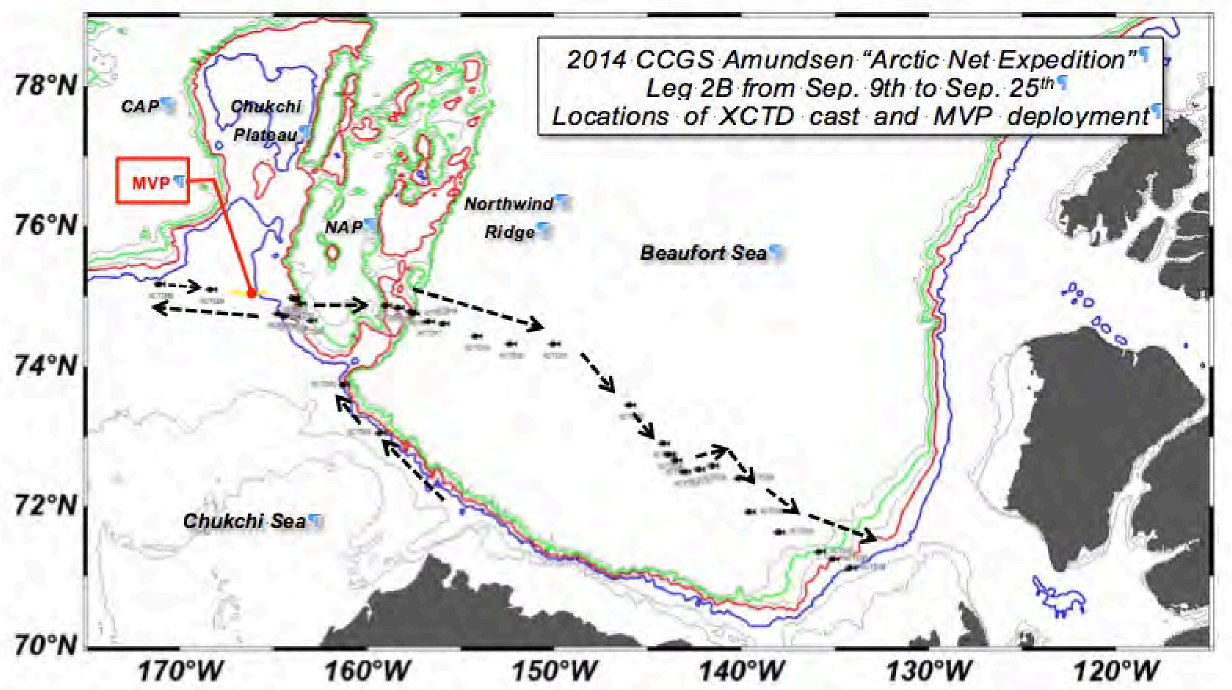

Figure 12.3. The bathymetric map of the observational area (blue: 500 m, red: 1000 m, green: 1500 m, and dashed black lines represent 50 m, 100 m, 1250 m and 1750 m water depths from the IBCAO). Black bullets indicate XCTD stations, and MVP measurements were done along the yellow line at the south of the Chukchi Plateau.

12.3.2 The spatial distribution of the Dynamic Ocean Topography (DOT)

One of the main objectives was to validate the dynamic ocean topography derived from the measurement of the ESA's earth observing satellite Cryosat-2/SIRAL (Synthetic Interferometric Radar Altimeter). The dynamic topography reflects the vertical structure of density (or the distributions of the surface mixed layer, PSW and PWW). DOTs obtained during this cruise are shown in Figure 12.4. Sharp and moderate gradients of DOTs were found at the Northwind Ridge and the eastern continental slope of the Chukchi Plateau (red and blue arrows). The horizontal gradient of the DOT is the proxy of the surface geostrophic velocity. Based on the geostrophy, northward flow must be at the Northwind Ridge and the eastern continental slope of the Chukchi Plateau (i.e. at least, the eastern rim of the Beaufort Gyre is located beyond the Northwind Ridge). The center of the Beaufort Gyre would be around 150ºW, indicated by highest DOT. Further investigation about the Beaufort Gyre and the distribution of the ocean heat content will be conducted using the DOTs from CTD/XCTD/MVP measurements after this cruise.

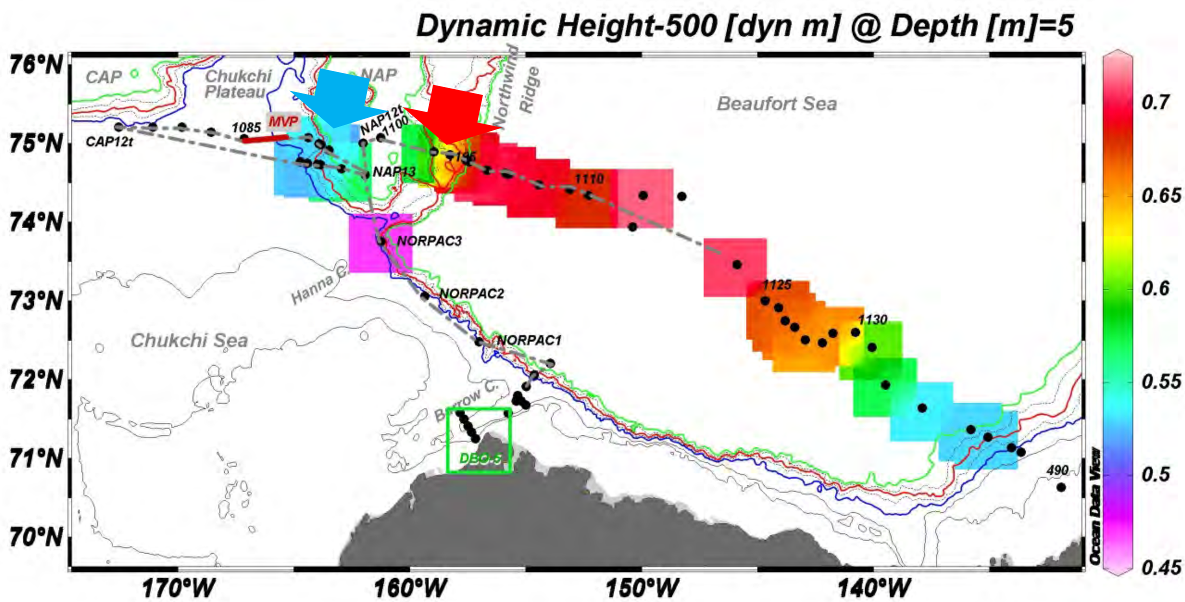

Figure 12.4. Spatial distribution of the dynamic ocean topography at 5-m relative to 500-m from CAP12t to 140º W.

12.3.3 Cross-section of temperature and salinity from Chukchi Plateau to the Northwind Ridge

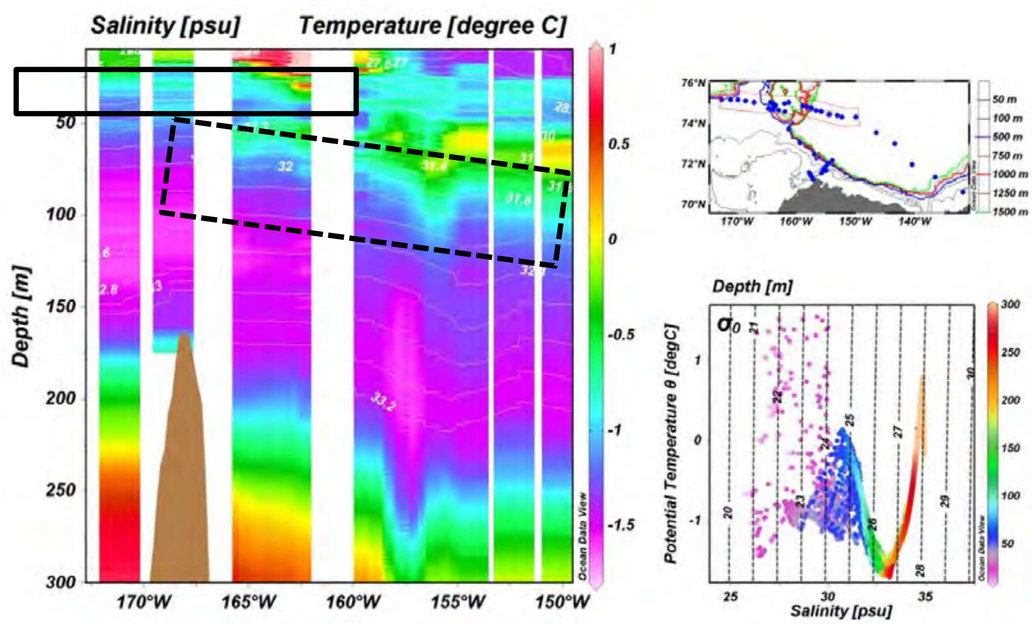

Figure 12.5. Cross section of temperature (color) and salinity (contour) and T-S diagram along the transect from Chukchi Plateau to the Canada Basin (150°W).

The section of XCTD (and CTD + MVP) across the Chukchi Border Land was made during this cruise (Figure 12.3). This area is the western side of the Beaufort Gyre where the PSW will be delivered. In Figure 12.5, the PSW (temperature maximum layer around the layer of salinity ~ 31.5 psu) was found in the subsurface layer from 165°W to 150°W (Black dashed square). The horizontal gradient of the isohaline (density is mostly governed by salinity in this region) was found around 163°W and 158°W where the continental slopes is found (i.e., the PSW was delivered to the eastern side of the Chukchi Plateau beyond the Northwind Ridge). This result corresponds to what we found before this cruise.

In the surface layer, relatively warm water above -0.5°C was found from the westernmost Station CAP12t to XCTD13 where no sea ice exists (Black square). In particular, warm water greater than 1°C was found at the eastern side of the Chukchi Plateau, so that we can expect long duration of the open water around the Chukchi Plateau. At the eastern side of the Chukchi Plateau, we can see a little bit complicated vertical profiles of temperature. Between surface warm water and the PSW, there is relatively cold water around 50-m water depth, indicating that vertical mixing during winter reached (i.e. there was the upward heat flux from the ocean to the Atmosphere or sea ice during last freeze-up season).

Deepening isohalines (or PSW and Pacific Winter Water; temperature minimum layer around the layer of salinity 33.1 psu) around 158~157°W suggests there was a clockwise eddy along the Northwind Ridge.

12.3.4 The spatial distribution of the Ocean Heat Content within the surface mixed layer (0-20m)

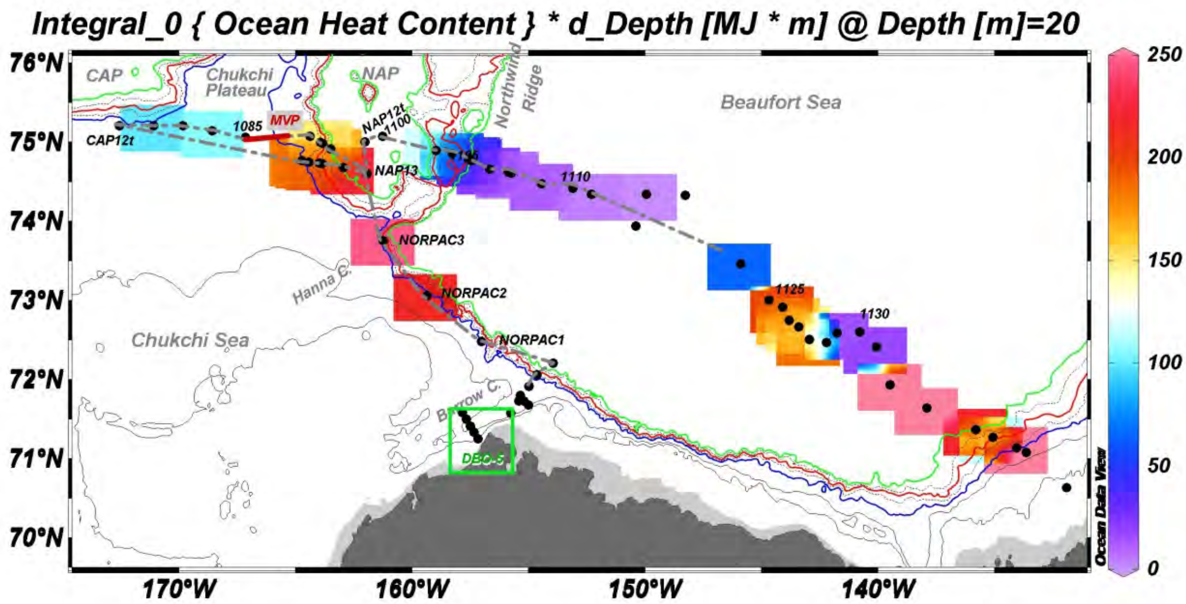

Figure 12.6. Ocean heat content in the surface mixed layer (0 – 20m water depth).

Large amount of ocean heat content was found at the Chukchi Border Land and the continental slope of the Chukchi Sea, but less OHC was in the eastern side of the Northwind Ridge (i.e. in the Canada Basin) (Figure 12.6). Using the satellite microwave-derived brightness temperature and NCEP reanalysis, Mizobata and Shimada (2012, *DSRII Special Issue "Satellite Oceanography and Climate Change*) estimated deep surface mixed layer (SML) and large amount of heat content within SML around the Chukchi Border Land. Results obtained during this cruise correspond the initial estimate of the SML and its heat content. This deep and warm SML will result in the formation of the Near Surface Temperature Maximum (Jackson et al. 2010). As mentioned above, this warm surface mixed layer is related to the period of the open water. Figure 12.7 shows the sea ice concentration and sea surface temperature maps on Sep. 16th with stations we made during this cruise. Wide-open water area was shown in the Chukchi Border Land area where we observed large amount of the OHC greater than 200MJ.

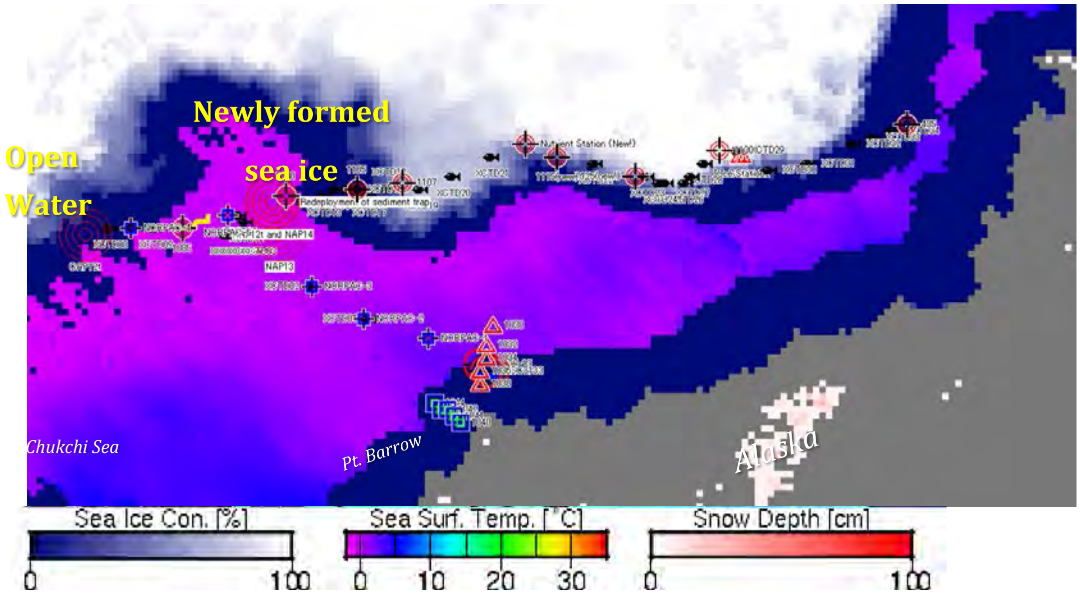

Figure 12.7. Hydrographic stations of the *Amundsen* 2014 Arctic Net Expedition Leg 2b and AMSR2 sea ice concentration map on Sep. 16th.

The relationship among the warm surface mixed layer, cold layer at 50m-water depth and the PSW will be investigated after the corrected CTD data is available.

Along the sea ice edge (~145ºW) in the Canada Basin, anomalous heat content was also found. In the surface layer (0-20m water depth), temperature was greater than 0.5ºC (maximum = 1.5ºC). The formation process of this warm surface layer is unknown at this moment. Salinity less than 27~28 indicate the strong density stratification due to sea ice melt or the river runoff from the Mackenzie River. Figure 12.8 presents the deployment of XCTD probe at the sea ice edge. During this cruise, there was always strong easterly wind due to high-pressure system. Surface warm water layer greater than 0ºC and strong wind mixing may result in efficient sea ice melting. The formation process and spatial distribution of this surface warm layer will be investigated after this cruise.

12.3.5 The spatial distribution of the Ocean Heat Content within the surface mixed layer (50-100m)

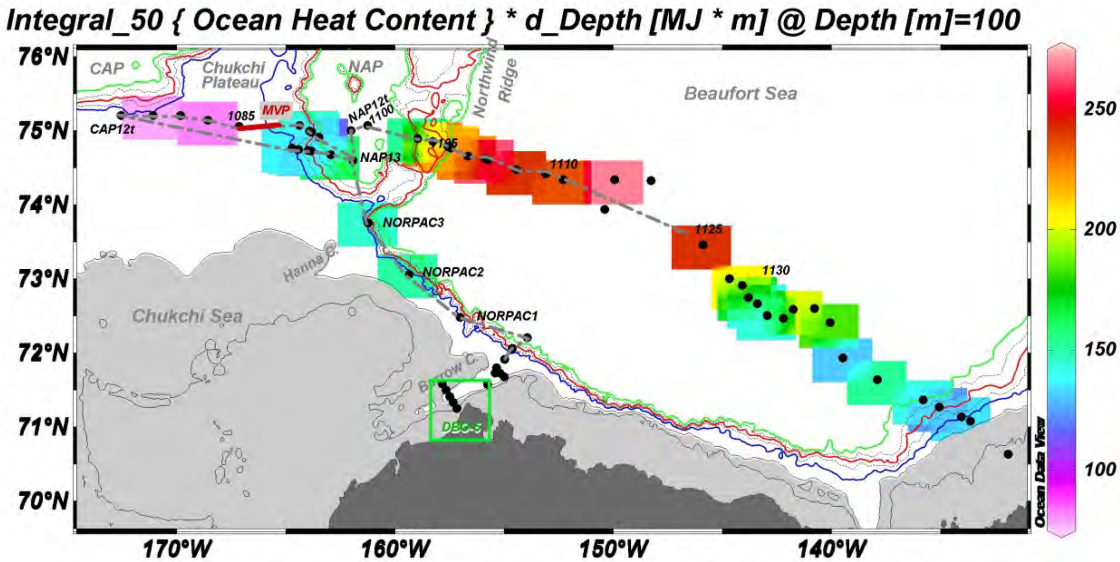

Figure 12.8. Ocean heat content in the surface mixed layer (50 – 100 m depth).

The depth/distribution of the Pacific Summer Water (PSW) is usually defined by temperature maximum layer around the layer of salinity ~ 31.5 psu. This layer is located, roughly, from 50 m to 100 m water depth. Figure 12.9 shows a preliminary estimate of ocean heat content (OHC) of the PSW layer (50-100 m water depth). Obviously, large amount of OHC due to the PSW is seen in the western side of the Canada Basin from Northwind Ridge to around 150° W, since the spatial distribution is determined by the clockwise Beaufort Gyre carrying the PSW from the Barrow Canyon or the continental slope of the Chukchi Sea. In the eastern side of the Canada Basin, the OHC of the PSW layer was suddenly decreased, indicating mixing (and/or diffusion) processes shrinking the PSW, which entered in the Canada Basin several years ago.

12.4 Comments and recommendations

Locations of XCTD casts depend on where the CTD stations are realized, so that updated/revised location of coming CTD stations is always needed. The waypoint shown on TV (Ch. 82) was sometimes different from the waypoint seen in the monitor at the Bridge. Also there was sometimes no announcement about cancellation of the hydrographic station due to sea state and/or sea ice condition. If possible, it would be helpful to show updated observational plan on TV using an unused channel (e.g. Ch.81).

CTD data (pressure, temperature, salinity, fluorescence etc.) displayed on TV, would also be helpful for understanding the current status of the station, and for modifying the observational plan (e.g., location of hydrographic station, transect, etc.).

13 Trace metal sampling of surface waters

ArcticNet Phase 3 – Carbon Exchange Dynamics in Coastal and Marine Ecosystems.
http://www.arcticnet.ulaval.ca/pdf/phase3/carbon-dynamics.pdf

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13.1 Introduction

The availability of dissolved iron (Fe) limits primary production in ~40% of the world's oceans. While the Arctic Ocean is presently not considered to be iron-limited, the role of sea ice in supplying and distributing Fe in this ocean is not sufficiently understood. Fe concentrations in sea ice may be several orders of magnitude higher than in open ocean waters. Melting sea ice thus constitutes a significant source of Fe to the ocean. With the sea ice rapidly receding in the Arctic, it is crucial to better understand the role that sea ice plays for the distribution of Fe in this particular ecosystem, and how its decline may affect future primary production in the Arctic Ocean.

13.2 Methodology

Trace metal clean sampling of surface waters was undertaken from the Zodiac at most Basic and Full stations – weather allowing (Table 13.1). Samples were taken about half a nautical mile upwind of the ship with the help of a pole sampler (custom design). In the ice, two samples were taken on each Zodiac expedition: one as close to the ice edge as possible, and one in more open waters. In addition to the samples for trace metal analysis, salinity samples were taken at each sampling location and were run aboard the *Amundsen* before the end of the leg.

Table 13.1. List of the stations sampled during Leg 2b.

Station	Open water sample	Near-ice sample
1041	X	
1044	X	
1038	X	
CAP12t	X	
1085	X	
1100	X	
1107	X	X
1115	X	X
1130	X	X
435	X	

Samples for trace metal analysis were filtered in a HEPA-class 100 laminar flow hood and acidified immediately to pH 1.7 with Seastar Baseline hydrochloric acid (HCl). Both filtered and unfiltered samples were preserved in this manner and will be analyzed for dFe and labile Fe in the laboratory in Victoria.

14 Marine productivity: Carbon and nutrients fluxes – Legs 1, 2 and 3

ArcticNet Phase 3 – Marine Biological Hotspots: Ecosystem Services and Susceptibility to Climate Change. http://www.arcticnet.ulaval.ca/pdf/phase3/marine-ecosystem-services.pdf

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Cruise participants Leg 1: Jonathan Gagnon[1], Isabelle Courchesne[1] and Jean-Sébastien Côté[1]
Cruise participants Leg 2: Pierre Coupel[1] and Nicolas Schiffrine[1]
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14.1 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 (IPCC 2007). Environmental changes already observed include a decline in the volume and extent of the sea-ice cover (Johannessen et al. 1999, Comiso et al. 2008), an advance in the melt period (Overpeck et al. 1997, Comiso 2006), and an increase in river discharge to the Arctic Ocean (Peterson et al. 2002, McClelland et al. 2006) due to increasing precipitation and terrestrial ice melt (Peterson et al. 2006). Consequently, a longer ice-free season was observed in both Arctic (Laxon et al. 2003) and subarctic (Stabeno & Overland 2001) environments. These changes entail a longer growth season associated with a greater penetration of light into surface waters, which is expected to favor phytoplankton production (Rysgaard et al. 1999), food web productivity and CO_2 drawdown by the ocean. However, phytoplankton productivity is likely to be limited by light but also by allochtonous nitrogen availability. The supply of allochtonous nitrogen is influenced by climate-driven processes, mainly the large-scale circulation, river discharge, upwelling and regional mixing processes. In the a global change context, it appears crucial to improve the knowledge of the environmental processes (i.e. mainly light and nutrient availability) interacting to control phytoplankton productivity in the Canadian Arctic. Moreover, interests are growing about the implication of environments such as sea ice and melt ponds upon the global Arctic environment. Thereby, the nutrient availability and interactions of these environments need to be studied as well.

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. This was mainly done in the water column, but also in sea ice and melt pond environments during Leg 1. An auxiliary objective was to calibrate the *ISUS* nitrate probe mounted on the Rosette.

14.2 Methodology

Samples for inorganic nutrients (ammonium, nitrite, nitrate, orthophosphate, orthosilicic acid and urea) were taken at all Rosette stations (Table 14.1) to establish detailed vertical profiles. Samples were stored at 4°C in the dark and analyzed for nitrate, nitrite, orthophosphate and orthosilicic acid within a few hours of collection on a Bran+Luebbe AutoAnalyzer 3 using standard colorimetric methods adapted for the analyzer (Grasshoff et al. 1999). During Leg 2b, some samples were frozen at -20°C and analyzed several days later. Additional samples for ammonium and urea determination were taken at stations where incubations were performed and processed immediately after collection using respectively the fluorometric method of Holmes et al. (1999) and the colorimetric method of Goeyens et al. (1998).

During Leg 1, deck incubations with ^{15}N and ^{13}C were performed at 7 photic depths in the water column and in melt pond water to quantify nitrogen uptake, nitrification, ammonification and fixation rates. During Leg 2, deck incubations were performed at 3 depths in the water column, including surface, maximum of chlorophyll (SCM) and the photic depth 5%. Sub-samples were taken in the incubation bottles at the beginning (T_{0h}) and the end of the incubations (T_{24h}). These T_{0h} and T_{24h} samples were analyzed on a Bran+Luebbe AutoAnalyzer 3 as the others nutrients samples. The difference in nutrient concentration between T_{0h} and T_{24h} provide a direct estimate of the various nutrients consumption.

The intracellular nutrient content was extracted in surface and SCM samples at stations where incubations were done. For each depth, 1L of seawater was filtered on a pre-combusted filter. After filtration, boiled water was added onto the filter to burst the cells and collect their intracellular nutrient content later analyzed onboard with the Bran+Luebbe AutoAnalyzer 3.

Table 14.1. List of sampling stations and measurements for carbon and nutrients fluxes experiments during Leg 1.

Station	NO_3, NO_2, Si, PO_4	NH_4	Urea	NO_3/NH_4/ Urea uptake	N_2 fixation	Nitrification	$^{15}N/^{18}O-NO_3$
ROV1	X						
ROV2	X				X		
323	X	X	X	X	X	X	X
300	X						
322	X						
324	X						
325	X						
301	X	X	X	X		X	X
346	X	X	X	X		X	X
304	X						

Station	NO_3, NO_2, Si, PO_4	NH_4	Urea	NO_3/NH_4/ Urea uptake	N_2 fixation	Nitrification	$^{15}N/^{18}O$-NO_3
305	X						
305a	X						
305b	X						
305c	X						
305d	X						
305e	X						
200	X	X	X	X		X	X
204	X	X	X	X		X	X
206	X						
210	X	X	X	X		X	X
214	X						
115	X	X	X	X		X	X
113	X						
111	X						
110	X						
108	X	X	X	X		X	X
107	X						
105	X						
103	X						
101	X	X	X	X		X	X
KEN01	X	X	X	X	X	X	X
KEN02	X						
KEN03	X	X	X	X		X	X
KEN04	X						
KANE01	X	X	X	X	X	X	X
KANE02	X						
KANE03	X	X	X	X		X	X
KANE04	X	X	X	X		X	X
132b	X						
KANE05	X						
127	X						
120	X	X	X	X	X	X	X
335	X	X	X	X		X	X
309	X	X	X	X		X	X
310	X						
314	X						
315	X						
316	X						
317	X						
318	X						
Ice Station*							
1	X	X		X		X	X
2	X	X		X		X	X
3	X	X		X	X	X	X
4	X	X		X	X	X	X

*For more details (GPS coordinates, etc.) about ice stations, see the DMS Team cruise report in Section 8.

Table 14.2 List of sampling stations and measurements during Leg 2.

Station	NO3, NO2, Si, PO4	NH4	Urea	NO3/NH4/Urea uptake	POP-BSi	Nitrification	Internal Pool
			Leg 2a				
407	X	X	X	X		X	X
437	X	X	X	X		X	X
410	X						
412	X						
414	X						
408	X	X	X	X		X	X
418	X						
420	X	X	X	X		X	X
422	X						
424	X						
435	X	X	X	X		X	X
434	X	X	X	X		X	X
432	X						
430	X						
428	X						
426	X						
421	X	X	X	X		X	X
460	X	X	X	X		X	X
482	X	X	X	X		X	X
470A	X	X	X	X		X	X
470	X						
472	X	X	X	X		X	X
474	X						
476	X						
478	X						
480	X						
			Leg 2b				
1040	X	X					
1042	X	X	X	X		X	X
1043	X						
1044	X	X					
1038	X	X					
1036	X	X					
1041	X	X					
1030	X	X					
1032	X	X					
1034-A	X	X					
1034-B	X	X	X	X		X	X
NORPAC-4	X	X					
1085	X	X	X	X		X	X

Station	NO3, NO2, Si, PO4	NH4	Urea	NO3/NH4/Urea uptake	POP-BSi	Nitrification	Internal Pool
NORPAC-5	X						
1100	X	X					
1107	X	X	X	X		X	X
1105	X						
1110	X	X					
1115	X						
1125	X						
1130	X	X					
435	X	X					

References

Comiso (2006) Geophys Res Lett 33, L18504, doi:10.1029/2006GL027341.
Comiso et al. (2008) Geophys Res Lett 35, L01703, doi:10.1029/2007GL031972.
Grasshoff et al. (1999) Methods of seawater analyses, Weinheim, New-York.
Goeyens et al. (1998) Estuarine, Coastal and Shelf Science (1998) 47, 415–418
Article No. ec980357.
Holmes et al. (1999) Can J Fish Aquat Sci 56:1801–1808.
IPCC (2007) Climate change 2007: The physical science basis. Cambridge University Press, Cambridge and New York.
Johannessen et al. (1999) Science 286:1937–1939.
Laxon et al. (2003) Nature 425:947–950.
McClelland et al. (2006) Geophys Res Lett 33, L06715, doi:10.1029/2006GL025753.
Overpeck et al. (1997) Science 278:1251–1256.
Peterson et al. (2002) Science 298:2171–2174.
Peterson et al. (2006) Science 313:1061–1066.
Rysgaard et al. (1999) Mar Ecol Prog Ser 179:13–25 .
Stabeno & Overland (2001) EOS 82:317–321.

15 Distribution, biodiversity and functional capacities of microorganisms – Leg 1b

ArcticNet Phase 3 – Marine Biological Hotspots: Ecosystem Services and Susceptibility to Climate Change. http://www.arcticnet.ulaval.ca/pdf/phase3/marine-ecosystem-services.pdf

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15.1 Introduction

This research project firstly aimed at surveying and mapping the biodiversity and structure of microbial communities in the Canadian Arctic. Microbes are defined as any single celled organism that routinely cannot be observed without a microscope and therefore includes: phytoplankton, heterotrophic protists (microbial eukaryote), Bacteria and Archaea. These groups are responsible for the net production in the Arctic and their interactions within the microbial food web determine the amount of fixed carbon (lipids, sugars, proteins etc.) that is available to higher trophic levels. Microbes also mediate biogeochemical cycling, including Carbon, Nitrogen and Sulfur. This work is incorporated within the framework of the ArcticNet project led by Dr. J-É Tremblay and contributes to ArcticNet 'hotspots' program.

Leg 1b covered a large geographical area and samples that were collected will contribute to several subprojects. For instance, the Baffin Bay data will be incorporated into Nathalie Joli's PhD work; the goal of her first chapter is to identify regional patterns in microbial eukaryote distribution across Baffin Bay. Collected samples will also be the source of preliminary data for 2015-2018 proposed programs. Specifically, the North-South transect from Kennedy Channel to Nares Strait is relevant to the Takuvik project led by Dr. Marcel Babin 'Green Edge' as information on microbial biodiversity will inform future sampling strategies for this project. Data from transect is also relevant to a circum-Greenland navigation project proposed for 2016 (G. Massé). Finally, deep-water samples will contribute to an ongoing collaboration with Dr. Pierre Galand and other researchers at CNRS Banyuls-sur-mer, which aims at identifying biogeochemical processes mediated by Euarcheaota. The marine Euarchaeota accounts for up to 10% of prokaryotes in the ocean and have not been cultivated. For this reason, genomic approaches will be used to characterize this group from different water masses.

After discussing with the NETCARE microlayer team, water surplus from microlayer and underlying surface were collected on an opportunistic basis. Samples were filtered and preserved for DNA and RNA analysis (see below). Such analysis will greatly facilitate the understanding of the microlayer as a biological habitat. Samples for single amplified genome (SAGs) studies were also collected from the microlayer itself. The genomic information from individual cells will provide a window into how they might be adapted for survival within the microlayer.

15.2 Methodology

Water samples were collected directly from Niskin-type bottles mounted on Rosette (Table 15.1). Sampling depths were identified on the downward cast based on specific features and the objective of collecting water from a variety of water masses. Samples were collected at Full and Basic stations during the cruise. For this mission, samples were primarily collected for microbial DNA and RNA and 5 to 7 L per sampling depth were filtered. At Full stations, samples were collected for fluorescence *in situ* hybridization (FISH), where specific taxonomic groups can be tagged with a fluorescent marker and their concentrations quantified. In addition to DNA-RNA, samples were also collected for Flow Cytometry as well as for single amplified genome (SAG) work. Using this technique, single cells are sorted into multiwall plates and their whole genome is amplified by random primers, and then sequenced. When time allowed, water from the same Niskin bottles was also filtered to facilitate quantification of the eukaryotic microbial biomass by means of chlorophyll *a* and microscopy.

Table 15.1. List of samples collected within the framework of the Marine Microbial Omics Program. Station coordinates were noted at the beginning of the downward cast while Cast+Bottle numbers were taken from AN1405XXX.

Station	Latitude (N)	Longitude (W)	Depth (m)	Cast. Bottle	DNA/ RNA	Chl *a*	FISH	DAPI	FNU	FCM	SAG
Micro3	74°00.067	075°47.318	0		x					x	x
200	73°16.703	063°37.972	0	22.24	x	x	x		x	x	x
200			20	22.22	x	x	x			x	x
200			50	22.19	x	x	x		x	x	x
200			110	22.15	x	x	x			x	x
200			250	22.01	x	x	x			x	x
200			490	22.07	x	x	x			x	x
200			700	22.05	x	x	x			x	x
200			1460	22.01	x	x	x			x	x
204	73°15.690	057°53.310	10	25.23	x	x	x		x	x	x
204			40	25.20	x	x	x		x	x	x
204			60	25.18	x	x	x			x	x
204			250	25.10	x	x	x			x	x
204			300	25.01	x	x	x			x	x
204			380	25.14	x	x	x			x	x
204			700	25.15	x	x	x			x	x
204			984	25.16	x	x	x			x	x
210	75°24.017	064°39.059	0	29.24	x	x	x		x	x	x
210			30	29.21	x	x	x		x	x	x

Station	Latitude (N)	Longitude (W)	Depth (m)	Cast. Bottle	DNA/ RNA	Chl *a*	FISH	DAPI	FNU	FCM	SAG
210			60	29.18	x	x	x			x	x
210			100	29.15	x	x	x			x	x
210			200	29.11	x	x	x			x	x
210			300	29.09	x	x	x			x	x
210			700	29.05	x	x	x			x	x
210			1014	29.01	x	x	x			x	x
115	76°19.532	071°09.845	0	33.24	x	x	x		x	x	x
115			20	33.22	x	x	x		x	x	x
115			60	33.18	x	x	x			x	x
115			80	33.16	x	x	x			x	x
115			200	33.11	x	x	x			x	x
115			300	33.08	x	x	x			x	x
115			510	33.06	x	x	x			x	x
115			663	33.04	x	x	x			x	x
111	76°18.402	073°13.120	0	39.22	x					x	x
111			30	39.19	x					x	x
111			50	39.17	x					x	x
111			150	39.11	x					x	x
111			240	39.08	x					x	x
108	76°16.163	074°36.114	0	42.24	x	x	x		x	x	x
108			30	42.20	x	x	x		x	x	x
108			80	42.14	x	x	x			x	x
108			150	42.11	x	x	x			x	x
108			200	42.09	x	x	x			x	x
108			250	42.08	x	x	x			x	x
108			300	42.06	x	x	x			x	x
108			437	42.04	x	x	x			x	x
105	76°19.052	075°46.534	0	46.23	x					x	x
105			40	46.18	x					x	x
105			160	46.09	x					x	x
105			250	46.05	x					x	x
101	76°22.585	077°23.990	0	51.24	x	x	x		x	x	x
101			13	51.22	x	x	x		x	x	x
101			40	51.19	x	x	x			x	x
101			50	51.17	x	x	x			x	x
101			70	51.14	x	x	x			x	x
101			100	51.12	x	x	x			x	x
101			230	51.07	x	x	x			x	x
101			353	51.01	x	x	x			x	x
Micro4	76°19.882	071°10.329	0		x						x
Micro4			0.5		x						

Station	Latitude (N)	Longitude (W)	Depth (m)	Cast. Bottle	DNA/ RNA	Chl *a*	FISH	DAPI	FNU	FCM	SAG
Micro5	76°16.568	074°36.063	0		x						x
Micro5			0.5		x						
Micro6	81°21.743	064°11.399	0		x						x
Micro6			0.5		x						
Ken 1	81°22.014	063°57.427	0	54.24	x	x	x		x	x	x
Ken 1			30	54.21	x	x	x			x	x
Ken 1			50	54.18	x	x	x		x	x	x
Ken 1			80	54.14	x	x	x			x	x
Ken 1			120	54.12	x	x	x			x	x
Ken 1			250	54.08	x	x	x			x	x
Ken 1			300	54.07	x	x	x			x	x
Ken 1			540	54.03	x	x	x			x	x
Ken3	80°79.548	067°30.112	0	57.23	x					x	x
Ken3			23	57.19	x					x	x
Ken3			40	57.17	x					x	x
Ken3			100	57.11	x					x	x
Kane1	79°59.882	069°45.413	0	60.19	x	x		x		x	x
Kane1				60.16	x	x		x		x	x
Kane1			50	60.12	x	x		x		x	x
Kane1			125	60.07	x	x		x		x	x
Micro7	79°58.672	069°56.051	0		x						x
Micro7			0.5		x						
Kane 3	79°21.005	071°51.908	0	63.24	x					x	x
Kane 3			12	63.20	x					x	x
Kane 3			50	63.14	x					x	x
Kane 3			125	63.8	x					x	x
Kane 3			160	63.6	x					x	x
Kane 4	79°00.371	070°29.483	0	64.23	x					x	x
Kane 4			35	64.18	x					x	x
Kane 4			50	64.15	x					x	x
Kane 4			125	64.10	x					x	x
Kane 4			225	64.6	x					x	x
micro8	79°04.673	071°39.205	0		x						x
micro8			0.5		x						
Kane 5	79°00.064	073°12.133	0	73.23	x	x	x		x	x	x
Kane 5			10	73.22	x	x	x		x	x	x
Kane 5			25	73.20	x	x	x			x	x
Kane 5			50	73.16	x	x	x			x	x
Kane 5			90	73.12	x	x	x			x	x
Kane 5			140	73.9	x	x	x			x	x

Station	Latitude (N)	Longitude (W)	Depth (m)	Cast. Bottle	DNA/ RNA	Chl *a*	FISH	DAPI	FNU	FCM	SAG
Kane 5			160	73.7	x	x	x			x	x
Kane 5			235	73.4	x	x	x			x	x
120	77°19.369	075°42.156	0	76.24	x	x	x		x	x	x
120			20	76.22	x	x	x			x	x
120			40	76.19	x	x	x		x	x	x
120			70	76.16	x	x	x			x	x
120			100	76.13	x	x	x			x	x
120			300	76.6	x	x	x			x	x
120			400	76.5	x	x	x			x	x
120			550	76.3	x	x	x			x	x
335	74°25.343	098°47.556	0	78.23	x	x				x	x
335			25	78.17	x	x				x	x
335			35	78.15	x	x				x	x
335			60	78.09	x	x				x	x
335			110	78.01	x	x				x	x
309	72°57.907	096°03.769	0	80.24	x	x				x	x
309			30	80.19	x	x				x	x
309			60	80.15	x	x				x	x
309			125	80.10	x	x				x	x
309			175	80.08	x	x				x	x
309			250	80.06	x	x				x	x
309			314	80.01	x	x				x	x
312	69°10.558	100°41.113	0	84.12	x	x				x	x
312			20	84.09	x	x				x	x
312			32	84.07	x	x				x	x
312			50	84.04	x	x				x	x
micro9	NA		0		x						x
micro9			0.5		x						
314	68°58.249	105°27.941	0	86.18	x	x	x	x		x	x
			10	86.16	x	x	x	x		x	x
			20	86.14	x	x	x	x		x	x
			32	86.12	x	x	x	x		x	x
			40	86.10	x	x	x	x		x	x
			50	86.08	x	x	x	x		x	x
			60	86.06	x	x	x	x		x	x
			70	86.04	x	x	x	x		x	x
micro10	NA		0		x						x
micro10			0.5		x						

DNA/RNA samples were used for multiplex meta-barcoding while selected samples were kept for metagenomes and metatranscriptomes (to be determined later). Ancillary data for most samples included chlorophyll *a* (Chl *a*), which was extracted at ULaval, filters for fluorescence *in situ* hybridization (FISH), slides for epi-fluorescence microscopy (DAPI), water samples for taxonomy using inverted microscopy (FNU), samples for flow cytometry (FCM) to estimate bacterial biomass, and samples for single cell sorting and genome amplification (SAG), which will depend on funding and outside collaborations. Latitude and longitude information for microlayers 9 and 10 were not available when this report was written; see the Microlayer report in Section 9.

15.3 Preliminary results

No preliminary results were generated, as samples will be analysed at Laval University.

15.4 Comments and recommendations

No significant problems or issues arose apart from the usual Arctic logistics delays (fog and ice). We commend the chief scientist for his leadership, attention to detail and ensuring all projects had sufficient time and opportunities, despite weather and ice conditions. We thank the captain and crew for their professionalism and high caliber support.

16 Phytoplankton assemblage analysis by microscopic and DNA analyses – Leg 2b

ArcticNet Phase 3 – Marine Biological Hotspots: Ecosystem Services and Susceptibility to Climate Change.
http://www.arcticnet.ulaval.ca/pdf/phase3/marine-ecosystem-services.pdf

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16.1 Introduction

In general, siliceous and calcareous micro-planktons (diatom, flagellates with siliceous skeleton, and coccolithophore) in upper layers are one of the significant contributors to biological pump in the ocean. Relationship between those microplankton assemblage and hydrographic conditions are useful basic information for the study of biological components in settling particles and biogeographic study of micro-planktons in the Arctic Ocean. In order to observe the relationship between distribution of shell bearing micro-planktons and different water masses, water samples were collected at several vertical layers in upper 100 m water column during the cruise. Water samples at selected stations were also used for DNA analysis of uni-cellar planktons as to elucidate species diversity of not only micro-planktons but also nano- and pico-planktons in the Arctic Ocean.

16.2 Methodology

At five Basic and four Full stations during Leg 2b, 0.3-2.0 L of water were sampled from CTD-Rosette bottles at 10, 30, 50, 70 or 75, 100 m, and at the subsurface chlorophyll maximum layer to perform microscopic microplankton assemblage analysis (Table 16.1). DNA samples were usually taken at 10 m, subsurface chlorophyll maximum layer, and 70 or 75 m water depths. Samples were filtered during the cruise using membrane filters (25 or 47 mm diameters, 0.45 µm pore size). Filtered water volumes for microscopic analysis ranged from 0.3 to 2.0 L, based on the concentration of suspended particle matters, while filtered volumes for DNA analysis ranged from 1.0 to 3.67 L. Sample filters were desalted for microscopic analysis using Milli-Q water, then put in petri dish and dried at room temperature. Sample filters for DNA analysis were stored in 2 mL plastic screw vials with 1 mL of DNA-degradation inhibitor (0.25M EDTA, 20% DMSO, and saturated NaCl liquid). All samples were shipped to Japan to be analysed at JAMSTEC and Tsukuba University in Japan.

Table 16.1. List of samples collected throughout Leg 2b. The abbreviations “scm” and “bt” refer to subsurface chlorophyll maximum and water depth of bottom-10 m, respectively. The symbol “*” in the Sampled Depth column notifies that DNA sample was taken.

Station (Coordinate)	CTD Cast	Time (UTC)	Sampled Depth (m)
Basic 1040 (71°14.820 N 157°10.020 W)	60	10 Sep. 2014 14:04	10*, 20*, 30*, bt (38)*
Basic 1042 (71°24.600 N 157°29.340 W)	62	10 Sep. 2014 21:11	10*, 30, scm (36)*, 50, 75*, 100, bt (116)*
Basic 1044 (71°34.680 N 157°50.400 W)	64	11 Sep. 2014 8:14	10, scm (20)*, 30, 50, bt (55)*,
Full 1034 (71°54.540 N 154°57.900 W)	72	13 Sep. 2014 10:36	10*, scm (26)*, 30, 50, 70*, 100
Basic 1030 (72°12.360 N 153°56.760 W)	75	14 Sep. 2014 4:15	10, scm (30), 50, 70
Full 1100 (75°04.080 N 161°15.720 W)	82	18 Sep. 2014 4:48	10*, 50, scm (60)*, 70*, 100
Full 1107 (74°37.140 N 155°58.860 W)	85	19 Sep. 2014 13:05	10*, 30, 50*, scm (70)*, 100*
Basic 1130 (72°35.760 N 141°50.160 W)	89	22 Sep. 2014 7:20	10*, 30, 50, 70*, scm (90)*, 100
Full 490 (71°04.680 N 133°38.100 W)	91	23 Sep. 2014 15:32	10*, 30*, 50, 70*, 100

16.3 Preliminary results

No preliminary results were obtained during the cruise.

17 Phytoplankton production and biomass – Legs 1, 2a and 3

ArcticNet Phase 3 – Marine Biological Hotspots: Ecosystem Services and Susceptibility to Climate Change. http://www.arcticnet.ulaval.ca/pdf/phase3/marine-ecosystem-services.pdf

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17.1 Introduction

Primary production plays a central role in the oceans as it supplies organic matter to the higher trophic levels, including zooplankton, fish larvae, marine mammals and birds. Marine polar ecosystems are particularly sensitive to any changes in primary production due to their low number of trophic links (Grebmeier et al. 2006, Moline et al. 2008, Post et al. 2009). The Arctic Ocean is changing as evidenced by the decrease in sea ice thickness and extent (Stroeve et al. 2007, Kwok et al. 2009), the early melt and late freeze-up of sea ice (Markus et al. 2009) and the enhancement of the hydrological cycle (Peterson et al. 2006, Serreze et al. 2006). These environmental changes have already altered the phytoplankton biomass distribution in the Arctic Ocean (Arrigo et al. 2008, Pabi et al. 2008).

In this context, the general objectives of this research project were to:

- Determine the spatial and temporal variability in production, biomass, abundance and taxonomic composition of the phytoplankton communities;
- Determine the role of environmental factors on phytoplankton dynamics and its variability in Baffin Bay and in the Canadian Arctic Archipelago;
- As part of the NETCARE project, algae dynamic in melt ponds were also studied, in open water and in the water near the ice edge during Leg 1.

The specific objectives were to determine:

- Down welling incident irradiance, every 10 minutes, with a Li-COR 2 pi sensor (Legs 1, 2a and 3);
- Transparency of the upper water column, using a Secchi disk (Legs 1 and 2a);
- Underwater irradiance profile with a PNF-300 probe (Legs 1 and 2a);
- Concentrations of dissolved organic carbon (DOC), total organic carbon (TOC), total dissolved nitrogen (TDN) and total nitrogen (TN) with a Shimadzu TOC-VCPN analyzer (Legs 1, 2a and 3);

- Chlorophyll a and pheopigment concentrations, using a Turner Designs fluorometer (3 size-classes: >0.7 µm, >5 µm, >20 µm) (Legs 1, 2a and 3);
- Abundance and taxonomic composition of phytoplankton using the inverted microscopy method (Legs 1, 2a and 3);
- Abundance of pico- and nanophytoplankton and heterotrophic bacteria by flow cytometry (Legs 1, 2a and 3);
- Phytoplankton production using the 14C assimilation method (2 size-fractions: >0.7 µm, >5 µm) (Legs 1 and 2a).

These measurements were done for the water column for all of the legs, as well as for the melt ponds and the ice during Leg 1.

17.2 Methodology

At each water column station, water samples were collected with 12 L Niskin-type bottles attached to the CTD-Rosette. During the daytime, the depth of the euphotic zone was determined using the Secchi disk and the PNF-300 probe, at water column stations only.

Size-fractionated (3 size-classes: >0.7 µm, >5 µm and >20 µm) chlorophyll *a* concentration was measured onboard the ship at each sampling depth with a Turner Designs fluorometer (model 10-AU). Size-fractionated (2 size-classes: >0.7 µm and >5 µm) primary production was estimated at 7 optical depths in the water column (i.e., 100%, 50%, 30%, 15%, 5%, 1%, and 0.2% of the surface irradiance), as well as in the melt ponds and at the ice bottom following JGOFS protocol for simulated *in situ* incubation. The other samples collected during this expedition will be analyzed at ISMER. Detailed sampling activities for Leg 1 are summarized in Table 17.1 and 17.2 for water column and melt pond sampling, respectively. Sampling activities for Legs 2a and 3 are presented in Table 17.3 and 17.4.

Table 17.1. Seawater sampling operations for phytoplankton production and biomass during Leg 1.

			Position (min)		Chlorophyll *a*								Primary production	
Station	Cast	Date (yy-mm-jj)	Latitude (N)	Longitude (W)	> 0.7 µm	>5 µm	>20 µm	POC/PON	DOC/DN TOC/TN	HPLC	Taxo	Cyto. flux	>0.7 µm	>5 µm
LC1 9h	Pompe	14-07-11	53°57.648	055°23.379	X	X			X	X	X	X		
LC1 13h	Pompe	14-07-11	54°47.055	055°40.945	X	X			X	X	X	X		
LC1 18h	Pompe	14-07-11	55°36.622	055°57.497	X	X			X	X	X	X		
LC2 9h	Pompe	14-07-12	58°25.078	056°57.105	X	X			X	X	X	X		
LC2 13h	Pompe	14-07-12	59°12.487	057°17.554	X	X			X	X	X	X		
LC2 18h	Pompe	14-07-12	60°09.987	057°38.667	X	X			X	X	X	X		
LC3 9h	Pompe	14-07-13	62°48.116	058°43.155	X	X			X	X	X	X		
LC3 13h	Pompe	14-07-13	63°37.544	058°58.101	X	X			X	X	X	X		
LC3 18h	Pompe	14-07-13	64°34.908	059°30.709	X	X			X	X	X	X		

Station	Cast	Date (yy-mm-jj)	Position (min)		Chlorophyll *a*								Primary production	
			Latitude (N)	Longitude (W)	> 0.7 µm	>5 µm	>20 µm	POC/PON	DOC/DN TOC/TN	HPLC	Taxo	Cyto. flux	>0.7 µm	>5 µm
LC4 9h	Pompe	14-07-14	67°18.666	061°12.196	X	X			X	X	X	X		
LC4 13h	Pompe	14-07-14	68°01.235	062°27.356	X	X			X	X	X	X		
LC4 18h	Pompe	14-07-14	68°48.409	063°46.550	X	X			X	X	X	X		
LC5 4h	Pompe	14-07-15	60°22.038	064°52.049	X	X			X	X	X	X		
ROV1	1	14-07-15	60°22.038	064°52.049	X	X	X	X	X	X	X	X		
LC5 18h	Pompe	14-07-15	69°51.221	065°48.859	X	X			X	X	X	X		
LC6 6h	Pompe	14-07-16	71°30.502	070°17.669	X	X			X	X	X	X		
ROV2	2	14-07-16	71°30.502	070°17.669	X	X	X	X	X	X	X	X		
LC6 18h	Pompe	14-07-16	71°43.126	071°10.583	X	X			X	X	X	X		
323	3	14-07-17	74°09.420	080°28.790	X	X	X	X	X	X	X	X	X	X
322	6	14-07-18	74°29.686	080°33.000	X	X	X	X	X	X	X	X		
325	8	14-07-19	73°48.966	080°28.764	X	X	X	X	X	X	X	X		
301	9	14-07-19	74°6.518	083°25.313	X	X	X	X	X	X	X	X	X	X
304	12	14-07-20	74°14.364	091°32.213	X	X	X	X	X	X	X	X	X	X
305	14	14-07-22	74°19.122	094°54.359	X	X	X	X	X	X	X	X	X	X
305A	16	14-07-22	74°13.008	094°12.727	X									
305B	17	14-07-23	74°13.774	095°54.500	X									
305C	18	14-07-23	74°21.572	095°48.631	X									
305D	19	14-07-23	74°27.384	095°42.166	X									
305E	20	14-07-23	74°35.324	095°03.718	X	X	X	X	X	X	X	X	X	X
200	21	14-07-27	73°16.575	063°38.215	X	X	X	X	X	X	X	X	X	X
204	24	14-07-28	73°15.784	057°52.780	X	X	X	X	X	X	X	X	X	X
210	28	14-07-29	75°24.446	061°39.024	X	X	X	X	X	X	X	X	X	X
115	32	14-07-30	76°20.080	071°12.830	X	X	X	X	X	X	X	X	X	X
110	38	14-07-31	76°18.383	073°13.406	X	X	X	X	X	X	X	X		
108	43	14-08-01	76°16.313	074°36.073	X	X	X	X	X	X	X	X	X	X
105	47	14-08-01	76°19.502	075°47.117	X	X	X	X	X	X	X	X		
101	52	14-08-02	76°23.071	077°23.816	X	X	X	X	X	X	X	X	X	X
Ken 1	53	14-08-03	81°22.068	064°10.442	X	X	X	X	X	X	X	X	X	X
Ken 3	56	14-08-04	80°47.520	067°17.984	X	X	X	X	X	X	X	X		
Kane 1	59	14-08-04	69°47.230	069°47.230	X	X	X	X	X	X	X	X	X	X
Kane 3	62	14-08-05	79°21.611	071°51.658	X	X	X	X	X	X	X	X	X	X
Ice island 1	Zodiac	14-08-05	79°03.842	071°38.912	X									
Ice island 2	Zodiac	14-08-05	79°03.815	071°39.210	X									
Ice island 3	Zodiac	14-08-05	79°04.035	071°37.480	X									
Ice island 4	Zodiac	14-08-05	79°04.009	071°37.251	X									
Ice island 5	Zodiac	14-08-05	79°04.436	071°37.035	X									
Ice island 6	Zodiac	14-08-05	79°04.479	071°36.901	X									
Ice island 7	Zodiac	14-08-05	79°04.418	071°38.287	X									
Ice island 8	Zodiac	14-08-05	79°04.470	071°38.496	X									
Kane 5	72	14-08-06	79°00.409	073°12.432	X	X	X	X	X	X	X	X	X	X
120	75	14-08-06	77°19.451	075°41.624	X	X	X	X	X	X	X	X	X	X
335	77	14-08-09	74°25.679	098°49.444	X	X	X	X	X	X	X	X	X	X
309	79	14-08-10	72°57.124	096°09.354	X	X	X	X	X	X	X	X	X	X

Station	Cast	Date (yy-mm-jj)	Position (min) Latitude (N)	Longitude (W)	Chlorophyll *a* > 0.7 µm	>5 µm	>20 µm	POC/PON	DOC/DN TOC/TN	HPLC	Taxo	Cyto. flux	Primary production >0.7 µm	>5 µm
310	81	14-08-10	71°17.934	097°41.005	X	X	X	X	X	X	X	X	X	X
312	83	14-08-11	69°10.612	100°40.092	X	X	X	X	X	X	X	X	X	X
314	85	14-08-12	58°68.228	105°28.235	X	X	X	X	X	X	X	X	X	X

Table 17.2. Sampling operations for phytoplankton production and biomass at melt pond stations during Leg 1.

Station	Date (yy-mm-jj)	Position (min) Latitude (N)	Longitude (W)	Chlorophyll *a* > 0.7 µm	>5 µm	>20 µm	POC/PON	DOC/DN TOC/TN	HPLC	Taxo	Cyto. flux	MAA	Primary production >0.7 µm	>5 µm
Ice 1	14-07-18	73°31.656	080°59.385	X	X	X	X	X	X	X	X	X	X	X
Ice 2	14-07-20	74°16.774	091°37.990	X	X	X	X	X	X	X	X	X	X	X
Ice 3	14-07-21	74°14.274	092°11.808	X	X	X	X	X	X	X	X	X	X	X
Ice 4	14-07-23	74°36.217	094°54.611	X	X	X	X	X	X	X	X	X		

Chlorophyll *a* data were shared with Jean-Éric Tremblay's teams for the calibration of the chlorophyll *a* fluorescence sensor. See report on melt ponds in Section 8 for detailed methodology of melt ponds and ice sampling.

Table 17.3. Sampling operations during Leg 2a of the ArcticNet 2014 expedition on board the CCCS *Amundsen*.

Station	Cast	Date (yy-mm-jj)	Position (min) Latitude (N)	Longitude (W)	Chlorophyll *a* > 0.7 µm	>5 µm	>20 µm	POC/PON	DOC/DN TOC/TN	HPLC	Taxo	Cyto. flux	Primary production >0.7 µm	>5 µm
405	2	14-08-17	70°38.179	123°03.089	X	X	X	X	X	X	X	X	X	X
407	4	14-08-18	71°00.246	126°04.404	X	X	X	X	X	X	X	X	X	X
437	6	14-08-19	71°47.201	126°29.676	X	X	X	X	X	X	X	X	X	X
408	13	14-08-20	71°18.744	127°34.538	X	X	X	X	X	X	X	X	X	X
420	19	14-08-21	71°03.020	128°30.847	X	X	X	X	X	X	X	X	X	X
435	24	14-08-22	71°04.734	133°38.483	X	X	X	X	X	X	X	X	X	X
434	29	14-08-23	70°10.312	133°32.976	X	X	X	X	X	X	X	X	X	X
421	42	14-08-24	71°27.337	133°53.488	X	X	X	X	X	X	X	X	X	X
460	44	14-08-25	72°09.432	130°49.082	X	X	X	X	X	X	X	X	X	X
Br4	46	14-08-28	73°13.048	127°03.522	X	X	X	X	X	X	X	X		
482	49	14-09-02	70°31.550	139°22.996	X	X	X	X	X	X	X	X	X	X

Station	Cast	Date (yy-mm-jj)	Position (min)		Chlorophyll *a*								Primary production	
			Latitude (N)	Longitude (W)	> 0.7 µm	>5 µm	>20 µm	POC/PON	DOC/DN TOC/TN	HPLC	Taxo	Cyto. flux	>0.7 µm	>5 µm
470A	52	14-09-04	69°21.959	138°13.965	X	X	X	X	X	X	X	X	X	X
472	54	14-09-06	69°36.414	138°13.130	X	X	X	X	X	X	X	X	X	X

Table 17.4. Sampling operations during Leg 3 of the ArcticNet 2014 expedition on board the CCCS *Amundsen*.

Station	Cast	Date (yy-mm-jj)	Position (min)		Chlorophyll *a*							
			Latitude (N)	Longitude (W)	> 0.7 µm	>5 µm	>20 µm	POC/PON	DOC/DN TOC/TN	HPLC	Taxo	Cyto. flux
PCBC-2	1	14-09-30	71°05.450	071°50.963	X	X	X	X	X	X	X	X
PCBC-3	2	14-10-01	70°46.169	072°15.541	X	X	X	X	X	X	X	X
GIBBS-N	3	14-10-01	71°07.385	070°57.521	X	X	X	X	X	X	X	X
176	4	14-10-02	69°35.490	065°25.985	X	X	X	X	X	X	X	X
179a	5	14-10-03	67°20.387	062°36.848	X	X	X	X	X		X	X
180	7	14-10-03	67°28.601	061°44.901	X	X	X	X	X	X	X	X
181	8	14-10-03	67°33.133	061°22.460	X	X	X	X	X	X	X	X
640	9	14-10-07	58°55.463	062°09.262	X	X	X	X	X	X	X	X
645	10	14-10-08	56°42.176	059°42.192	X	X	X	X	X	X	X	X
650	11	14-10-08	53°48.268	055°26.218	X	X	X	X	X	X	X	X

17.3 Preliminary results

17.3.1 Results for Leg 1

During Leg 1, chlorophyll *a* concentrations varied between 25 and 50 mg m^{-2} in the southern Baffin Bay transect and did not show any longitudinal gradient. Large cells (> 5 µm) composed most of the biomass at all stations (Figure 17.1).

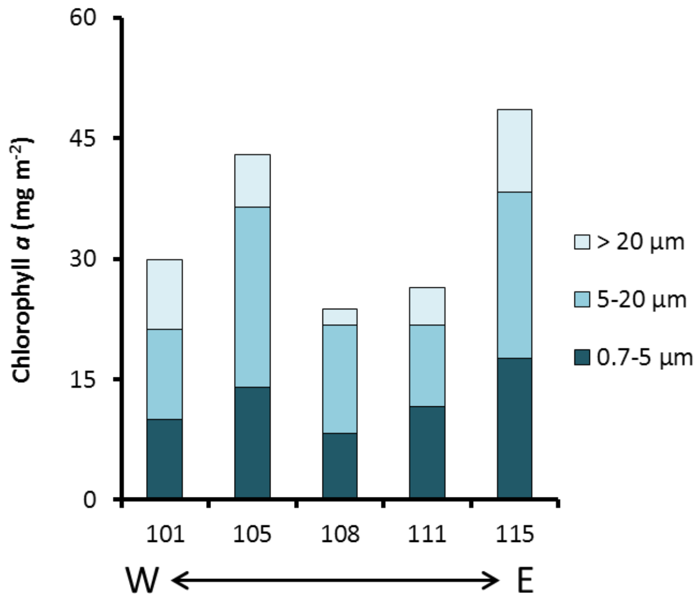

Figure 17.1. Chlorophyll *a* concentrations integrated over 100 m for different size fractions, 0.7-5 µm, 5-20 µm and > 20 µm, in the southern west to east Baffin Bay transect during Leg 1.

Chlorophyll *a* concentrations increased from north to south on the Baffin Bay transect and as a phytoplankton bloom formed (Figure 17.2). Concentrations reached a peak value of 175 mg m^{-2} at Kane 1 and then decreased. The rapid increase of biomass was mostly due to large cells that accounted for > 80% of total biomass from Station Ken 3 down to Kane 5. The proportion of phaeopigments, indicative of cells degradation or senescence, was relatively high at the beginning of transect, likely due to the sudden exposure of phytoplankton cells to increased irradiance. As the bloom formed, proportion of phaeopigments became low, which is a sign of healthy bloom. Station 120 showed important sign of cell degradation associated with the end of the bloom. Vertical chlorophyll *a* profiles were also typical of a bloom formation. At the northernmost stations, highest chlorophyll *a* concentrations were measured at the surface and, as the water moved southward, a subsurface chlorophyll maximum formed (Figure 17.3).

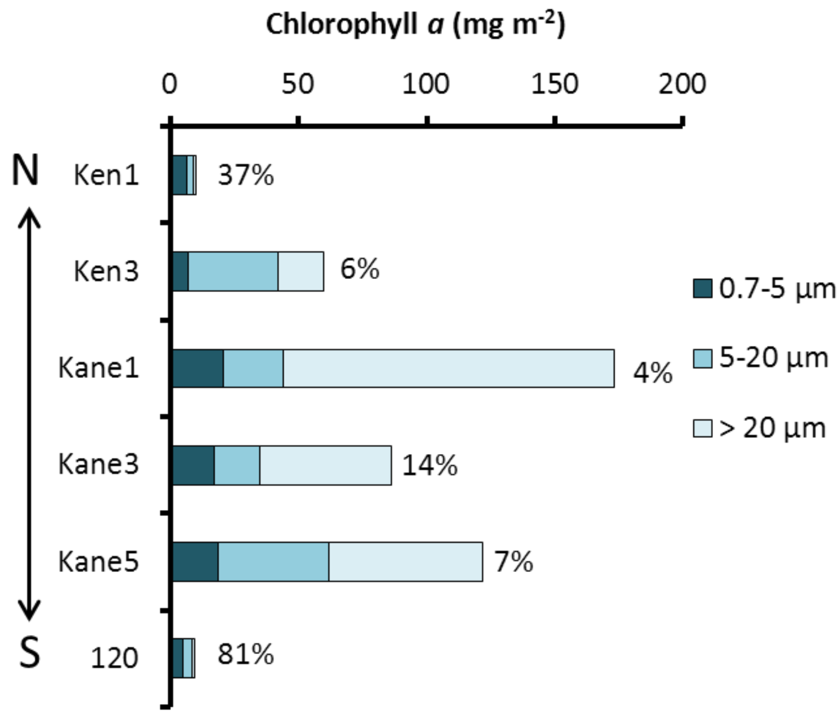

Figure 17.2. Chlorophyll *a* concentrations integrated over 100 m for different size fractions, 0.7-5 µm, 5-20 µm and > 20 µm, in the northern north to south Baffin Bay transect during Leg 1. Percentages indicate the proportion of phaeopigments relatively to total chlorophyll *a* concentrations.

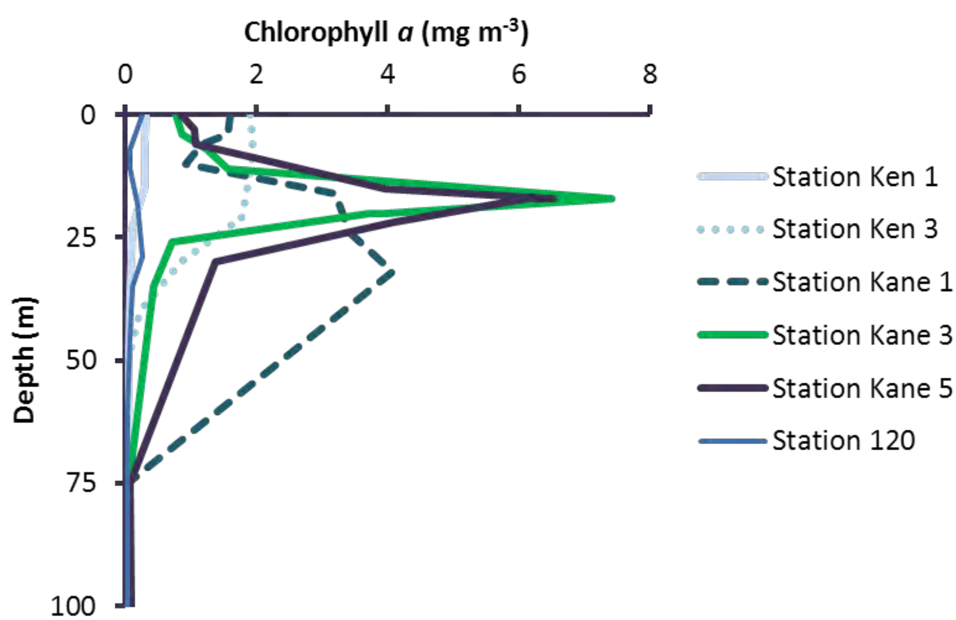

Figure 17.3. Vertical profiles of total chlorophyll *a* in the northern north to south Baffin Bay transect during Leg 1.

17.3.2 Results for Leg 2a

Chlorophyll *a* concentrations varied between 7 and 110 mg m^{-2}. Highest biomass was retrieved at the Station 472, nearby the Mackenzie River mouth. Stations in the Amundsen Gulf had higher biomass than stations in Beaufort Sea. This higher biomass was mostly due to large cells (> 5 µm) that accounted for 90%, in average, of total biomass in the Amundsen Gulf. Large cells only accounted for about 15% of total biomass in Beaufort Sea, with the exception of Station 470A and 472 (Figure 17.4).

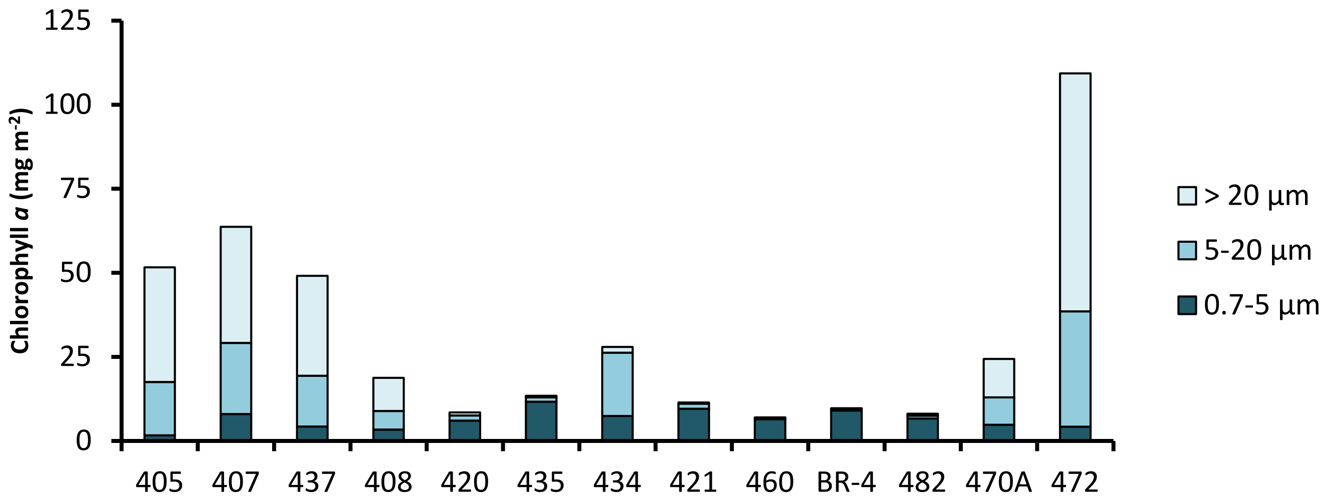

Figure 17.4. Chlorophyll *a* concentrations integrated over 100 m for different size fractions, 0.7-5 µm, 5-20 µm and > 20 µm, at all stations sampled during Leg 2a.

17.3.3 Results for Leg 3

Chlorophyll *a* concentrations varied between 18 and 140 mg m^{-2} when integrated over 100m depth. Highest biomass was retrieved at the Station 176, located on the northern coast of Baffin Island, largely due to the increased contributions of cells greater than 5 um in size. Stations in the fjords along Baffin Island (PCBC-2, PCBC-3 and Gibbs-N) had higher biomass than stations in the Labrador Sea (Figure 17.5).

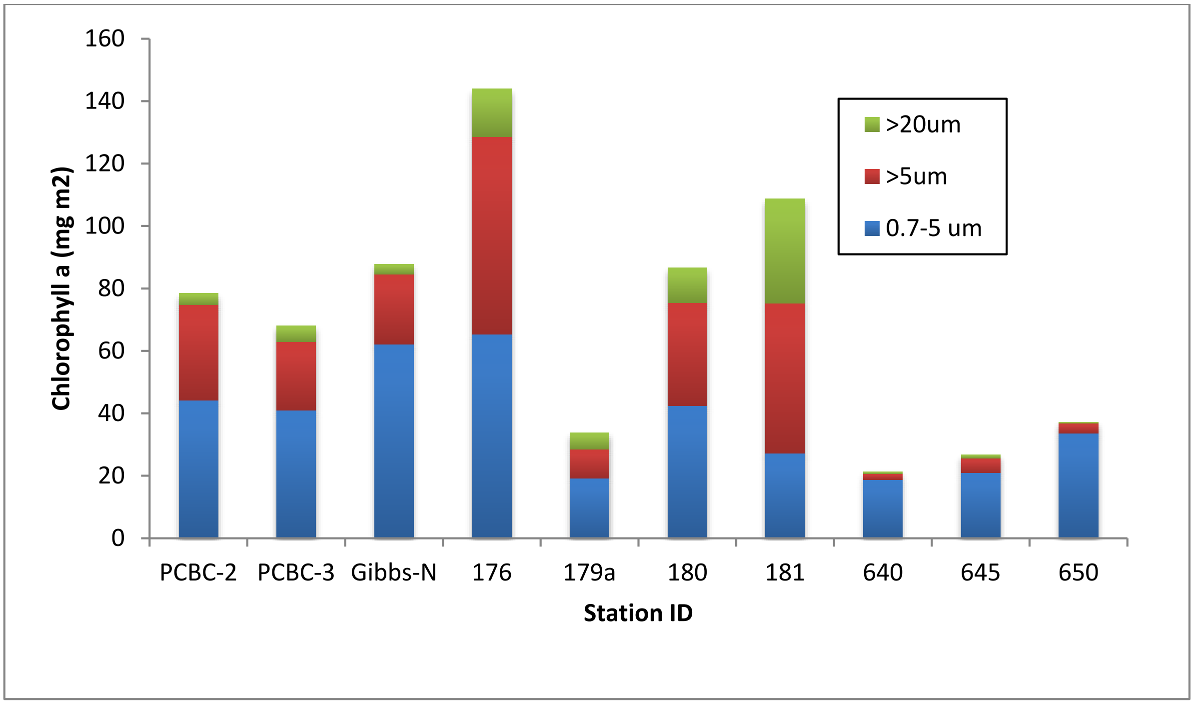

Figure 17.5. Chlorophyll *a* concentrations integrated over 100 m for different size fractions, 0.7-5 µm, 5-20 µm and > 20 µm, at all stations sampled during Leg 3.

17.4 Comments and recommendations

The blue barrels that we use for radioactive waste are too soft and tend to deform themselves even when they are slightly squeezed with the outer straps. A different system should be implemented to facilitate the disposal of radioactive waste.

Every year, we, and other labs as well, need to make filtered seawater for our analysis (about 3L per station). It would be interesting if we could have an efficient system that would provide access to clean seawater. In previous years, we have used the seawater coming through the tap in most labs. The water has always been rusty, but after an hour flushing out, it was generally good enough to filter. However, this year, it stayed too rusty to be used. So we were wondering if there would be a way to use the seawater coming through the pump used for the incubator, or the water pumped by the TSG.

It would also be beneficial to see the status of the Rosette cast while preparing for the station in the labs. Putting a monitor into any one of the aft labs would therefore be beneficial.

References

Arrigo KR, van Dijken G, Pabi S (2008) Impact of a shrinking Arctic ice cover on marine primary production. Geophys Res Lett 35:L19603, doi:10.1029/2008GL035028

Grebmeier JM, Overland JE, Moore SE, Farley EV, Carmack EC, Cooper LW, Frey KE, Helle JH, McLaughlin FA, McNutt SL (2006) A major ecosystem shift in the northern Bering Sea. Science 311:1461-1464

Kwok R, Cunningham GF, Wensnahan M, Rigor I, Zwally HJ, Yi D (2009) Thinning and volume loss of the Arctic Ocean sea ice cover: 2003-2008. J Geophys Res 114:C07005, doi:10.1029/2009JC005312

Landry, M.R., Brown, S.L., Yoshimi M.R., Selph, K.E., Bidigare, R.R., Yang, E.J., & Simmons, M.P. (2008). Depth-stratified phytoplankton dynamics in Cyclone Opal, a subtropical mesoscale eddy. Deep-Sea Research II 55: 1348– 1359

Markus T, Stroeve JC, Miller J (2009) Recent changes in Arctic sea ice melt onset, freezeup, and melt season length. J Geophys Res 114:C12024, doi:10.1029/2009JC005436

Moline MA, Karnovsky NJ, Brown Z, Divoky GJ, Frazer TK, Jacoby CA, Torrese JJ, Fraser WR (2008) High latitude changes in ice dynamics and their impact on polar marine ecosystems. Ann N Y Acad Sci 1134:267-319

Pabi S, van Dijken GL, Arrigo KR (2008) Primary production in the Arctic Ocean, 1998-2006. J Geophys Res 113, C08005, doi:10.1029/2007JC004578

Peterson BJ, McClelland J, Curry R, Holmes RM, Walsh JE, Aagaard K (2006) Trajectory Shifts in the Arctic and Subarctic Freshwater Cycle. Science 313:1061-1066

Post E, Forchhammer MC, Bret-Harte MS, Callaghan TV, Christensen TR, Elberling B, Fox AD, Gilg O, Hik DS, Hoye TT, Ims RA, Jeppesen E, Klein DR, Madsen J, McGuire AD, Rysgaard S, Schindler DE, Stirling I, Tamstorf MP, Tyler NJC, van der Wal R, Welker J, Wookey PA, Schmidt NM, Aastrup P (2009) Ecological Dynamics Across the Arctic Associated with Recent Climate Change. Science 325:1355-1358

Serreze MC, Barrett AP, Slater AG, Woodgate RA, Aagaard K, Lammers RB, Steele M, Moritz R, Meredith M, Lee CM (2006) The large-scale freshwater cycle of the Arctic. J Geophys Res 111:C11010, doi:10.1029/2005JC003424

Stroeve J, Holland MM, Meier W, Scambos T, Serreze M (2007) Arctic sea ice decline: Faster than forecast. Geophys Res Lett 34:L0950, doi:10.1029/2007GL029703

18 Distributions of pacific copepods and phytoplankton resting cells – Leg 2b

ArcticNet Phase 3 – Marine Biological Hotspots: Ecosystem Services and Susceptibility to Climate Change.
http://www.arcticnet.ulaval.ca/pdf/phase3/marine-ecosystem-services.pdf

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18.1 Introduction

After 1990s, decreasing of sea ice has been reported in the western Arctic Ocean, due to an increasing amount of warm Pacific water entering the Arctic Ocean through Bering Strait. Such an inflow may induce intrusion of Pacific originated zooplankton into the Arctic Ocean. Before 1990s, transported Pacific zooplankton was considered harmless and reported as an invalid dispersion because of the small amount of individuals transported. Zooplankton by transported by Pacific water is mainly composed of large-sized copepods (*Neocalanus cristatus, N. flemingeri*, *N. plumchrus*, *Eucalanus bungii*, *Metridia pacifica*), which are dominant components in the North Pacific Ocean (Matsuno et al. 2011, 2012).

Arctic zooplankton is diversified in the North Pacific. Early copepodite stages of copepods (e.g. *Neocalanus* spp.) grow and store oil in their body during phytoplankton bloom. Pre-adult stage (C5) descent into deeper layer (> 1000 m), mature and spawn at that depth. Spawning of the Arctic copepods (e.g. *Calanus glacialis* and *Metridia longa*) is known to occur in the epipelagic zone during phytoplankton bloom. Thus, the utilization of phytoplankton bloom varies with the species (i.e. Pacific species utilize it as a source of energy for growth, while Arctic species use it as a source of energy for reproduction). Despite their importance, the food items grazed by the sympatric copepods have not been evaluated in the details in the western Arctic Ocean. While sea ice is decreasing in this area, details of the ecological impacts of Pacific copepods intrusion have not been evaluated.

Many of the microphytoplankton (diatoms and dinoflagellates) forms resting cells under unsuitable conditions for photosynthesis. These resting cells (termed resting spore for diatoms and cysts for dinoflagellates) settle on bottom sediments, and germinate under favourable conditions. In the Arctic Ocean, because of the presence of long dark periods and ice coverage, resting cells formation, distribution and germination are considered to be key mechanisms to maintain phytoplankton population as seed population.

The goals of this study include:

- Estimation of the amount of the transported Pacific copepods into the Arctic Ocean;
- Evaluation of phytoplankton species composition with copepods faecal pellets based on rDNA sequence;
- Evaluation of spatial distribution and survival mechanism of resting cells.

18.2 Methodology

Zooplankton samples were collected by vertical haul of two types of nets at 22 stations in the western Arctic Ocean. Twin NORPAC net (mesh sizes: 335 and 62 μm, mouth diameter: 45 cm) was towed between surface and 150 m depth or bottom -5 m (stations shallower than 150 m) at all stations (Figure 18.1 and Table 18.1). Zooplankton samples collected by the NORPAC net with 335 μm mesh were immediately token by photo using a digital single-lens camera imaging system, and then fixed with 5% buffered formalin for zooplankton structure analysis. Other samples collected with 62 μm mesh were split using a Motoda box splitter. One aliquot was immediately fixed with 5% buffered formalin for further zooplankton structure analysis. Using the remaining aliquot, faecal pellets, which were egested by sorted copepods in the refrigerator, were collected for DNA analysis. After that, the remaining aliquot was fixed with 99.5% ethanol to perform Foraminifera analysis (investigator: Katsunori Kimoto [JAMSTEC]). The volume of water filtered through the net was estimated from the reading of a flowmeter mounted in the mouth ring.

Sediment samples were collected by gravity core sampling (length: 1 m, diameter: 10 cm, weight: 30 kg) at 7 stations located in the shallower area, along the cruise track. The top 3 cm of the sediment were sampled and preserved in refrigerator.

18.3 Preliminary results

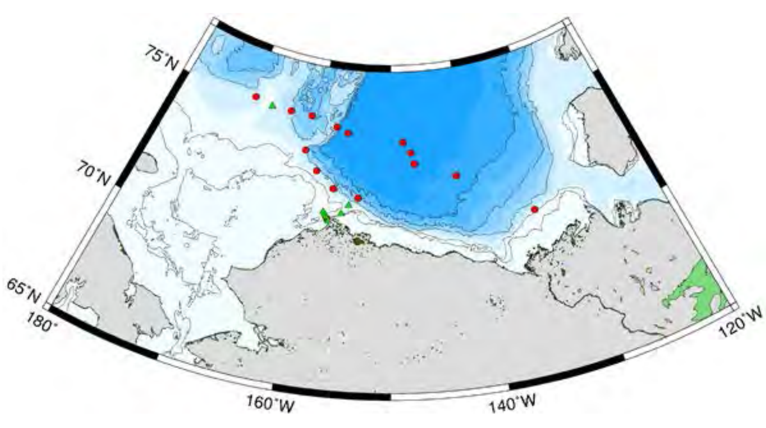

Figure 18.1. Location of the sampling stations in the western Arctic Ocean (circles: NORPAC net; triangles: NORPAC net + gravity core).

Table 18.1. List of plankton samples collected by vertical hauls, using NORPAC net.

GG54: 335 μm mesh.

Station no.	Position Lat. (N)	Lon.		S.M.T. Date	Hour	Length of wire (m)	Angle of wire (°)	Depth estimated by wire angle (m)	Kind of cloth	Flowmeter No.	Reading	Estimated volume of water filtered (m^3)	Remark
001 (1040)	71-14.82	157-9.9	W	10 Sep	9:14	42	1	42	GG54	1562	388	6.17	
									62 μm	1858	350	5.57	
002 (1041)	71-19.8	157-19.92	W	10 Sep	12:36	87	1	87	GG54	1562	1089	17.32	
									62 μm	1858	715	11.37	1)
003 (1042)	71-24.6	157-29.4	W	10 Sep	16:15	124	3	124	GG54	1562	1310	20.83	
									62 μm	1858	807	12.83	1)
004 (1043)	71-30	157-39.6	W	10 Sep	23:12	83	2	83	GG54	1562	808	12.85	
									62 μm	1858	655	10.42	1)
005(1044)	71-34.68	157-50.28	W	11 Sep	2:41	62	1	62	GG54	1562	540	8.59	
									62 μm	1858	450	7.16	1)
006(1038)	71-34.32	155-45.48	W	12 Sep	1:03	150	5	149	GG54	1562	1777	28.26	
									62 μm	1858	1481	23.55	1)
007(1034)	71-54.5	154-57.9	W	13 Sep	0:27	150	1	150	GG54	1562	1300	20.68	
									62 μm	1858	1145	18.21	1)
008(1030)	72-12.36	153-55.74	W	14 Sep	4:13	150	5	149	GG54	1562	1291	20.53	
									62 μm	1858	1195	19.01	1)
009(NORPAC1)	72-28.565	157-0.557	W	14 Sep	9:13	150	15	145	GG54	1562	1735	27.59	
									62 μm	1858	1550	24.65	1)
010(NORPAC2)	73-3.551	159-20.573	W	14 Sep	14:18	150	6	149	GG54	1562	1609	25.59	
									62 μm	1858	1548	24.62	1)
011(NORPAC3)	73-45.102	161-14.377	W	14 Sep	19:05	150	1	150	GG54	1562	1323	21.04	
									62 μm	1858	1310	20.83	1)
012(NORPAC4)	75-12.427	169-49.444	W	16 Sep	4:34	150	4	150	GG54	1562	1251	19.90	
									62 μm	1858	1105	17.57	1)
013(1085)	75-3.694	167-8.315	W	16 Sep	15:15	150	1	150	GG54	1562	1248	19.85	
									62 μm	1858	1319	20.98	1)
014(NORPAC5)	75-4.275	164-21.662	W	17 Sep	2:15	150	1	150	GG54	1562	1235	19.64	
									62 μm	1858	1098	17.46	1)
015(1100)	75-4.158	161-15.592	W	18 Sep	2:23	150	1	150	GG54	1562	1185	18.85	
									62 μm	1858	1234	19.63	1)

S.M.T. was GMT-7h.

1) shared 1/2 sample with JAMSTEC Kimoto.

Table 1. Continued.

Station no.	Position Lat. (N)	Lon.		S.M.T. Date	Hour	Length of wire (m)	Angle of wire (°)	Depth estimated by wire angle (m)	Kind of cloth	Flowmeter No.	Reading	Estimated volume of water filtered (m^3)	Remark
016(1105)	74-48.083	157-34.774	W	18 Sep	19:07	150	2	150	GG54	1562	1571	24.99	
									62 μm	1858	1513	24.06	1)
017(1107)	74-36.810	155-54.080	W	19 Sep	0.17	150	1	150	GG54	1562	1131	17.99	
									62 μm	1858	1050	16.7	1)
018(1110)	74-20.167	148-18.536	W	20 Sep	0.3	160	1	160	GG54	1562	1174	18.67	
									62 μm	1858	1033	16.43	1)
019(1115)	73-55.985	147-20.842	W	20 Sep	0.73	150	1	150	GG54	1562	1072	17.05	
									62 μm	1858	753	11.98	1)
020(1125)	73-30.809	146-56.558	W	21 Sep	0.32	150	2	150	GG54	1562	1219	19.39	
									62 μm	1858	1313	20.88	1)
021(1130)	72-55.991	141-46.216	W	21 Sep	0.97	150	1	150	GG54	1562	915	14.55	
									62 μm	1858	1005	15.98	1)
022(1125)	71-4.762	133-37.750	W	23 Sep	0.39	150	1	150	GG54	1562	1070	17.02	
									62 μm	1858	1043	16.59	1)

S.M.T. was GMT-7h.

1) shared 1/2 sample with JAMSTEC Kimoto.

18.4 Comments and recommendations

It would be helpful to display the sampling schedule in the rooms or in the laboratories as to optimize the work. I recommend sharing the sampling schedule via TV or PC.

19 Zooplankton, ichtyoplankton and bioacoustics – Legs 1b, 2 and 3

ArcticNet Phase 3 – The Arctic cod (*Boreogadus saida*) ecosystem under the double pressure of climate change and industrialization. http://www.arcticnet.ulaval.ca/pdf/phase3/arctic-cod.pdf
ArcticNet Phase 3 – Long-Term Observatories in Canadian Arctic Waters.
http://www.arcticnet.ulaval.ca/pdf/phase3/marine-observatories.pdf

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Cruise participants Leg 2a: Cyril Aubry[1], Maxime Geoffroy[1], Jordan Grigor[1] and Moritz Schmid[1]
Cruise participants Leg 2b: Jordan Grigor[1], Cyril Aubry[1], Maxime Geoffroy[1] and Catherine Lalande[1]
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19.1 Introduction

Zooplankton and fish are key components of Arctic marine ecosystems, transferring energy from lower trophic levels (phytoplankton and herbivores) to higher trophic levels such as seals, whales and seabirds. Many zooplankton and fish are known as “key species”, as they are numerous, and provide energy-rich fat and protein for a range of predators.

Overall, the objectives of the zooplankton, ichtyoplankton and bioacoustics program were to:

- Sample the overall mesozooplankton assemblage over the entire water column (Legs 1, 2a, 2b and 3);
- Sample the mesozooplankton assemblage in discrete water layers (Legs 1, 2a, 2b and 3);
- Sample the ichthyoplankton community, focusing on the dominant species Arctic cod (*Boreogadus saida*) (Legs 1, 2a, 2b and 3);
- Conduct experiments on the rates of gut evacuation and fecal pellet production of living zooplankton (with the exclusion of amphipods and jellyfish) (Leg 2a);
- Collect baseline data on the distribution and abundance of adult fish (particularly *B. saida*) using the multi-frequency EK60 echosounder (38, 120 and 200 kHz), SX90 fish finding sonar and fish trawls (Legs 2a, 2b and 3);
- Detect marine mammals with the SX90 sonar to complement marine mammal surveys conducted by the Marine Wildlife Observers (MWOs) (Leg 2a);
- Sample the zooplankton living in the hyperbenthic zone (just above the seafloor) with the MOKI and chaetognath trap (Legs 2b and 3).

Nested project – Leg 1

Climate change in the Arctic favours the poleward expansion of temperate and boreal marine species (Schiermeier 2007). These invasive species could dramatically distort the Arctic marine food web, principally by altering the lipid fluxes between the different trophic levels. In the Arctic ecosystem, lipid compounds are of critical importance since they are the principal energy source for all living organisms from zooplankton to marine mammals. Lipids are key determinants for the structure and dynamics of the Arctic marine ecosystem (Falk-Petersen et al. 2009) and they are crucial for Inuit health (Bjerregaard et al. 1997). The establishment of species coming from southern ecosystems in the Arctic could lead to a major ecosystem regime shift, which is a profound modification of an ecosystem's structure and dynamics. The project conducted during Leg 1 aimed at elucidating the bioenergetics impacts of invasive marine species on the Arctic marine ecosystem and the consequences of shifts in the ecosystem on Inuit food provisioning and health. This project focused on characterizing lipids in fish, but lipid compounds will also be studied in marine mammals and for their importance in Inuit health in the coming years.

The specific objectives of the project for Leg 1 were:

- Characterize the lipid content and composition of Arctic cod (*Boreogadus saida*) and other fish species sampled in the Arctic;
- Define the change in lipid composition between the different life stages of the same fish species.

19.2 Methodology

19.2.1 Mesozooplankton assemblages

The zooplankton assemblages integrated over the entire water column were collected by deploying the 5-Net Vertical Sampler (5NVS) from 10 m above the bottom to the surface at a retrieval rate of 24 m min^{-1}. The 5NVS carried three 1-m^2 aperture nets (two with 200-µm mesh and one with 500 µm mesh), one 50-µm mesh cylindrical nets of 0.1 m diameter, for the collection of the entire mesozooplankton size spectrum, and was also equipped with the LOKI, which is a high resolution In-Situ digital image recorder. The LOKI takes images of the zooplankton using a 200-µm mesh with a 60 cm diameter opening, that concentrate the particles through a cell where a camera takes a picture of each individual organisms. Each picture is associated with the environmental data measured by the associated sensors (depth, salinity, O_2 concentration and chl *a* fluorescence). One of the 200-µm mesh samples was preserved in formalin and the other one was provided to the ArcticNet contaminant team (Alexis Burt) for the assessment of contaminant levels. The 50-µm mesh sample (copepod eggs and *naupli*) and the 500-µm mesh sample (macrozooplankton including jellies) were preserved in formalin. One of the two 200-µm mesh samples and the 500-µm mesh sample will be sorted in priority for the full assessment of zooplankton abundance by species and developmental stages, as well as total biomass, for each station. The data from the LOKI will be treated with learning machine algorithms to establish the vertical distribution of species in the water column.

Depth specific sampling of the zooplankton assemblage was collected using the Hydrobios, a multi-depth plankton profiler equipped with nine 200 µm-mesh nets (opening 0.5 m^2). The Hydrobios is also equipped with a CTD to record water column properties while collecting biological samples. Downward and upward winch speeds are 40 and 30 m/min respectively. The content of each net was preserved in formalin for taxonomy.

19.2.2 Ichthyozooplankton assemblages

The ichthyoplankton and mesozooplankton assemblages in the surface layer were sampled with the Double Square Net sampler (DSN), a rectangular metal frame carrying side by side two 6-m long, 1-m^2 mouth aperture, 500- and 750-µm mesh, square-conical nets, and one 50-µm mesh cylindrical nets of 0.1 m diameter. The DSN was towed by the ship at 1 m s^{-1}. All fish from the two nets were sorted at sea and either frozen in -80°C freezer or preserved in 95% ethanol. At each station, a subset of up to 25 Arctic cod specimens was measured (standard length). The zooplankton (minus fish larvae) from the 750-µm mesh net was provided fresh to the ArcticNet contaminant team (Alexis Burt) for the assessment of mercury (Hg) contaminant levels. Zooplankton (minus fish larvae) from the 50-µm and 500-µm mesh nets was preserved in formalin for further analysis of the micro- and macro-zooplankton assemblage in the layer occupied by fish larvae.

The distribution of fish larvae in the surface layer was also investigated using the multinet sampler Bioness at each Full station. This sampler uses 9 nets of 750-µm mesh with an aperture of 1-m^2 to stratify the first 80 m of the water column. Zooplankton (minus fish larvae) from the nets was preserved in formalin for further analysis of the micro- and macro-zooplankton assemblage in the layer occupied by fish larvae.

A portion of the fish larvae samples collected this year will be used to quantify lipids. Also, during Leg 1b a new net sampler was tested on 3 occasions. The Isaac-Kidd Middle water Trawl (IKMT) has a 9 m^2 aperture and 1 cm mesh for catching adult fish. The deployment procedure was adjusted after every test, and on one occasion an Arctic cod was caught alive.

Table 19.1. Stations sampled for zooplankton and ichthyoplankton during Leg 1b.

Station	Station type	Date	Latitude N	Longitude W	Depth (m)	5 NVS	DSN	Hydrobios	Bioness	IKMT

Station	Station type	Date	Latitude N	Longitude W	Depth (m)	5 NVS	DSN	Hydrobios	Bioness	IKMT
323	Basic+	07/16/2014	74°09.273	080°31.210	773	X			X	
301	Full	07/19/2014	74°05.935	083°24.581	667	X	X			
304	Full	07/20/2014	74°14.040	091°29.688	312	X		X		
305	Full	07/22/2014	74°19.386	094°52.180	191	X		X	X	
200	Basic	07/27/2014	73°17.414	063°36.515	1470		X	X		
204	Basic	07/28/2014	73°15.666	057°53.165	987	X	X			
210	Basic	07/30/2014	75°24.323	061°39.316	1154	X	X			
115	Full	07/30/2014	76°19.257	071°09.968	657	X	X	X	X	X
111	Basic	07/31/2014	76°18.335	073°13.622	599	X	X			
108	Full	08/01/2014	76°16.052	074°35.952	448	X	X	X	X	
105	Basic	08/01/2014	76°18.825	075°46.495	333	X	X			
101	Full	08/01/2014	76°22.246	077°24.660	383	X	X	X	X	
KEN1	Full	08/03/2014	81°21.604	063°57.361	530	X	X	X	X	
KEN3	Basic	08/04/2014	80°47.729	067°18.067	406	X	X			
KANE1	Basic	08/04/2014	79°59.584	069°46.636	239	X	X			
KANE3	Basic	08/05/2014	79°20.767	071°51.469	215	X	X			
KANE5	Basic	08/05/2014	79°00.918	073°12.274	250	X	X			
120	Basic	08/06/2014	77°19.553	075°42.248	558	X	X			X
335	Basic	08/08/2014	74°25.271	098°47.260	118	X		X		
309	Basic	08/10/2014	72°41.952	096°03.180	333	X	X			
310	Basic	08/10/2014	71°17.706	097°41.871	50	X	X			
312	Basic	08/11/2014	69°10.801	100°40.491	60	X	X			
314	Full	08/12/2014	68°58.218	105°28.239	110	X	X	X	X	
IKMT	IKMT	08/13/2014	68°19.000	112°17.300	227					X

Table 19.2. Summary of sampling activities during Leg 2a of the 2014 *Amundsen* expedition.

Station	Station type	Date	Latitude (N)	Longitude (W)	Depth (m)	5NVS	DSN	Hydrobios	Bioness	2-Net Sampler
405	Basic	17/08/2014	70°38.390	123°02.209	597	X	X			
407	Basic	18/08/2014	71°00.390	126°04.550	403	X	X			
437	Basic	19/08/2014	71°47.340	126°29.840	318	X	X			
408	Full	20/08/2014	71°18.840	127°34.930	212	X	X	X	X	
420	Basic	21/08/2014	71°03.050	128°30.960	42	X	X			
435	Basic	22/08/2014	71°04.680	133°38.530	295	X	X			
BS-2	Mooring	23/08/2014	70°53.242	135°05.477	302					X
434	Basic	23/08/2014	70°10.760	133°32.970	46	X	X			
BR-G	Mooring	24/08/2014	71°00.396	135°29.723	678					X
421	Full	24/08/2014	71°27.190	133°51.580	1193	X	X	X	X	
460	Basic	25/08/2014	72°09.188	130°49.545	965	X	X			
BR-3	Mooring	27/08/2014	73°19.767	129°15.560	689					X
BR-1	Mooring	01/09/2014	70°25.954	139°10.542	756					X
482	Basic	02/09/2014	70°31.792	139°23.210	830	X	X			

Station	Station type	Date	Latitude (N)	Longitude (W)	Depth (m)	5NVS	DSN	Hydrobios	Bioness	2-Net Sampler
470-A	Basic	04/09/2014	69°21.836	138°13.982	48	X	X			
472	Basic	06/09/2014	69°36.706	138°12.398	125	X	X			X

Table 19.3. Summary of sampling activities during Leg 2b of the 2014 *Amundsen* expedition.

Station	Station type	Date	Latitude (°N)	Longitude (°W)	Depth (m)	5NVS/ 2-net Sampler	DSN	Hydrobios	Beam Trawl	IKMT	Didson acoustic camera	MOKI + Chaeto trap
1040	Basic	10/09/2014	71°14.780	157°10.401	47	X	X					
1042	Basic	10/09/2014	71°24.500	157°28.955	127	X	X		X			X
1044	Basic	11/09/2014	71°34.582	157°50.295	55	X	X		X			X
1038	Basic	12/09/2014	71°34.295	155°45.620	165	X	X		X			X
1034	Full	13/09/2014	71°54.364	154°58.319	379	X	X	X	X	X	X	X
1030	Basic	14/09/2014	72°12.696	153°57.792	2081		X	X				
1085	Basic	16/09/2014	75°03.447	167°08.000	254	X	X		X			X
1100	Full	18/09/2014	75°04.161	161°16.249	1985	X (2net)	X			X		
1107	Basic	19/09/2014	74°36.589	155°43.722	3860	X		X				
1115	Basic	20/09/2014	73°54.250	147°11.155	3773	X	X	X				
1130	Basic	22/09/2014	72°35.862	144°44.402	3234	X	X	X				
435	Basic	23/09/2014	71°04.611	133°38.232	296				X			

Table 19.4. Information on deployments used to source chaetognaths for fatty acid analyses during Leg 2b.

Date	Station	Depth (m)	Sampling device	Sampling depth (m)	Chaetognaths removed
13/09/2014	1034	379	DSN (740µm)	90	30 *P. elegans*
14/09/2014	1030	2081	DSN (750µm)	90	10 *P. elegans*
16/09/2014	1085	254	DSN (750µm)	90	30 *P. elegans*
17/09/2014	1085	245	Beam Trawl	235	1 *P. maxima*
18/09/2014	1100	1985	DSN (750µm)	90	30 *P. elegans*
18/09/2014	1100	1985	2-Net Sampler (200µm)	1972-0	15 *E. hamata*
20/09/2014	1115	3773	5NVS (200µm)	999-0	12 *E. hamata*
20/09/2014	1115	3773	5NVS (500µm)	999-0	9 *E. hamata*
20/09/2014	1115	3773	Hydrobios (200µm)	1500-1000	1 *P. maxima*
22/09/2014	1130	3234	5NVS (200µm)	1000-0	10 *E. hamata*
22/09/2014	1130	3234	5NVS (500µm)	1000-0	20 *E. hamata*

Table 19.5. Summary of sampling activities during Leg 3 of the 2014 *Amundsen* expedition.

Station	Region	Station type	Date	Latitude (N)	Longitude (W)	Depth (m)	5NVS	DSN	Hydrobios	MOKI
PCBC-2	Scott Inlet	Full	01/10/2014	71°04.976	071°49.834	580-693	X	X	X	X
Gibbs-B	Gibbs fjord	Full	01/10/2014	70°45.634	072°13.633	190-440	X	X		
180	Baffin Bay	Basic	03/10/2014	67°28.382	061°42.329	179-214	X	X		X

Table 19.6. Information on Leg 3 deployments used to source chaetognaths for fatty acid analyses.

Station	Date	Depth (m)	Sampling device	Sampling depth (m)	Chaetognaths removed
PCBC-2	01/10/2014	580-693	DSN (500µm)	90-0	30 *P. elegans*
PCBC-2	01/10/2014	580-693	5NVS (500µm)	685-0	2 *P. maxima,* 18 *E. hamata*
Gibbs-2	01/10/2014	190-440	5NVS (500µm)	430-0	30 *E. hamata*
180	03/10/2014	179-214	DSN (500µm)	90-0	30 *P. elegans,* 30 *E. hamata*

P. elegans = Parasagitta elegans; *E. hamata = Eukrohnia hamata*; *P. maxima = Pseudosagitta maxima*

19.2.3 Gut evacuation and fecal pellet production rates

This year, experiments were conducted to examine the gut evacuation and fecal pellet production rates of living zooplankton (excluding amphipods and jellyfish). At select stations (Table 19.7), semi-quantitative zooplankton samples were collecting using the 2-Net Sampler (two 6m long square-conical nets with 1m^2 mouth diameter, 200µm mesh), towed vertically from ~70m (slightly deeper at two stations) to the surface. Upward and downward winch speed was 30m min^{-1}. One full cod end sample was used to investigate gut evacuation rates and the other fecal pellet production rates. Three of the stations were the sites of BS, BR and BG oceanographic moorings equipped with sediment traps, which allowed fecal pellet production data gained from our experiments to be compared with the contents of the trap samples.

Before rinsing the nets, the cod end samples were immediately poured into jars of filtered seawater (previously collected from 100 m depth at nearby stations using the CTD Rosette) and stored at 4°C. The gut evacuation experiment involved transferring all zooplankton to previously filtered seawater and then filtering the zooplankton through 200µm mesh filter papers at successive time intervals (T=0, 5, 10, 15, 30, 45 minutes). Each successive pour was completed when zooplankton entirely covered the mesh. Mesh samples were frozen at -80°C until the end of the cruise. The fecal pellet production experiment, conducted in the cold lab of the *Amundsen* (4°C) involved sieving the living zooplankton into two size fractions (200-1000µm) and (>1000µm). Where possible, amphipods and jellyfish were removed from the samples as amphipods voraciously feed on other zooplankton and jellyfish can clog filtration apparatus. Each size fraction was then thoroughly rinsed in filtered seawater to remove excess particles, and placed in incubation chambers. These chambers consisted of a relatively coarse grained sieve (100µm in the case of the smaller zooplankton fraction and 500µm for the larger size fraction), and fastened underneath, a finer grained sieve (20µm) to capture fecal pellets produced by the animals. Zooplankton were left in incubation in total darkness for 6 hours, 12 hours or 24 hours, depending on time availability for other sampling needs. Thereafter, zooplankton and fecal pellets produced were removed from the experimental chambers and preserved in formalin-filtered seawater solution. Samples from all experiments will be returned to Makoto Sampei at the University of Hiroshima for analyses.

Table 19.7. Information on samples used to examine gut evacuation and fecal pellet production rates during Leg 2a of the 2014 *Amundsen* expedition.

Station	Station type	Sampling depth (m)	Time on deck (UTC)	Start time Gut Evacuation expt. (UTC)	Start time Fecal Pellet Production expt. (UTC)
BS-2	Mooring	200	00:28	00:45	01:20
BR-G	Mooring	125	00:47	01:02	01:12
BR-3	Mooring	70	15:49	16:15	16:20
BR-1	Mooring	70	23:21	23:50	23:45
472	Basic	70	18:15	19:00	18:50

19.2.4 Distribution and abundance of adult fish

The split-beam Simrad EK60 echosounder was continuously operating and recording throughout Legs 2a, 2b and 3 to monitor the distribution and abundance of adult fish. In addition, the SX90 sonar was operated during one dedicated and three oportunistic surveys (Table 19.8). The frequency of the sonar varied from 20 to 30 kHz by 1 kHz increment. A 3m benthic beam trawl (Figure 19.1) was also deployed to validate the acoustic data. The mesh of the trawl net was 1-5/8" x 1.2 mm in the first section, 1-1/4" in the last section, and 3/8" in the bottom panel. Net opening was 3m^2. The beam trawl was deployed at selected Basic and Full stations (Table 19.9 and 19.10). The net was lowered down at a speed varying from 60 to 80 m min^{-1}, towed near the bottom for 20-30 minutes, and retrieved at 60m min^{-1}. An Isaac Kidd Mid-water Trawl (IKMT) was also deployed at a few stations (Table 19.9 and 19.10). This had an opening area of 4.5 m^2 and mesh sizes of 2.5 cm in the upper section, 1.6 cm and 1.1 cm in the middle sections and finally 0.5cm in the lower section. A Didson acoustic camera was deployed at one station, but failed to work properly.

Table 19.8. Summary of SX90 surveys.

Date (UTC)	Area	Description	Duration	Detections
2014-08-17 to 2014-08-19	Amundsen Gulf	Dedicated acoustic survey between Banks Island and Cape Bathurst	57 hours	20 bowhead whales No surface schools of fish Scattered individual fish near the bottom (detected with the EK60)
2014-08-21	Beaufort Sea	Opportunistic survey	12.5 hours	13 bowhead whales

Date (UTC)	Area	Description	Duration	Detections
	(north of Cape Bathurst)	during transit		One group of bearded seals Scattered individual fish near the bottom (detected with the EK60)
2014-08-30 to 2014-08-31	Beaufort Sea (Marginal Ice Zone)	Opportunistic survey during transit	11 hours	No marine mammals No surface schools
2014-09-03	Mackenzie Shelf	Opportunistic survey during transit	4 hours	No marine mammals No surface schools
2014-09-03	Beaufort Sea towards the US border	Opportunistic survey during mapping and transit to Barrow	7.5 hours	No marine mammals Scattered surface schools. Most likely juveniles. Scattered fish between 200 and 400 on the EK60 echosounder.

Figure 19.1. The beam trawl being retrieved. Photo credit: Gordon Chamberlain.

Table 19.9. Summary of beam trawl and IKMT deployments for adult fish sampling (Leg 2a).

Date	Station	Sampling device	Station depth (m)	Sampling depth (m)	Number of fish
2014-08-18	407	Beam trawl	397	397	18
2014-08-19	Beam trawl 1	Beam trawl	316	316	38
2014-08-20	408	Beam trawl	212	212	39
2014-08-25	460	Beam trawl	973	973	3
2014-09-02	482	IKMT	821	300	54 (Including 44 young-of-year)
2014-09-05	470-A	Beam trawl	50	50	4
2014-09-07	476	Beam trawl	265	265	67

Table 19.10. Summary of beam trawl and IKMT deployments for adult fish sampling (Leg 2b).

Date	Station	Depth (m)	Sampling device	Sampling depth (m)	# of fish	% of which polar cod
10/09/2014	1042	126	Beam Trawl	126	131	9.2
11/09/2014	1044	66	Beam Trawl	66	75	28
12/09/2014	1038	160	Beam Trawl	160	202	5.9
13/09/2014	1034	430	Beam Trawl	430	20	55
13/09/2014	1034	467	IKMT	200	53	100

17/09/2014	1085	245	Beam Trawl	235	34	94.1
18/09/2014	1100	1978	IKMT	250	0	
23/09/2014	435	296	Beam Trawl	296	53	94.3

19.2.5 Zooplankton of the hyperbenthic zone

During Leg 2b, the MOKI was deployed for the first time in an attempt to take images of the zooplankton living in the hyperbenthic zone, just above the seabed. At four stations, the MOKI was lowered to the seabed at a speed of ~25m min^{-1} and left there for ~30 minutes. Photos were taken by the system every 10 seconds. Unfortunately MOKI returned few photographs of zooplankton, with the exception of a few harpacticoid copepods. A trap designed for the (hopeful) collection of hyperbenthic animals was also attached to the MOKI frame (Figure 19.2). The trap comprised lights in its interior that may attract some animals, and an anaesthetic release system to anaesthetise them *in situ* was fixed to the MOKI frame. This also failed to capture animals, possibly due to low abundances in these waters or trap avoidance behaviour.

During Leg 3, the MOKI was deployed at two stations in an attempt to take images of zooplankton aggregations living near the seabed. It was deployed at various depths of the water column, and left it there for 10-20 minutes in order to compare and contrast results. Downward and upward winch speed was 40mmin^{-1}. Images will be closely scrutinised upon the return to Laval, but it is already clear that few animals were captured in the photos, despite high zooplankton abundances in the water column (based on 5NVS sampling). Consequently the MOKI design may need to be revised to improve its capture efficiency.

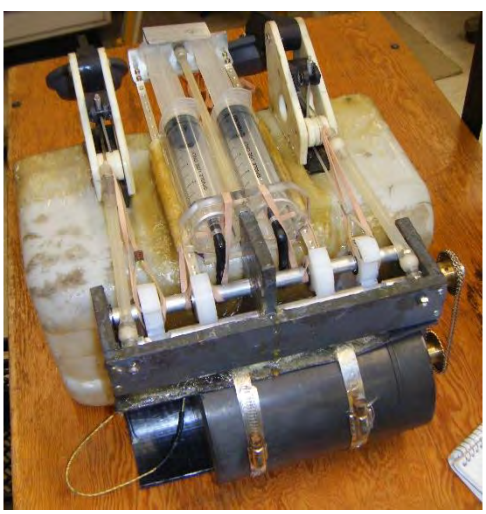

Figure 19.2. The hyperbenthic chaetognath trap.

19.3 Preliminary results

19.3.1 Ichthyoplankton assemblages

Ichthyoplankton assemblages of the Baffin Bay and the Northwest Passage (Leg 1b) were dominated by Gadidae (82%), a family that is generally represented by Arctic cod (*Boreogadus saida*) at 95%. The second most abundant family was Liparidae (11%), followed by Cottidae (4%) and Ammodytidae (2%).

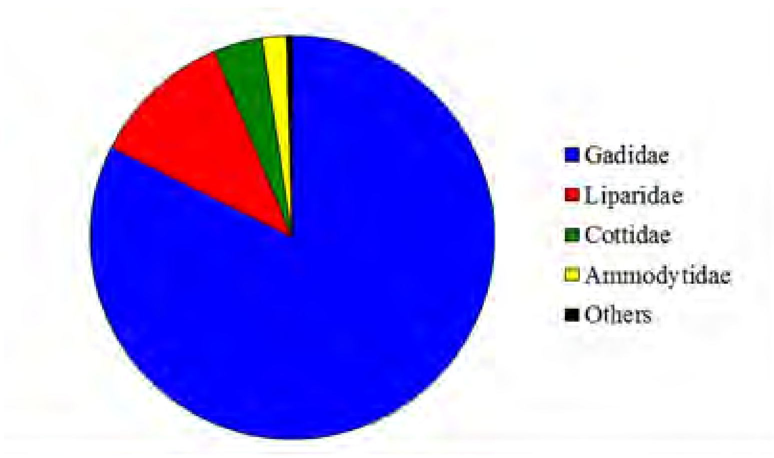

Figure 19.3. Family composition of ichthyoplankton sampled during Leg 1b in Baffin Bay and the Northwest Passage (n=1411).

During Leg 1b, 42% of Arctic cod sampled measured between 10 and 15 mm and 38% between 15 and 20 mm. Arctic cod metamorphosis occurs at lengths around 25 mm, which indicates that the majority of the fish sampled during this part of the expedition were still in the larval period.

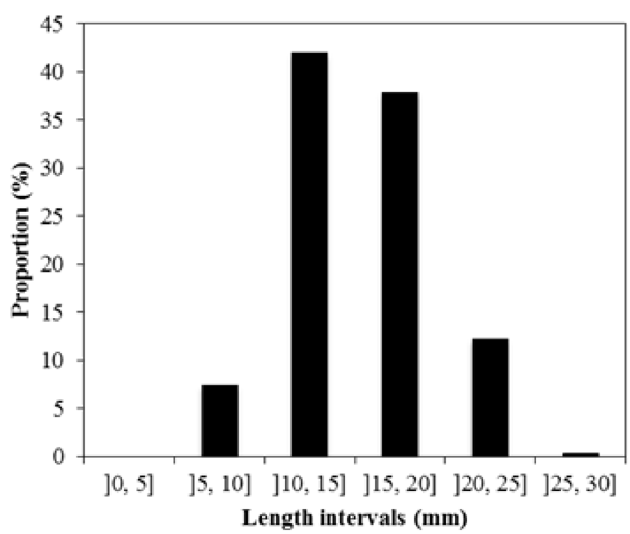

Figure 19.4. Length frequency distribution of Arctic cod (*Boreogadus saida*) early stages sampled during Leg 1b in Baffin Bay and the Northwest Passage (n=269).

During Leg 2b, most of the fish caught in the beam trawls were *Boreogadus saida*, Arctic alligator fish, Lycodes sp., Liparidae and Cottidae (sculpin). Whilst polar cod dominated the fish composition in the beam trawls at four stations, and was the only fish in the IKMT at Station 1034, Arctic alligator fish dominated in the beam trawls at Stations 1042 and 1038 (relatively shallow stations), and Lycodes sp. dominated at Station 1044.

19.3.2 Bioacoustics results

Thirty-three bowhead whales and a group of bearded seals were detected with the SX90 sonar (Figure 19.5). These detections will complement the MWO observations and will allow mapping the distribution of the marine mammals along the track of the ship.

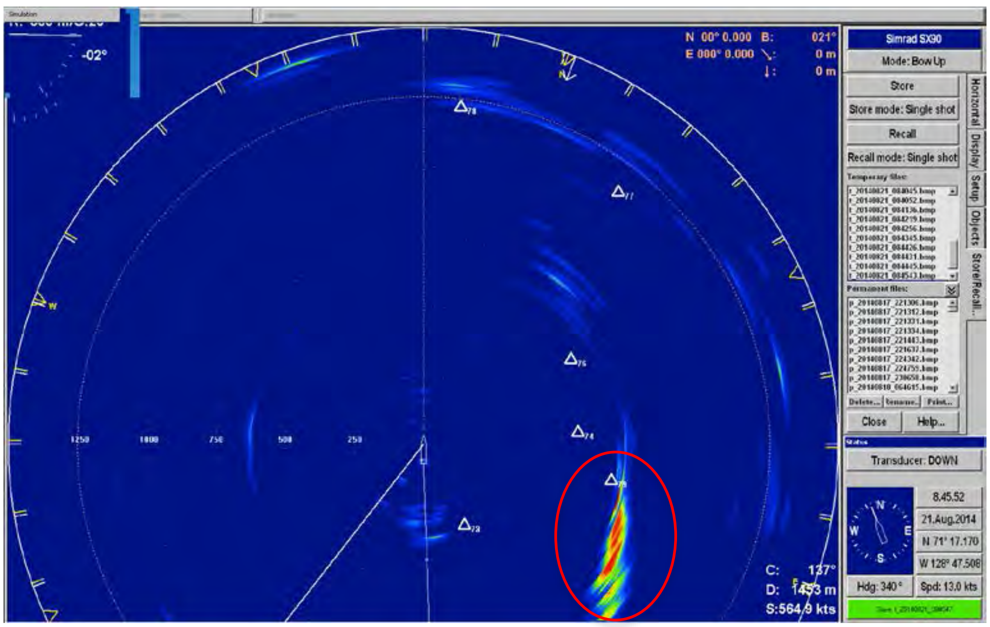

Figure 19.5. Example of a bowhead whale detected with the SX90 sonar at 750 m on August 21, 2014.

223 fish were sampled with the beam trawl and the IKMT, of which 90 were age-1+ Arctic cod (*Boreogadus saida*) with an average length of 12.4 cm. Lycodes and Cottidae spp. dominated the rest of the assemblage.

No surface schools of fish were detected with the SX90 or the EK60, either in open-water areas or at the Marginal Ice Zone.

The backscatter from age-1+ mesopelagic fish on the EK60 echosounder was much weaker than during previous years. The backscatter from YOY epipelagic fish was, however, similar to what was previously observed. A scientific crew on board the F/V *Frosti* concomitantly conducted a hydroacoustic survey in the same area and they observed similar backscatter values on their EK60 echosounder. The *Amundsen* and *Frosti* hydroacoustic data sets will eventually be pooled together to estimate the pelagic fish abundance in the area.

19.3.3 Mesozooplankton assemblages

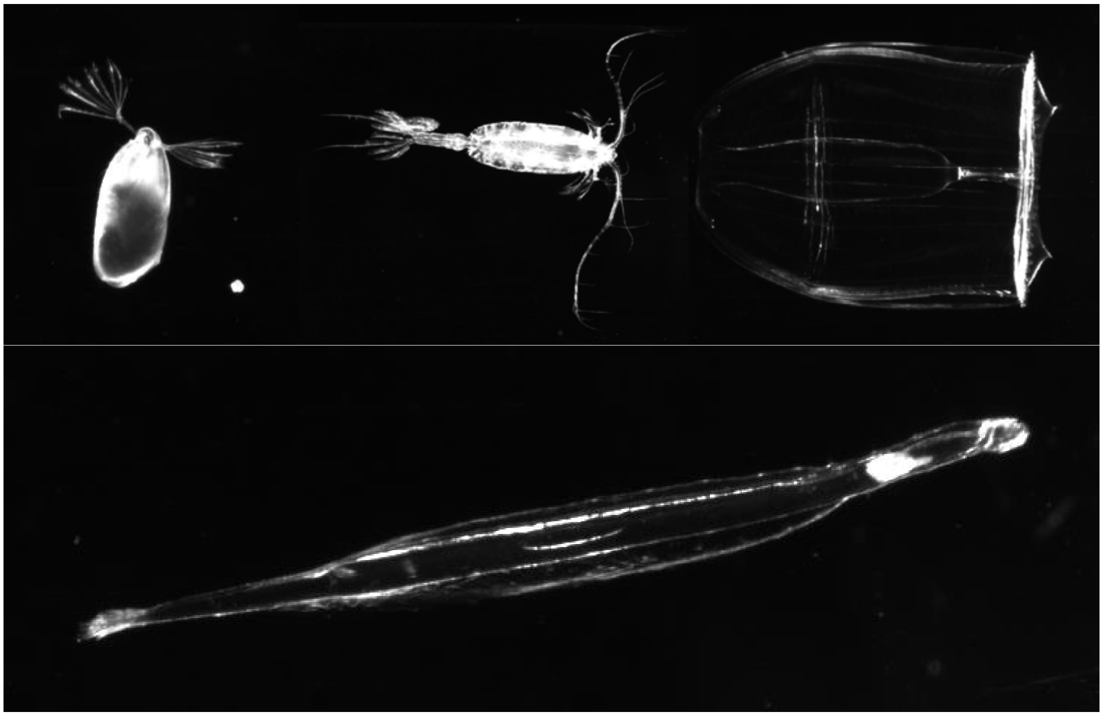

Figure 19.6. Assortment of zooplankton images taken by the LOKI at Station 408: ostracod (upper left), copepod *Paraeuchaeta* sp. (upper centre), hydrozoan medusa (upper right) and chaetognath *Eukrohnia hamata* with visible oil vacuole in the centre of its body and possible prey in its tractus (below).

During Leg 2b, chaetognaths were caught in 5NVS samples from the Chukchi Sea (Station 1030). Further research is required on this potential feeding mode.

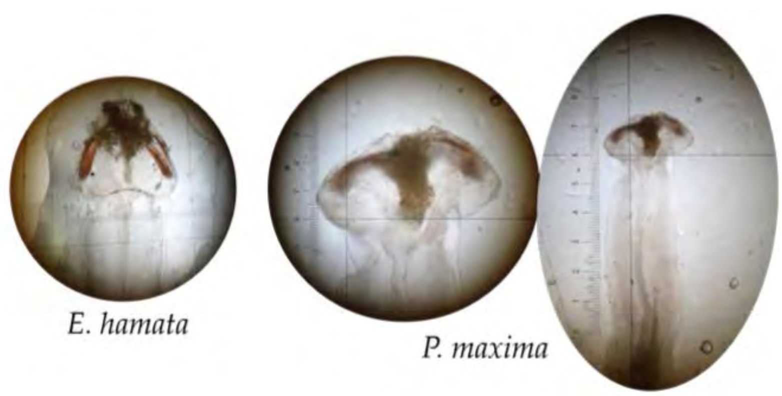

Figure 19.7. Photos showing living *Eukrohnia hamata* (30 mm) and *Pseudosagitta maxima* (46 mm) chaetognaths apparently feeding on green detritus. This could suggest these animals are omnivores, instead of strictly carnivores, which contrasts the present literature.

During Leg 3, LOKI returned high-quality photos of a diversity of zooplankton taxa at all three stations (Table 19.8).

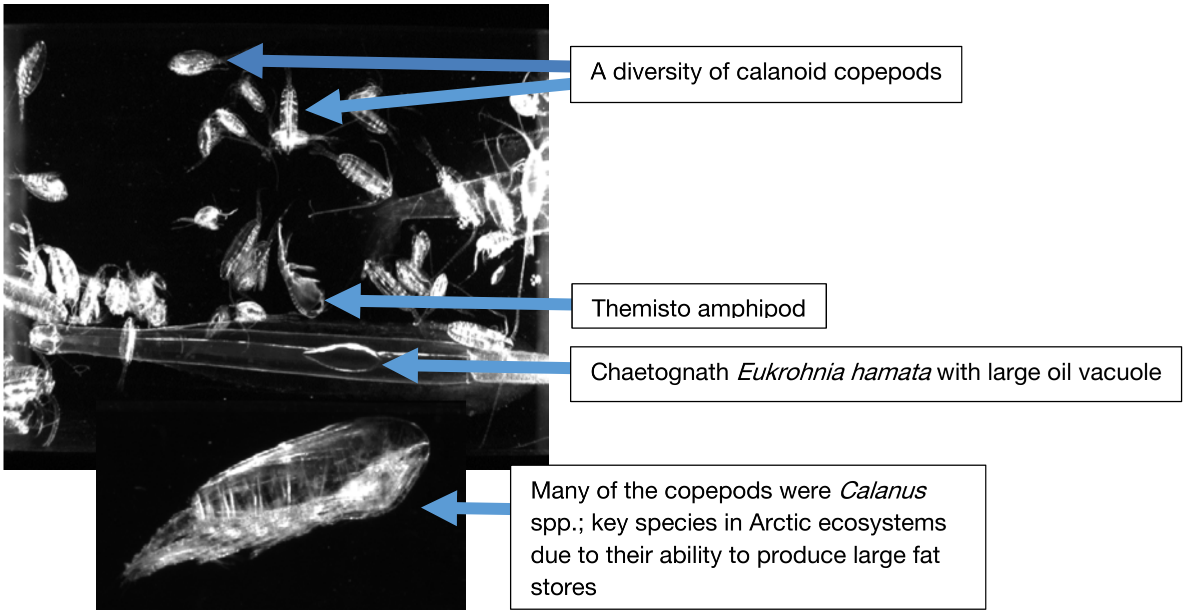

Figure 19.8. LOKI images from the productive Station PCBC-2 with major taxa identified.

19.4 Comments and recommendations

Overall, Leg 3 sampling program was a great success, with LOKI and nets working well. During the next year, the MOKI design should be improved in order to improve its capture efficiency. This could involve devising a way to concentrate near-seabed zooplankton, as is achieved in the case of the LOKI by its concentrating net. The deployment of the MOKI in other locations such as sill fjords with reduced bottom currents and advection of zooplankton, or to sample locations where hyperbenthic zooplankton aggregations have previously been reported.

Most bioacoustics operations were conducted with success. A high-resolution Didson acoustic camera was deployed during Leg 2a, but was interrupted by communication issues during the first deployment. Batteries have been changed and settings updated. The cable between the camera and the computer should also be checked.

On two occasions, the beam trawl was full of mud upon retrieving. The beam trawl should be deployed only if the Agassiz trawl comes back with a relatively low volume of mud.

References

Bjerregaard, P., Mulvad, G., and Pedersen, H.S. 1997. Cardiovascular risk factors in Inuit of Greenland, International Journal of Epidemiology. 26, 1182–1190.
Falk-Petersen, S., P. Mayzaud, et al. 2009. Lipids and life strategy of Arctic Calanus. Marine Biology Research. 5(1): 18-39.
Schiermeier, Q. 2007. The new face of the Arctic. Nature, 446: 133-135.

20 Contaminants sampling program – Legs 1b, 2 and 3

ArcticNet Phase 3 – Effects of Climate Change on Contaminant Cycling in the Coastal and Marine Ecosystems. http://www.arcticnet.ulaval.ca/pdf/phase3/contaminants.pdf

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Cruise participants Leg 2a: Alexis Burt[2], Gord Chamberlain[2], Justen Poole[4] and Cecilia Shin[4]
Cruise participants Leg 2b: Alexis Burt[2] and Gord Chamberlain[2],
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20.1 Introduction

20.1.1 Hydrocarbon sampling (Legs 1b, 2 and 3)

Oil reserves under the sediments in Baffin Bay (including the North Water polynya, Davis Strait, Lancaster Sound and Jones Sound) are the largest in Arctic Canada; with some potential reservoirs estimated to contain billions of barrels of oil. Global warming and reduced ice coverage has made these reserves more accessible and the exploration/exploitation of offshore oil in the region more feasible. With declining ice conditions, oil exploration and shipping traffic through the North West Passage will only increase; both of these activities have the potential to increase petroleum hydrocarbon concentrations in Baffin Bay. However, hydrocarbons are also naturally present as a result of natural oil seeps, fossil fuel combustion, and terrestrial run-off. The purpose of this study was to measure baseline concentrations of hydrocarbons in the Baffin Bay marine environment in advance of future oil exploration/exploitation and increased shipping.

20.1.2 Benthic microbial diversity (Legs 1b, 2 and 3)

Marine sediment environments are high in microbial diversity and abundance with a cubic centimeter of seabed typically containing billions of microbial cells – about a thousand fold more than in overlying seawater. The goal of this research in the Canadian Arctic Archipelago was to establish baseline data for the diversity and activity of microorganisms in Arctic sediments, and experimentally investigate how short and long term changes in environmental parameters (e.g. temperature, pulses of organic compounds such as hydrocarbons) may affect the community composition, metabolic rates and cycling of carbon and other nutrients. This work will determine the impact of permanently cold temperatures on the rates of biogeochemical processes such as sulfate reduction, which is responsible for up to half of organic carbon mineralization in coastal sediments (Jørgensen 1982).

A second goal targeted diversity studies to explore the abundance and function of spore-forming thermophilic sulfate-reducing bacteria in permanently cold sediments, extending biogeography analyses that have been performed in other Arctic sediments (Hubert et al*.* 2009). Arctic thermophiles are thought to derive from warm deep sediments and get transported up into the cold ocean via seabed hydrocarbon seepage.

The occurrence of marine hydrocarbon seeps in Canada's Arctic is related to a third goal, to assess the ability of microbiota in Arctic seawater and sediments to biodegrade accidentally released crude oil or other pollutants. A rapid natural response may depend on a region's microbiota being 'primed' for such biodegradation by the slow natural release of hydrocarbons from seabed seeps (Hazen et al. 2011). Given that industrial activity and traffic in the Northwest Passage is poised to increase, the inherent biodegradation capacity of marine microorganisms was tested experimentally on samples obtained. This data will be used to help develop a predictive measure of how different regions of the Arctic could respond to various pollution scenarios.

20.1.3 Monitoring of organic pollutants (Leg 2a)

The purpose of this study was to determine the occurrence, concentrations, and gas exchange of select organic pollutants. Compound classes of interest included: pesticides (current use and legacy), flame retardants (FR's), perfluorinated compounds (PFC's), and polycyclic aromatic compounds (PAC's), which include polycyclic aromatic hydrocarbons (PAH's). The goal was to use the air and water samples collected to set baseline environmental concentration levels for PAC's and select FR's, as well as to continue to monitor concentration trends for compounds previously studied (PFC's, pesticides, and select FR's). Air and water samples were paired and the gas exchange calculated for priority pollutants in order to determine whether the water is acting as a source or a sink for these compounds. Recent sampling indicated that legacy pesticides were near air-water equilibrium, while current use pesticides were being deposited into the Arctic Ocean.

20.1.4 SPMD deployments (Leg 2a)

The goal with the SPMDs was to monitor concentrations of persistent organic pollutants (POPs) in the mixed surface layer, the Pacific water mass and the deep Atlantic waters.

20.1.5 Long-term monitoring (Legs 2b and 3)

In the Beaufort Sea, long-term monitoring of mercury (Hg) and methyl Hg levels in the food web were continued. All invertebrate samples collected for hydrocarbon analyses were also be analyzed for Hg and methyl Hg.

20.2 Methodology – Hydrocarbon sampling

While on board the CCGS *Amundsen,* invertebrates (both benthic and pelagic) and sediment cores were collected for this research.

20.2.1 Pelagic Invertebrates

Zooplankton were sampled from the whole water column using the vertical net tow (Monster Net with LOKI: 1 m^2 200 µm mesh (Figure 20.1)), and from the surface 60m using the oblique net tow (Tucker Net: 1 m^2 750 µm mesh), at 19 stations during Leg 1b (Table 20.1), 12 stations during Leg 2a (Table 20.2), 11 stations during Leg 2b (Table 20.3) and 3 stations during Leg 3 (Table 20.4). Species of interest included: *Calanus hyperboreus*, *C. glacialis*, *Paraeuchaeta glacialis*, Chaetognaths (including *Parasagitta elegans*, *Pseudosagitta maxima*, and *Eukrohnia* sp.), *Themisto libellula*, *T. abyssorum*, *Hyperia galba, Clione limacina*, *Limacina helicina,* Ostracoda, Appendicularia (*Oïkopleura* sp.), Ctenophora and Hydromedusae. Some unique species were found, including *Sympagohydra tuuli*, *Scina borealis,* and *Gammarus wikitzii*.

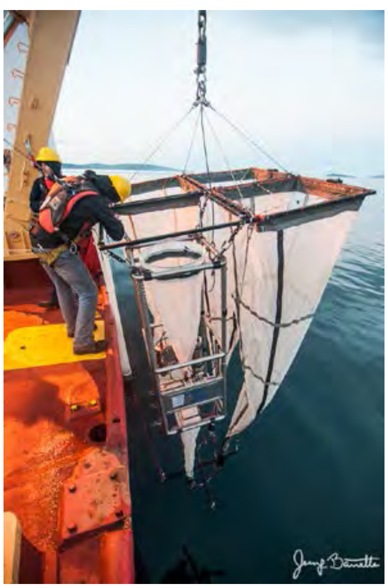

Figure 20.1. The 5-net vertical zooplankton sampler with LOKI (Monster net).

20.2.2 Benthic Invertebrates

Benthic animals were collected using the Agassiz trawl as well as opportunistically from the beam trawl. Samples were identified as best as possible and set aside by the members of the Archambault team (Figure 20.2). They were subsequently labelled and frozen at -20°C. Groups of interest included: *Asteroidea* (sea stars), *Ophiopleura* (brittle stars), molluscs, isopods, amphipods, and polychaete worms. Stations sampled are noted in Table 20.6 to 20.9.

Figure 20.2. Benthic invertebrates were collected by the benthic team, cleaned and sorted to species.

20.2.3 Push coring

Samples destined for hydrocarbon analysis were collected using 10 cm diameter plastic push cores from the boxcore (Figure 20.3). Sediment compression was limited by using an electric negative-suction pump connected to the top cap of the plastic core. The sediment core was subsequently placed on a manual extruder and sectioned by 0.5 cm intervals for the first 10 cm, and then 1.0 cm for the balance of the core (approximately 30 cm total). Sediment was stored in Whirl-pak plastic bags and frozen at -20°C.

Figure 20.3. Push coring the boxcore (photo: Jessy Barrette 2013 ArcticNet Leg 1a).

Table 20.1. Zooplankton tows made for contaminants during Leg 1b.

Leg	Station	Location	Date	Latitude (N)	Longitude (W)	Tow	Bottom Depth (m)	Sampler Depth (m)
1B	200	Mid Baffin Bay	27-Jul-14	73°16.816	063°36.530	Oblique Tow (1m2, 750um mesh)	1451	90
1B	204	W Greenland	28-Jul-14	73°15.370	057°53.390	Vertical Tow (1m2, 200um mesh)	998	946
1B	204	W Greenland	28-Jul-14	73°16.143	057°52.727	Oblique Tow (1m2, 750um mesh)	987	95
1B	210	W Greenland	29-Jul-14	75°24.613	061°39.569	Vertical Tow (1m2, 200um mesh)	1154	950
1B	210	W Greenland	29-Jul-14	75°24.244	061°34.638	Oblique Tow (1m2, 750um mesh)	1126	90
1B	115	Northwater Transect	30-Jul-14	76°19.968	071°13.559	Vertical Tow (1m2, 200um mesh)	676	666
1B	115	Northwater Transect	30-Jul-14	76°20.409	071°12.681	Oblique Tow (1m2, 750um mesh)	674	90
1B	111	Northwater Transect	31-Jul-14	76°18.000	073°13.000	Vertical Tow (1m2, 200um mesh)	598	588
1B	111	Northwater Transect	31-Jul-14	76°18.595	073°13.892	Oblique Tow (1m2, 750um mesh)	600	90
1B	108	Northwater Transect	31-Jul-14	76°16.176	074°36.681	Vertical Tow (1m2, 200um mesh)	446	436
1B	108	Northwater Transect	31-Jul-14	76°16.723	074°35.922	Oblique Tow (1m2, 750um mesh)	447	90
1B	105	Northwater Transect	1-Aug-14	76°19.024	075°47.431	Vertical Tow (1m2, 200um mesh)	336	326
1B	105	Northwater Transect	1-Aug-14	76°19.390	075°54.585	Oblique Tow (1m2, 750um mesh)	338	90
1B	101	Northwater Transect	1-Aug-14	76°21.126	077°25.835	Oblique Tow (1m2, 750um mesh)	387	90
1B	101	Northwater Transect	1-Aug-14	76°22.991	077°26.929	Vertical Tow (1m2, 200um mesh)	393	375
1B	KEN 1	Kennedy Channel	3-Aug-14	81°22.725	064°08.233	Oblique Tow (1m2, 750um mesh)	558	90
1B	KEN 1	Kennedy Channel	3-Aug-14	81°22.460	063°57.974	Vertical Tow (1m2, 200um mesh)	530	520
1B	KEN 3	Kennedy Channel	4-Aug-14	80°47.646	067°18.742	Vertical Tow (1m2, 200um mesh)	401	391
1B	KEN 3	Kennedy Channel	4-Aug-14	80°48.283	067°14.825	Oblique Tow (1m2, 750um mesh)	406	90
1B	KANE 1	Kane Basin	4-Aug-14	79°58.856	069°49.469	Oblique Tow (1m2, 750um mesh)	246	90
1B	KANE 1	Kane Basin	4-Aug-14	79°59.473	069°45.314	Vertical Tow (1m2, 200um mesh)	246	236
1B	KANE 3	Kane Basin	5-Aug-14	79°21.412	071°48.675	Oblique Tow (1m2, 750um mesh)	216	90
1B	KANE 3	Kane Basin	5-Aug-14	79°20.669	071°51.331	Vertical Tow (1m2, 200um mesh)	215	205
1B	KANE 5	Kane Basin	6-Aug-14	79°01.196	073°12.940	Oblique Tow (1m2, 750um mesh)	244	90
1B	KANE 5	Kane Basin	6-Aug-14	79°00.149	073°12.649	Vertical Tow (1m2, 200um mesh)	250	240
1B	120	Northwater: Smith Sound	6-Aug-14	77°19.142	075°41.344	Oblique Tow (1m2, 750um mesh)	567	90
1B	120	Northwater: Smith Sound	6-Aug-14	77°19.537	075°42.748	Vertical Tow (1m2, 200um mesh)	562	552
1B	120	Northwater: Smith Sound	6-Aug-14	77°19.407	075°44.722	IKMT trawl	558	nr
1B	335	Lancaster	9-Aug-14	74°25.212	098°47.286	Vertical Tow	116	106

Leg	Station	Location	Date	Latitude (N)	Longitude (W)	Tow	Bottom Depth (m)	Sampler Depth (m)
		Sound				(1m2, 200um mesh)		
1B	309	Peel Sound	10-Aug-14	72°57.723	096°06.745	Oblique Tow (1m2, 750um mesh)	324	90
1B	309	Peel Sound	10-Aug-14	72°57.750	096°06.006	Vertical Tow (1m2, 200um mesh)	319	309
1B	310"F"	Peel Sound	10-Aug-14	71°17.870	097°40.649	Oblique Tow (1m2, 750um mesh)	145	90
1B	310"F"	Peel Sound	10-Aug-14	71°17.644	097°41.477	Vertical Tow (1m2, 200um mesh)	135	125
1B	312	Victoria Strait	11-Aug-14	69°10.247	100°40.711	Oblique Tow (1m2, 750um mesh)	60	50
1B	312	Victoria Strait	11-Aug-14	69°10.492	100°41.179	Vertical Tow (1m2, 200um mesh)	60	50
1B	314	Dease Strait	12-Aug-14	68°58.299	105°27.250	Oblique Tow (1m2, 750um mesh)	110	100
1B	314	Dease Strait	12-Aug-14	68°58.201	105°28.175	Vertical Tow (1m2, 200um mesh)	110	100

Table 20.2. Zooplankton tows where species were collected for contaminants during Leg 2a.

Leg	Station	Location	Date	Latitude (N)	Longitude (W)	Tow	Bottom Depth (m)	Sampler Depth (m)
2A	405	Amundsen Gulf	16 to 17-Aug-14	70°37.861	123°01.610	Oblique Tow (1m2, 750um mesh)	597	100
2A	405	Amundsen Gulf	16 to 17-Aug-14	70°38.291	123°02.223	Vertical Tow (1m2, 200um mesh)	610	599
2A	407	Amundsen Gulf	18-Aug-14	70°59.790	126°02.960	Oblique Tow (1m2, 750um mesh)	403	90
2A	407	Amundsen Gulf	18-Aug-14	71°00.350	126°04.690	Vertical Tow (1m2, 200um mesh)	394	380
2A	437	Beaufort Sea	19-Aug-14	71°46.900	126°28.410	Oblique Tow (1m2, 750um mesh)	318	95
2A	437	Beaufort Sea	19-Aug-14	71°47.180	126°29.610	Vertical Tow (1m2, 200um mesh)	313	303
2A	408	Amundsen Gulf	20-Aug-14	71°19.000	127°32.440	Oblique Tow (1m2, 750um mesh)	211	90
2A	408	Amundsen Gulf	20-Aug-14	71°18.940	127°34.820	Vertical Tow (1m2, 200um mesh)	207	197
2A	420	Amundsen Gulf	21-Aug-14	71°03.260	128°31.650	Oblique Tow (1m2, 750um mesh)	42	30
2A	420	Amundsen Gulf	21-Aug-14	71°03.030	128°30.940	Vertical Tow (1m2, 200um mesh)	40	30
2A	435	Tuk Transect	21-Aug-14	71°04.860	133°39.070	Oblique Tow (1m2, 750um mesh)	295	90
2A	435	Tuk Transect	21-Aug-14	71°04.510	133°39.330	Vertical Tow (1m2, 200um mesh)	290	280
2A	434	Tuk Transect	23-Aug-14	70°11.160	133°32.580	Oblique Tow (1m2, 750um mesh)	46	35
2A	434	Tuk Transect	23-Aug-14	70°10.800	133°32.880	Vertical Tow (1m2, 200um mesh)	46	35
2A	421	Tuk Transect	24-Aug-14	71°27.138	133°50.183	Oblique Tow (1m2, 750um mesh)	1125	90
2A	421	Tuk Transect	24-Aug-14	71°27.500	133°52.640	Vertical Tow (1m2, 200um mesh)	1114	980

Leg	Station	Location	Date	Latitude (N)	Longitude (W)	Tow	Bottom Depth (m)	Sampler Depth (m)
2A	460	Beaufort Sea	25-Aug-14	72°08.735	130°48.218	Oblique Tow (1m2, 750um mesh)	965	90
2A	460	Beaufort Sea	25-Aug-14	72°09.047	130°49.648	Vertical Tow (1m2, 200um mesh)	975	950
2A	482	Mackenzie	1-Sep-14	70°31.735	139°22.422	Oblique Tow (1m2, 750um mesh)	830	90
2A	482	Mackenzie	1-Sep-14	70°31.833	139°23.760	Vertical Tow (1m2, 200um mesh)	830	820
2A	482	Mackenzie	1-2-Sept-14	70°31.547	139°21.851	IKMT trawl	821	300
2A	470 "A"	Mackenzie Bay	4-Sep-14	69°22.179	138°15.157	Oblique Tow (1m2, 750um mesh)	48	35
2A	470 "A"	Mackenzie Bay	4-Sep-14	69°21.647	138°14.044	Vertical Tow (1m2, 200um mesh)	48	38
2A	472	Mackenzie	6-Sep-14	69°36.794	138°11.224	Oblique Tow (1m2, 750um mesh)	125	90
2A	472	Mackenzie	6-Sep-14	69°36.637	138°12.229	Vertical Tow (1m2, 200um mesh)	125	115

Table 20.3. Zooplankton tows where species were collected for contaminants during Leg 2b.

Leg	Station	Location	Date	Latitude (N)	Longitude (W)	Tow	Bottom Depth (m)	Sampler Depth (m)
2B	1040	Barrow Canyon DBO 5	10-Sep-14	71°14.955	157°09.412	Oblique Tow (1m2, 750um mesh)	47	30
2B	1040	Barrow Canyon DBO 5	10-Sep-14	71°14.707	157°10.262	Vertical Tow (1m2, 200um mesh)	47	37
2B	1042	Barrow Canyon DBO 5	10-Sep-14	71°24.252	157°26.756	Oblique Tow (1m2, 750um mesh)	127	90
2B	1042	Barrow Canyon DBO 5	10-Sep-14	71°24.639	157°29.133	Vertical Tow (1m2, 200um mesh)	126	116
2B	1044	Barrow Canyon DBO 5	11-Sep-14	71°34.271	157°49.976	Oblique Tow (1m2, 750um mesh)	55	40
2B	1044	Barrow Canyon DBO 5	11-Sep-14	71°34.650	157°50.432	Vertical Tow (1m2, 200um mesh)	67	57
2B	1038	Barrow Canyon	12-Sep-14	71°34.325	155°45.558	Vertical Tow (1m2, 200um mesh)	162	152
2B	1034	Barrow Canyon	13-Sep-14	71°54.220	154°56.942	Oblique Tow (1m2, 750um mesh)	379	90
2B	1034	Barrow Canyon	13-Sep-14	71°54.443	154°57.739	Vertical Tow (1m2, 200um mesh)	398	388
2B	1034	Barrow Canyon	13-Sep-14	71°53.401	154°54.234	IKMT trawl (9m2, 1cm mesh)	467	200
2B	1030	Barrow Canyon	14-Sep-14	72°12.054	153°55.922	Oblique Tow (1m2, 750um mesh)	2081	90
2B	1085	International Waters	16-Sep-14	75°03.000	167°07.343	Oblique Tow (1m2, 750um mesh)	254	90
2B	1085	International Waters	16-Sep-14	75°03.855	167°08.882	Vertical Tow (1m2, 200um mesh)	245	235
2B	1100	International Waters	18-Sep-14	75°03.896	161°15.002	Oblique Tow (1m2, 750um mesh)	1985	90
2B	1100	International Waters	18-Sep-14	75°03.365	161°10.121	IKMT trawl (9m2 aperture, 1cm mesh)	1978	250
2B	1107		19-Sep-14	74°36.464	155°43.890	Vertical Tow (1m2, 200um mesh)	3860	999

Leg	Station	Location	Date	Latitude (N)	Longitude (W)	Tow	Bottom Depth (m)	Sampler Depth (m)
2B	1115	US Beaufort	20-Sep-14	73°53.815	147°12.577	Oblique Tow (1m2, 750um mesh)	3773	90
2B	1115	US Beaufort	20-Sep-14	73°54.300	147°13.216	Vertical Tow (1m2, 200um mesh)	3767	999
2B	1130	US Beaufort	22-Sep-14	72°35.499	141°45.777	Oblique Tow (1m2, 750um mesh)	3234	90
2B	1130	US Beaufort	22-Sep-14	72°35.929	141°45.614	Vertical Tow (1m2, 200um mesh)	3235	1000

Table 20.4. Zooplankton tows where species were collected for contaminants during Leg 3.

Date (UTC)	Station	Depth (m)*	Latitude (N)**	Longitude (W)**	O-Tow	V-Tow
1-Oct-14	PCBC-2	695	71°05.590	071°50.230	X	X
1-Oct-14	Gibbs-B	440	70°45.940	072°15.830	X	X
3-Oct-14	180	181	67°27.850	061°14.730	X	X

* Depth when vertical tow performed; ** Coordinates of vertical tow deployment

20.3 Methodology – Benthic microbial diversity

20.3.1 Surface sampling

Samples collected for microorganism incubation experiments (Table 20.6 to 20.9) were scraped from the top 5 cm of the boxcore using a plastic spatula, stored in ~475 mL self-locking plastic Starfrit containers and then kept at 4 °C. An effort was made to eliminate all headspace from the plastic containers.

Surface samples destined for microorganism diversity analysis were scraped from the top 5 cm of the boxcore using a stainless steel pallet knife into 5 mL plastic vials, spiked with 2.5 mL of 95 % ethanol and stored at -80 °C. Headspace was limited by aiming to collect ~2.5 mL of surface sediments. Triplicate sample vials were collected whenever possible.

20.3.2 Push coring

Cores for microorganism incubations and diversity were collected using the same equipment as the hydrocarbon study. These cores were sectioned by 2.0 cm intervals for the first 10 cm and then 5.0 cm intervals for the balance. At each interval, duplicate or triplicate subsamples were collected for microorganism diversity using the same 5 mL vials and methods described earlier. The bulk of the remaining section was kept in 150 mL plastic bottles and stored at 4 °C.

Table 20.5. List of benthic sample collections for contaminants during Leg 1b.

Station	Surface	Hydrocarbon cores	Incubation cores	Agassiz benthos
200	X	X	1X (Boxcore #1) 2X* (Boxcore #2)	X
204	X	X	1X (Boxcore #1) 2X* (Boxcore #2)	X
210	X	X	1X (Boxcore #1) 2X* (Boxcore #2)	X
115	2X (1/Boxcore)	X	1X (Boxcore #1) 2X* (Boxcore #2)	X
111	X			X
108	X			X
105	X			X
101	2X (1/Boxcore)	X	1X (Boxcore #1) 2X* (Boxcore #2)	X
KEN1	X	X	X	X
KEN3				X
KANE1				X
KANE2b	X	X	1X (Boxcore #1) 2X* (Boxcore #2)	
KANE3				X
KANE5				X
120				X
335				X
309	X	X	X	X
310F				X
312	X	X	X	X
314	X	X	X	X

Table 20.6. List of benthic sample collections during Leg 2a.

Date	Station	Depth*	Latitude (N)**	Longitude (W)**	Boxcore			Agassiz	Beam
					Surface	Mbio Core	HC Core	Benthic Inverts	
17-Aug-14	405	608	70°38.420	123°02.280	X	X	X		
18-Aug-14	407	393	71°00.450	126°03.830	X			X	X
19-Aug-14	Beam Trawl 1	316	71°11.380	126°53.430					X
19-Aug-14	437	318	71°47.180	126°29.980	X		X	X	
20-Aug-14	GSC_4PCBC	397	71°21.020	126°47.720	X		X		
20-Aug-14	408	206	71°18.790	127°35.010				X	X
21-Aug-14	420	46	71°02.810	128°30.540				X	
22-Aug-14	435	297	71°04.770	133°38.200	X	X	X	X	
23-Aug-14	434	47	70°10.910	133°33.050	X	X	X	X	
24-Aug-14	421	1165	71°27.580	133°54.170	X	X	X		
24-Aug-14	AMD0214_02	998	71°22.970	133°34.340	X		X		
25-Aug-14	460	961	72°08.900	130°48.950	X	X	X		X
25-Aug-14	GSC_1PCBC	124	72°40.240	127°18.090	X				
26-Aug-14	GSC_3PCBC	453	72°26.510	129°26.730	X				
29-Aug-14	GSC_2PCBC	413	73°15.760	128°30.820	X				
31-Aug-10	GSC_08PCBC	603	70°39.740	136°18.440	X				

Date	Station	Depth*	Latitude (N)**	Longitude (W)**	Boxcore			Agassiz	Beam
					Surface	Mbio Core	HC Core	Benthic Inverts	
31-Aug-10	GSC_12BC	778	70°41.430	136°25.780	X				
31-Aug-10	GSC_05PCBC	1246	70°44.500	136°38.500	X				
01-Sep-14	AMD0214_03	1048	70°33.060	137°32.100	X				
02-Sep-14	482	826	70°31.460	139°22.950	X	X	X		
02-Sep-14	GSC_6PCBC	132	70°35.090	136°00.740	X				
02-Sep-14	GSC_10BC	215	70°35.950	136°04.180	X				
02-Sep-14	GSC_11BC	504	70°37.850	136°11.300	X				
02-Sep-14	GSC_14BC	320	70°31.600	136°20.340	X				
02-Sep-14	GSC_15BC	548	70°34.330	136°30.580	X				
02-Sep-14	GSC_7PCBC	1068	70°41.530	136°43.170	X				
02-Sep-14	GSC_16BC	1086	70°38.740	136°48.280	X				
04-Sep-14	470A	48	69°21.960	138°13.970	X	X	X	X	X
06-Sep-14	472	125	69°36.630	138°13.360	X	X	X	X	□
06-Sep-14	476	265	69°58.790	138°38.950	□	□	□	□	X
07-Sep-14	GSC_9PCBC	1502	70°38.410	139°00.90'	X	X	X		

* Depth of boxcore (if performed); ** Coordinates of boxcore (if performed)

Table 20.7. List of benthic sample collections during Leg 2b.

Date	Station	Depth (m)*	Latitude (N)**	Longitude (W)**	Boxcore			Agassiz	Beam
					Surface	Mbio Core	HC Core	Benthic Inverts	
10-Sep-14	1040	47	71°14.720	157°10.120				X	
10-Sep-14	1042	128	71°24.560	157°28.890	X	X	X	X	X
11-Sep-14	1044	65	71°34.710	157°50.420	X			X	X
12-Sep-14	1038	164	71°31.390	155°45.670	X			X	
13-Sep-14	1034	460	71°54.350	154°57.580				X	X
16-Sep-14	1085	249	75°03.680	167°08.300	X			X	X
23-Sep-14	435	296	71°04.610	133°37.650					X

* Depth of boxcore (if performed); ** Coordinates of boxcore (if performed)

Table 20.8. List of benthic sample collections during Leg 3.

Date	Station	Depth (m)*	Latitude (N)**	Longitude (W)**	Boxcore			Agassiz
					Surface	Mbio Core	HC Core	Benthic Inverts
30-Sep-14	PCBC-2	696	71°05.320	071°50.660	X	X		
30-Sep-14	PCBC-2	696	71°05.250	071°50.750	X	X		
30-Sep-14	PCBC-2	695	71°05.180	071°50.570	X	X		
1-Oct-14	Gibbs-B	443	70°45.860	072°15.590	X		X	X

* Depth of boxcore (if performed); ** Coordinates of boxcore (if performed)

20.4 Methodology – Monitoring of organic pollutants

20.4.1 Atmospheric

Sampler was mounted to the bow of the ship. Incoming air was pulled through a sample head, which contained a 0.45 micron quartz fiber filter followed by a resin column to sample the particulate and gaseous phases respectively. This work was a continuation of sampling already being graciously carried out by Jeremy, followed by Alexis Burt throughout Leg 1. The sampler ran continuously and the sample head was changed every 36 hours. Across Legs 1 and 2a, 13 and 16 samples were collected, respectively. The samples collected during Leg 1 were taken in parallel with a University of Toronto volatile organic compounds study; the results from these two studies will be compared in order to determine the impact of the ships exhaust on atmospheric sampling. Samples were stored at -20°C.

20.4.2 High volume surface water

High volume surface water samples (95-120 L) were collected by the use of a submersible pump deployed from the foredeck. These samples were extracted by pumping the water collected through a resin column; care was taken to limit the flow rate (~130mL/min) to ensure all compounds of interest were captured. Eight samples were collected at selected Basic Stations, as outlined in Table 20.10. Samples were stored at 4°C.

Table 20.9. High volume surface water samples.

Leg	Station	Location	Date	Latitude (N)	Longitude (W)
2A	405	Amundsen Gulf	16 -Aug-14	70°37.861	123°01.610
2A	407	Amundsen Gulf	18-Aug-14	70°59.790	126°02.960
2A	437	Beaufort Sea	19-Aug-14	71°46.900	126°28.410
2A	408	Amundsen Gulf	20-Aug-14	71°19.000	127°32.440
2A	460	Beaufort Sea	25-Aug-14	72°09.047	130°49.648
2A	482	Mackenzie Tr	1-Sept-14	70°31.547	139°21.851
2A	470-A	Mackenzie Tr	4-Sept-14	69°12.600	138°08.400
2A	472	Mackenzie Tr	6-Sept14	69°21.600	138°07.200

20.4.3 Low volume depth samples

Water samples of 1 litre were collected from the Rosette at select stations in order to study the distribution of organic pollutants near the thermocline. To do this, samples were obtained at the surface, and at depths above and below the thermocline. Across Leg 2a, 8 stations were sampled; outlined in Table 20.11.

Table 20.10. Low volume water samples collected on Leg 2a.

Leg	Station	Location	Date	Latitude (N)	Longitude (W)
2A	405	Amundsen Gulf	16 -Aug-14	70°37.861	123°01.610
2A	407	Amundsen Gulf	18-Aug-14	70°59.790	126°02.960
2A	437	Beaufort Sea	19-Aug-14	71°46.900	126°28.410
2A	460	Beaufort Sea	25-Aug-14	72°09.047	130°49.648
2A	BR-4	Beaufort Sea	27-Aug-14	73°12.000	126°32.400
2A	470-A	Mackenzie Tr	4-Sept-14	69°12.600	138°08.400
2A	476	Mackenzie Tr	6-Sept14	69°21.600	138°07.200
2A	478	Mackenzie Tr	6-Sept14	69°36.600	138°13.200

20.4.4 Water Particulate Samples

Seawater pumped from the engine room was filtered continuously throughout Leg 2a using a glass fibre filter in the coring lab. Filters were changed every three days, translating into a sample volume of ~1000L. Flow rate data and the filtrate were collected to determine the volume sampled. Samples were stored at -20°C.

20.4.5 SPMD Associated Water Samples

Water samples at the same location and depth of the 10 deployed SPMD's were collected (Table 20.12) and extracted using the same method used in the extraction of the high volume water samples. The results from the analysis of these samples will be compared to those of the SPMD's upon recovery in order to estimate the volume of water being sampled by the SPMD's. Resin columns were stored at 4°C.

Table 20.11. High volume water samples collected at SPMD deployment sites.

SPMD Depth (m)	BS-1 (80m)	BS-2 (300m)	BS-3 (500m)	BR-04 (155m)	BR-03 (700m)
50-60m surface mixed layer	96L at 50m	96L at 50m	S6L at 50m	96L at 60m	96L at 60m
50-200m Pacific water		96L at 100m	96L at 100m		96L at 200m
>200 m Atlantic water?		96L at 200m	96L at 300m		

20.5 Methodology – SPMD deployments

The SPMDs were placed close to CTDs and/or current meters located in each of these layers to allow results to be related to information gathered from them and confirm which water mass they were sampling. For more mooring information, refer to Section 7.

10 SPMD cages were deployed on 3 ArcticNet (BS) and 2 BREA (BR) moorings as outlined below (Table 20.13). At some depths, SPMD cages were fixed directly to the instrument cages (Figure 20.4), while at some depths the cages were fixed to the mooring line (Figure 20.5).

Table 20.12. SPMDs deployed during Leg 2a of the ArcticNet 2014 cruise.

SPMD Depth (m)	BS-1 (80m)	BS-2 (300m)	BS-3 (500m)	BR-04 (155m)	BR-03 (700m)
50-60m surface mixed layer	SPMD 50m	SPMD 50m	SPMD 50m	SPMD 60m	SPMD 60m
50-200m Pacific water		SPMD 100m	SPMD 100m		SPMD 200m
>200 m Atlantic water?		SPMD 200m	SPMD 300m		

Figure 20.4. SPMD cage installed on ArcticNet mooring BS-3.

Figure 20.5. SPMD cage installed on the line on BREA mooring BR-3.

20.6 Preliminary results

No analyses were performed on the ship.

20.7 Comments and recommendations

Always take push cores from the boxcore when expecting a gravity core, since the top ~15 cm of the gravity core is disturbed and not ideal for sectioning.

The boxcore failed to collect sediment samples several times, thus samples should be collected opportunistically at nearby stations as a backup.

References

Hazen, T.C. 2010. Deep-Sea Plume Enriches Indigenous Oil-Degrading Bacteria. Science, 330: 204-207.

Hubert, C. et al. 2009. A constant flux of diverse thermophilic bacteria into the cold Arctic seabed. Science, 325 (5947): 1541-1544.

Jorgensen, B.B. 1982. Mineralization of organic matter in the seabed – the role of sulphate reduction. Nature, 296: 643-645.

21 Marine Wildlife Observer Program – Leg 2a

ArcticNet Phase 3 – Marine Biological Hotspots: Ecosystem Services and Susceptibility to Climate Change.
http://www.arcticnet.ulaval.ca/pdf/phase3/marine-ecosystem-services.pdf

Cruise Participants Leg 2a: IMG-Golder Corporation

21.1 Introduction

The Marine Wildlife Observer (MWO) Program conducted for ArcticNet by IMG-Golder Corporation (IMG-Golder) was designed to gather baseline data on the occurrence of marine wildlife in offshore areas of the Canadian Beaufort Sea. The goal of the 2014 MWO Program was to collect information on marine wildlife presence during the scientific cruise operations of Leg 2a from the Canadian Coast Guard Ship (CCGS) *Amundsen*. Marine mammal and seabird sightings were recorded according to standard industry protocols during scheduled observation periods and opportunistically (outside of scheduled observation periods).

The objective of the program was twofold:

- Collect data that could be analysed to describe the distribution and relative abundance of marine wildlife (marine mammals and seabirds) during scheduled scientific programs carried out aboard the research vessel;
- Verify marine mammal detections made by the SX90 sonar equipment with visual observations.

21.2 Methodology

To achieve this objective, two MWOs recorded all marine mammal and seabird sightings during scheduled observations (and opportunistically) throughout Leg 2a of the 2014 Field Program, and communicated all marine mammal observations to the SX90 team when the sonar was active. This data will contribute to baseline knowledge of the use of the area by marine wildlife.

During Leg 2a, two MWOs recorded wildlife sightings from August 16 to September 8, 2014. MWOs performed scheduled watches between 08:00 and 20:00 hours each day unless impeded by weather or rough sea conditions. One team of two MWOs conducted two-hour shifts throughout the day to allow time for breaks and data downloading. Marine wildlife observations were made all day from the bridge, regardless of whether the vessel was stationary or in-transit. Watches were discontinued when visibility was poor due to weather conditions or on rare occasions when all MWOs were required to attend mandatory ship crew meetings. During each watch, one of the two MWOs was positioned on the port side of the bridge and the other on the starboard side. Each MWO was responsible for surveying the area on their side of the vessel.

Two types of observations were carried out each day: marine mammal and seabird observations. Marine mammal observations were completed four times per day during the WATCH blocks. Seabird observations were completed three times per day during the BIRD blocks. Toolbox meetings took place daily at the beginning of the first watch at 8:00 am. Daily data records were downloaded and reviewed each day during DATA blocks. Draft reports were issued weekly during Leg 2a to summarize the marine mammal and seabird sightings made each week.

21.2.1 Marine Mammal Observation Method

The IMG-Golder's monitoring protocol for marine mammals is based on requirements outlined by Fisheries and Oceans Canada (DFO) and guidelines from other organizations used in other jurisdictions, e.g. by the National Marine Fisheries Service (NMFS) and the Joint Nature Conservation Committee (JNCC).

When the *Amundsen* was moving, marine mammal observations consisted of one MWO scanning from the bow (0°) to the stern (180°) on the port side of the vessel and the other scanning on the starboard side of the vessel with a focus on the water ahead and to the side of the vessel (0° to 90° or 0° to 270°; Figure 21.1). When the *Amundsen* was stationary, MWOs distributed focus evenly around the entire port and starboard sides of the vessel (360°). To ease the strain on the observers' eyes, two types of scanning techniques were used to detect marine mammals: U and S scans (Figure 21.2). The S scan method (in s-shaped lines) was used to scan water parallel to the horizon. The U scan method consisted of scanning lines perpendicular to the horizon (shaped like the letter u). Scans were performed using a combination of the naked eye and reticle binoculars. Big-Eye binoculars (e.g., X25 or X40 zoom) were used to help spot and identify distant marine mammal sightings during these scans.

Information collected by the MWOs included:

- MWO watch start time and date;
- Environmental data – sea state, visibility and weather conditions;
- Time, bearing from vessel, marine mammal travel direction, and distance and GPS location;
- Species, number of individuals, certainty of identification, approximate size and appearance;
- Activity of each individual (e.g. diving/surfacing or feeding);
- Presence and shape of blows; and photos whenever possible.

This information was recorded using hand-held computers (iPAQ). At the end of each Watch period, all data was downloaded to a master database stored on a laptop computer.

Opportunistic seabird sightings (i.e., seabird sightings outside a scheduled seabird watch) were also recorded during the scheduled marine mammal observations; these were a secondary priority to marine mammal sightings.

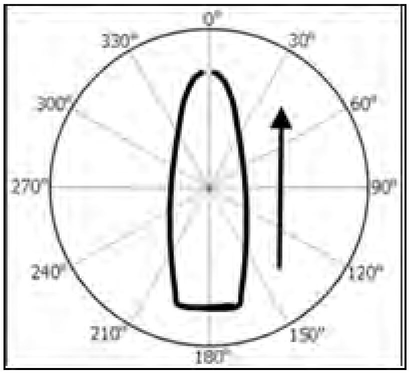

Figure 21.1. Degrees in relation to the CCGS *Amundsen*.

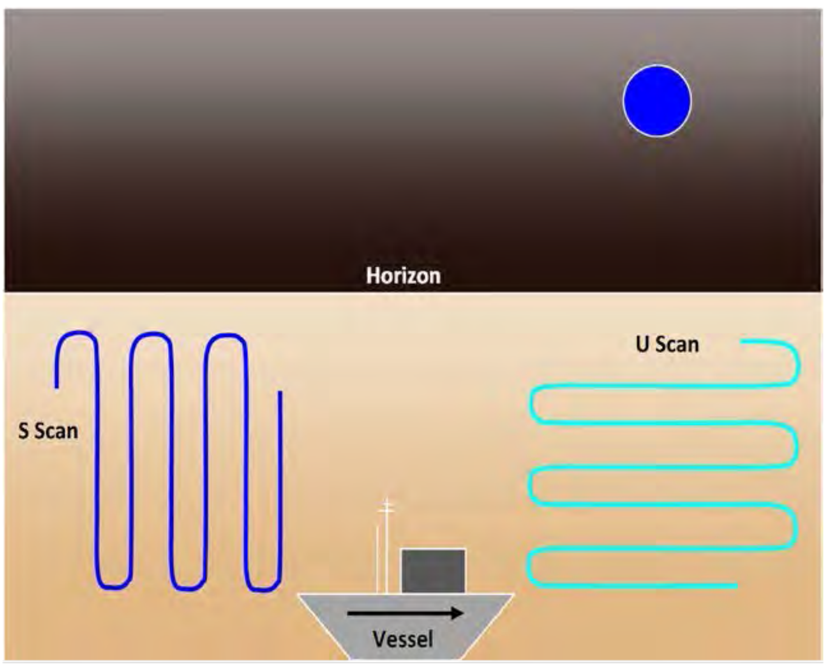

Figure 21.2. U and S Scanning Techniques during Marine Wildlife Observations.

21.2.2 Collaboration and Communications with SX90 Operators

When marine mammals were sighted during SX-90 sonar surveys, MWOs would notify the SX-90 team of a sighting.

When a MWO identified a marine mammal, the following information was communicated to the SX-90 sonar operator:

- Species observed ;
- Number of individuals ;

- Distance and bearing of the individuals;
- Activity or behaviour observed (for example, diving/surfacing, feeding).

If the SX-90 team detected a target on their sonar, they notified the MWOs of the distance and bearing to the animal and the MWOs would attempt to verify the detection.

21.2.3 Seabird Observations Methods

Seabird observations were completed during three watch periods each day: in the morning, afternoon and in the evening. Each watch consisted of three consecutive 10 minute intervals and was completed by both MWOs on watch. When the vessel was in-transit, surveys consisted of a continuous scan of the water in a 300 m wide transect to 90° from the bow (0°) along the side of the vessel (Figure 21.3). When the vessel was stationary, the survey consisted of scanning a 300 m wide transect from the bow (0°) to the stern of the vessel (180°; Figure 21.4). The methods are consistent with Canadian Wildlife Services (CWS) seabird survey protocol. Books and laminated photo cards were available to assist MWOs with bird identifications. Whenever possible, photographs were taken to facilitate subsequent confirmation of field identifications. The big eye binoculars were also used to identify very distant seabird sightings when possible.

As stated above, opportunistic seabird sightings (i.e., seabird sightings outside a scheduled seabird watch) were also recorded during marine mammal watch periods.

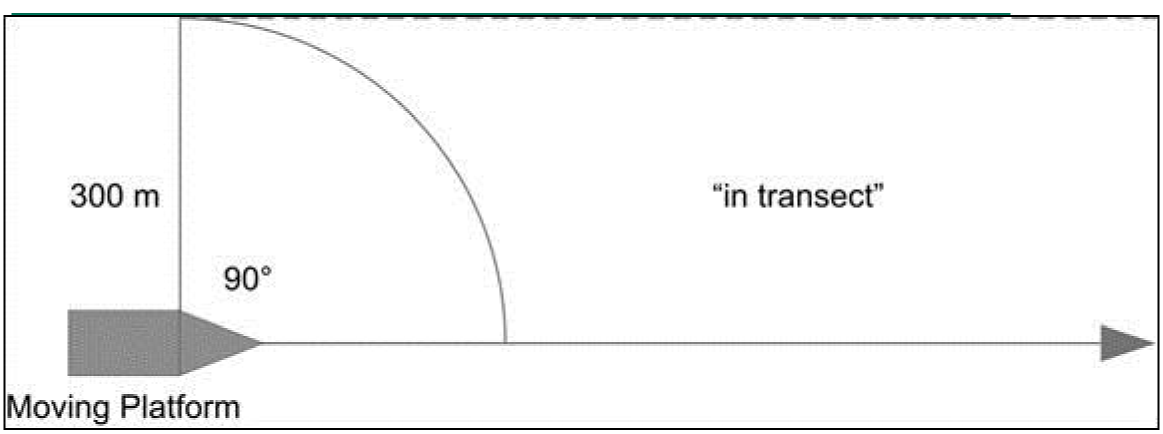

Figure 21.3. Seabird observations on a moving vessel using a 90° scan.

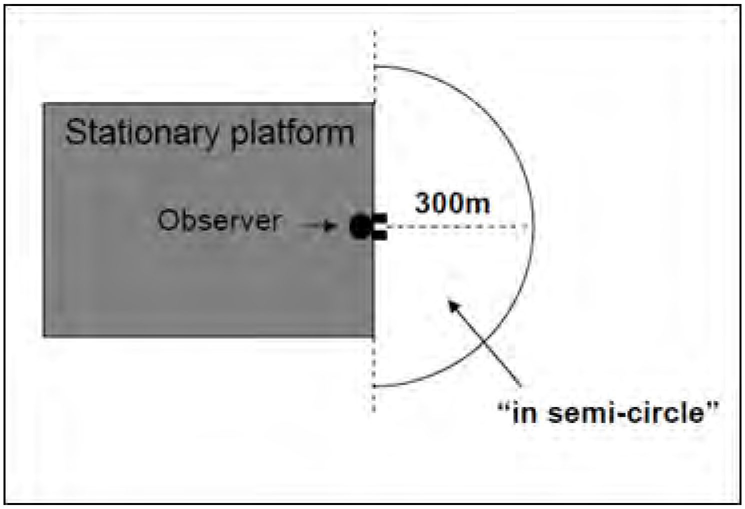

Figure 21.4. Seabird observations on a stationary vessel using a 180° scan.

21.2.4 Data Recording

All marine mammal and seabird sightings as well as environmental conditions and navigational information (vessel speed, direction etc.) were recorded using iPAQs (handheld computers). Four data forms were developed prior to the MWO Program and stored on each iPAQ:

- Environmental Observation Form;
- Marine Mammal Observation Form;
- Seabird Observation Form;
- Vessel Observation Form.

The appropriate forms were completed by the MWOs during each watch period. At the beginning of each watch period, the MWOs on duty completed an Environmental Observation Form. If weather conditions changed during the watch, another Environmental Observation Form was completed to reflect the changed conditions at that time. All marine mammal sightings were reported in the Marine Mammal Observation Form and seabird sightings were entered into the Seabird Observation Form. Bluetooth GPS units were used to record the locations of sightings. Photographs of sightings were taken frequently using a Nikon D300s digital SLR Camera with a 70 to 300 mm lens.

21.2.5 Data Download and Quality Assurance/Quality Control

All completed data forms were downloaded to a laptop computer at the end of every watch period. At the end of each day, all compiled data underwent QA/QC and back-up copies were produced. All data was stored on the laptops and remained stored on the iPAQs after downloading. Additional backup copies of all data were saved onto external hard drives. Once a week, a weekly report was issued, and distributed.

21.3 Preliminary results

The following sections summarize the results of the 2014 MWO Program.

21.3.1 Marine Mammal Sighting Summary

To minimize the risk of recording and analyzing marine mammal sightings more than once, the marine mammal observation forms provided an option to record re-sightings. For the analyses, all sighting and re-sighting entries were carefully appraised and any recorded and suspected re-sightings removed from the database.

Four different species of marine mammals were observed during scheduled marine mammal watches of Leg 2a: bowhead whale (*Balaena mysticetus),* ringed seal (*Pusa hispida),* bearded seal (*Erignathus barbatus*) and polar bear (*Ursus maritimus*). Unidentified whales and seals were also recorded when MWOs were unable to identify the marine mammals due to one or a combination of the following factors:

- Poor sightability due to environmental conditions;
- The mammal was too far away;
- And/or the mammal dove under water

There were approximately 61 sightings of a total of 98 individual marine mammals (corrected for re-sightings) during scheduled marine mammal watches of Leg 2a; the most commonly observed species was ringed seals.

An additional 7 sightings of a total of 12 individual marine mammals (corrected for re-sightings) were observed opportunistically. This included the only sighting of beluga whales (*Delphinapterus leucas*) during Leg 2a made by the *Amundsen* crew and included two adults and one juvenile swimming near the vessel on August 19, 2014. Opportunistic sightings of polar bears and ringed seals were also recorded.

21.3.2 Seabird Sighting Summary

Because there is a likelihood that bird(s) are recorded more than once, the MWOs had the option to record whether the observation was a re-sighting when they suspected that either they or the second MWO on the seabird watch had entered that sighting previously. Prior to finalization of the database (and weekly reports), recorded re-sightings were eliminated from the database, unless it was determined that the observation was only recorded once. Additionally, all other sightings were closely investigated for species, time and location. All suspected (but not recorded) re-sightings were removed from the dataset as well. All currently presented seabird data are corrected for re-sightings. However, it is acknowledged that there may still be observations in the opportunistic sightings database that were recorded more than once.

A total of 18 seabird species and 2 land bird species were observed during scheduled seabird watches and a total of 19 seabird species and 1 land bird species were observed opportunistically during scheduled marine mammal watches on Leg 2a. Species observed were: arctic tern (*Sterna paradisaea*), black-legged kittiwake (*Rissa tridactyla*), brant (*Branta bernicla*), common eider (*Somateria mollissima*), common loon (*Gavia immer*), common murre (*Uria aalge*), glaucous gull (*Larus hyperboreaus*), king eider (*Somateria spectabilis*), long-tailed duck (*Clangula hyemalis*), long-tailed jaeger (*Stercorarius longicaudus*), northern fulmar (*Fulmarus glacialis*), pacific loon (*Gavia pacifica*), pomarine jaeger (*Stercorarius pomarinus*), parasitic jaeger (possible; *Stercorarius parasiticus*), Sabine's gull (*Xema sabini*), Ross's gull (*Rhodostethia rosea*), barnacle goose (*Branta leucopsis*), short-tailed shearwater (*Puffinus tenuirostris*), snow goose (*Chen caerulescens*), Thayer's gull (*Larus thayeri*), and thick-billed murre (*Uria lomvia*), white-winged scoter (*Melanitta fusca*), red-necked phalarope (*Phalaropus lobatus*), red phalarope (*Phalaropus fulicarius*). Recorded land bird species were: one unknown sparrow and unknown songbird and a peregrine falcon (*Falco peregrinus*). Additional sightings of unknown loons, eiders, ducks, jaegers, phalaropes, and gulls were also recorded. Some birds could not be identified due to one, or a combination of the following factors:

- Poor sightability due to environmental conditions;
- The bird was too far away;
- And/or the bird was flying too fast

There were approximately 367 sightings of a total of 1696 individual birds (corrected for re-sightings) during Leg 2a (scheduled surveys and opportunistic sightings data pooled); the most common seabirds observed during Leg 2a were the glaucous gulls and unknown loons.

22 Distribution of baleen whales in the Arctic Sea – Leg 2b

ArcticNet Phase 3 – Marine Biological Hotspots: Ecosystem Services and Susceptibility to Climate Change.
http://www.arcticnet.ulaval.ca/pdf/phase3/marine-ecosystem-services.pdf

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22.1 Introduction

Biological and physical environments in the Arctic Sea have changed drastically in recent years. One of the most dramatic change is the reduction of sea ice, caused by the increased flux of waters from the Pacific Ocean to the Arctic Sea (Woodgate et al. 2010). The decreasing in the sea ice has led to the rise in sea temperature as the the solar radiation increases (Perovich et al. 2007, Steele et al. 2008). These environmental changes have affected the marine ecosystem in the Arctic Sea such in a way that an increase in mesozooplankton community in the Chukchi Sea was observed from the 1990s to the 2000s (Matsuno et al. 2011). It is hypothesized that the biota in the eastern Arctic will shift from a 'benthos-dominated' to a 'zooplankton-dominated' mode if the sea ice extent became smaller. This shift will fundamentally change the general pattern of kryo-pelago-benthic fluxes of matter and energy in the Arctic Seas (Piepenburg 2005). Additionally, the increase in the sea surface temperature will cause changes in zooplankton biota in the Arctic Sea; for example, endemic pelagic species will face interspecific competition with subarctic species and high Arctic zooplankton, which may shift northward (Gradinger 1995).

The changes in the species compositions will alter the distributions and diet of top predators such as marine mammals. The relationships between these changes and their distributions and diet will likely occur among cetaceans (Moore 2008). In the Arctic Sea, two types of mystecetes (baleen whales) are observed: ice-associated species and seasonally migrant species. The ice-associated species such as bowhead whales (*Balaena mysticetus*) distribute in the Arctic or around the Arctic throughout the year, whereas the seasonally migrant species such as gray whales (*Eschrichtius robustus*), humpback whales (*Megaptera novaeangliae*) and minke whales (*Balaenoptera acutorostrata*) are mostly observed in summer and fall (Moore and Huntington 2008). If the warm climate continues to decrease sea ice in the Arctic Sea, these seasonally migrant species may disperse further northward because no barriers affect their movements (Moore and Huntington 2008). In contrast, habitats of the ice-associated species will likely become smaller. Therefore, long-term observations of cetacean distributions relating to their prey species are important in the process of ecosystem change in the Arctic Sea.

In this study, we aimed to quantify the impact of climate change on the spatial and temporal distribution of baleen whales in the Arctic Sea.

22.2 Methodology

Two observers conducted watch for cetaceans, using binocular from the bridge. Whenever a cetacean was found, the position, time, distance, angle, species, number of them were recorded. Survey conditions were recorded every thirty minutes, including weather, true wind speed, true wind direction, sea state, glear, wave height, visibility range. Sea state was classified according to the Beaufort scale.

22.3 Preliminary results

In total, sighting survey was conducted for 15 days, 69.5 hours. Gray whales (two groups, three animals), bowhead whales (two groups, three animals) and two unidentified whales were observed (Figure 22.1).

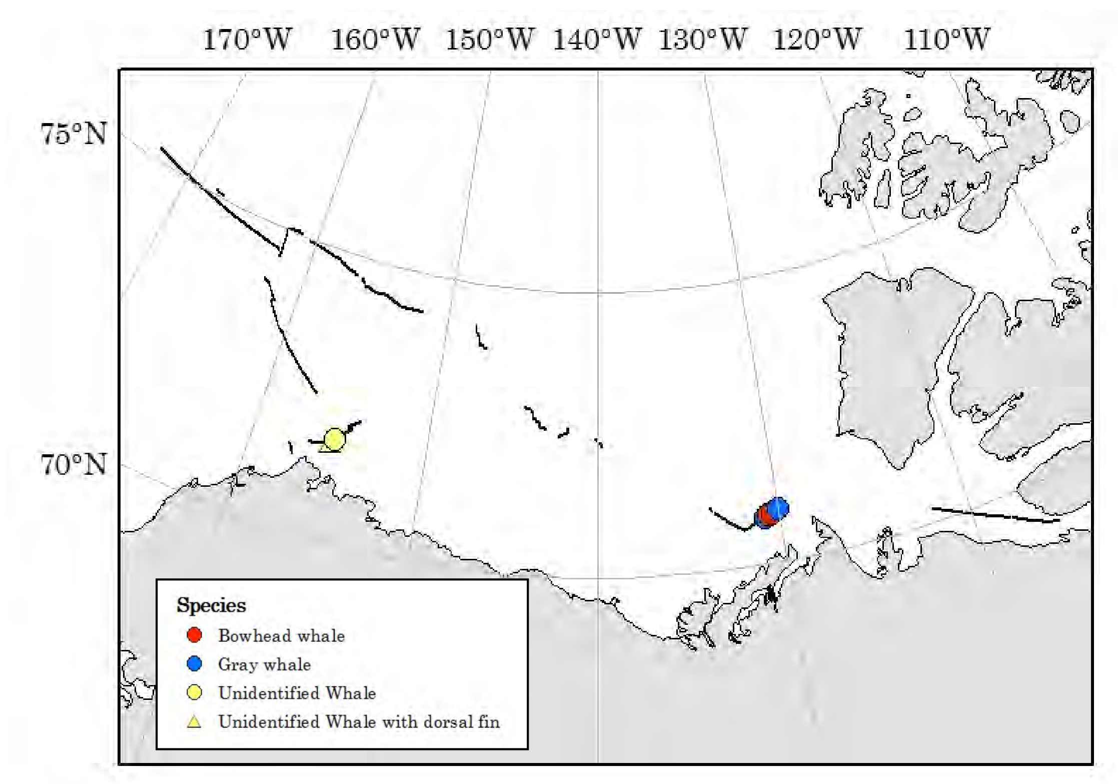

Figure 22.1. Survey line and the position of whales.

22.4 Comments and recommendations

Installation of wipers on side windows would improve visibility, regardless conditions.

23 Seafloor mapping, water column imaging and sub-bottom profiling – Legs 1, 2 and 3

ArcticNet Phase 3 – The Canadian Arctic Seabed: Navigation and Resource Mapping.
http://www.arcticnet.ulaval.ca/pdf/phase1/16.pdf

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Cruise Participants Leg 1: Étienne Brouard[1], Jean-Guy Nistad[3] and David Thornhill[4]
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23.1 Introduction

2014 marks a change of responsibility for the *Amundsen* seabed mapping project from the University of New Brunswick (UNB) to a partnership between Laval University and the Canadian Hydrographic Service (CHS). This first mission was an opportunity for the participants to familiarize themselves with the survey instruments on board and to develop processing methodologies suitable on the *Amundsen* cruises. As much as possible, what was known of UNB processing methodologies was followed when feasible. However, the reliance of the UNB on in-house software (e.g. SwathEd) and licensed software (e.g. Aldebaran) required the development of alternative methods.

Although suitable for the expedition, the survey equipment is starting to show signs of wear. Initial efforts were put in place to minimize major failures during the course of the 2014 cruise. Problems that were noticed with the equipment are reviewed in section 23.4 of this report. Most notably, the EM302 requires a transmission sector adjustment if useful products are to be derived from the measurable backscatter response.

It was possible to collect transit data continuously during Leg 1 except during periods when the *Amundsen* was breaking ice. Additional special applications asked of the seabed mapping team were: deep water coral mapping site near Baffin Island, 2 MVP transects (Eastern Lancaster Sound and East of Baffin Bay), several mapping sites for potential CASQ coring and 2 ice islands mapping.

Part of the time available during Leg 1 was also dedicated to developing strategies to integrate 2003-2013 datasets collected by UNB with newly acquired 2014 datasets. This was a significant objective aiming at increasing coverage of high-resolution Arctic hydrographic data.

During Legs 2b and 3, most of the work made by the mapping team was opportunistic mapping, multibeam surveys and some mooring imaging.

23.2 Methodology

23.2.1 Equipment

EM302. The 30 kHz Kongsberg Simrad EM302 multibeam was used to collect bathymetry, seabed image and water column data. The raw data formats (.all and .wcd files) were collected using the Kongsberg SIS software. The dry-end units of the EM302 were the processing unit (PU), located in the scientific locker room and the hardware workstation (HWS) location in the acquisition room. The following problems were noticed with the HSW and the PU:

- Probable failure of the RAID controller on the HSW which makes the mirrored RAID impossible to create;
- Potential faulty network connection between the PU and the HWS;
- Incompatibility issue between the PU and the version of SIS (4.1.3) running on the HSW
- Failure of 2 tests of the Built-in-self-test (BIST):
  - TX36 unique firmware test
  - Tx Channels

Other sources of worry were:

- Occasional crashes of the HSW (Windows blue screen);
- Blinking green “READY TO SWAP” LED on the PU’s main CPU board.

A component of the collaboration between Laval University and CHS was the upgrade of the existing survey equipment. Laval University would purchase a new C-NAV receiver (see section C&C Technologies C-NAV 3050 below) while CHS would upgrade the EM302 hardware. The upgrade had not been performed prior to the 8 July departure from Quebec City. CHS did provide a refurbished HSW for Leg 1b, shipped to Resolute. However, it was deemed unnecessary to swap units during Leg 1b as long as the existing HSW was functional since the refurbished HSW does not provide any improvement other than newer hardware.

EM302 – Seabed image. The seabed image data of a multibeam was generally more susceptible to wear of the electronic components. As such, it was important to regularly assess the amplitude responses of the EM302’s configurations[1]. The *Amundsen*’s EM302 was showing significant amplitude response deviations in some of its configurations, most notable in DEEP mode. A transmission sector adjustment procedure could be applied

[1] Kongsberg multibeam echosounders are unique in their use of multiple configurations comprised of depth modes, pulse types and swath types.

which would optimize the seabed image response directly at the source rather than in post-processing, which required a significant time effort. This research is ongoing at IFREMER and Kongsberg and this author hoped to acquire datasets during the 2014 expedition that would prove suitable for this procedure still being under study. Some data was collected during the June 2014 sea trials and during Leg 1b but more data would be required and could be collected during Leg 2a (see proposed sites in Figure 23.2) in two different sectors. Sector A would require less than 2 hours of ship time. Sector B would not require any ship time as it is performed while transiting on an upward slope.

During Legs 2b and 3, the EM302 multibeam system behaved properly as expected. When wave conditions exceeded 1.5 m or during ice-breaking operations, the EM302 transducer had problems tracking the bottom because of turbulence or ice packs under the transducers. In shallow waters (<50 m), the operation frequency of the system (30 kHz) caused the acoustic pulses to penetrate into the seafloor at the nadir. This caused artifacts that needed to be removed in post processing steps. Previous observations on the backscatter data quality (Leg 1) showed that the EM302 sounder was not well calibrated (i.e. different backscatter strength between the various operational modes or between the transducer sectors). Well-calibrated backscatter data can help support coring activities as it may offer a reliable way to interpret surficial sediment composition. A transmission sector adjustment procedure could be applied, which would optimize the seabed image response directly at source rather than in post-processing, which requires a significant amount of time and effort. Calibration tests were performed during the seatrials off Tadoussac for the shallow modes (0-300m). Further tests were supposed to take place during Leg 2b but the weather made it impossible (no more time left at the end of the Leg 2b). It was thought that there was a chance to perform the tests in Baffin Bay on the transit back to Quebec City during Leg 3 but the sea conditions and the weather were not good enough to perform the tests.

Infrequent CTD casts for long transit periods forced the team to use a World Ocean Atlas model in order to get enough sound velocity profiles (SVP) to correct possible refraction artifacts (Beaudoin 2013). The SVP correction process is quite complex with the Seafloor Information System (SIS) software. SVP or CTD casts can only be applied for the following lines. A post-processing technique is being discussed between CHS and Laval University in order to increase the data quality with respect to sound speed refraction on the outer beams.

The known issues identified during Leg 1 with Kongsberg SIS (EM302 controller software) reappeared as well as new software and hardware (on the Hydrographic Working Station - HWS) issues. The HWS faced many hardware crashes (blue screens) that are thought to be due to hardware degradation in time. Other unexpected shut downs occurred during file back up on the NAS server. This recurrent problem limits the possibility of logging or visualisation during file transfer. Finally, the low disk space on the HWS (250 GB) forced the team to delete the data on the hard drive from the previous leg.

External software used for multibeam corrections such as tidal model (Arctic9 in WebTide), sound velocity correction (SVPEditor) and integration (CARIS Hips&Sips) worked perfectly.

K320BR. The 3.5 kHz Knudsen 320B/R was used to collect sub-bottom profile data. The raw data formats (.keb and .sgy) were collected using the Knudsen echocontrol software. The sub-bottom profiler (SBP) behaved as expected but the Knudsen acquisition PC manifested signs of wear: upon power-up, the boot disk may not be detected by the BIOS. It may take up to 8 reboots before the boot disk was detected and Windows could boot properly. During Leg 2, it was used to support the GSC scientific program and helped find piston coring sites. At some point, the profiler have been able to penetrate up to 70 m below the seafloor. This high penetration and vertical resolution (compared to existing low frequency seismic data in the region) accounted for a better assessment of the surficial geology and the sediment architecture below the seafloor.

Aplanix POS/MV 320. The inertial navigation unit Applanix POS/MV 320 behaved as expected. A GAMS calibration was performed during the June 2014 sea trials and demonstrated required consistency. A single fault was detected on 23 July at which moment the IMU component was in a failed state. This may have been due to excessive vibration due to ice breaking. The network setup of the POS/MV made it impossible to log raw pseudo-range data. A solution that consisted in a change of network setup was found on 19 July. Data could be collected consistently from this date. RTCM connection was lost when the ship passed by the 75th parallel.

C&C Technologies C-NAV 3050. The newly purchased C-NAV 3050 behaved as expected. In the northern sections of Leg 1, data gaps would occur in the differential correction sent to the POS/M. These data gaps did not seem to affect the behaviour of the POS/MV 302 except in the northernmost survey areas (~80 degrees of latitude North) where the POS/MV would transition to a C/A solution.

AML Smart Sensor. The accuracy of the bathymetric solution provided by the EM302 depended on accurate measurement of the surface sound speed. The AML Smart sensor worked as expected. However, maintenance is required on the water intake basin setup for two reasons:

1. A water leak was detected in the water basin by ArcticNet technicians. This will require attention after the 2014 cruise.
2. Whenever the *Amundsen* would be breaking ice, the AML Smart sensor would stop sending valid data. After reaching open water, accurate data would generally come back within 5 to 10 minutes.

To alleviate the ice problem, a speed of sound measurement was calculated from the temperature and salinity probe located in the same water basin. However, discrepancies of up to 30 m/s were observed under special circumstances between the measured and calculated speed of sound.

During Leg 2b, the electronic connection deteriorated as the ship entered the Mackenzie Bay. This problem was rapidly fixed by Simon Morisset. The smart sensor worked properly during Leg 3.

MVP300. Two MVP transects (Eastern Lancaster Sound and east of Baffin Bay) were completed during Leg 1. The MVP300 behaved as expected except for a communication problem with the CTD probe. ArcticNet technicians are investigating the problem.

It was also noticed that the fluorescence sensor graphs were showing unexpected results, which may be indicative of a problem with the fluorescence sensor (Analog output 3 of the MVP). ArcticNet technicians are investigating the problem.

Based on the experience of the two transects, the PowerPoint presentation *Moving Vessel Profiler (MVP) – Procédure de déploiement* was reworked. It should be reviewed together with Coast Guard personnel during the next MVP deployment briefing.

Two MVP transects (Chuckchi Sea) were completed during Leg 2b. The first transect collected 16 MVP dives, as the second recorded 34 profiles. Two majors issues were identified during the second deployment: 1) bad sea state triggered the messenger sensor and automatically stopped the fish dives and 2) technical issues with the MVP winch forced the transect to stop as the emergency brake would continuously be activated. Nevertheless, the data acquired during these transits seemed to please the Japenese researchers for their physical oceanography purposes (Kohei Mizobata and Takashi Kikuchi). The mapping te
post-processing of the multibeam data.

K-sync. The Kongsberg K-Sync behaved as expected. Previously the responsibility of UNB, it was unclear during Leg 1 if the K-sync was the responsibility of the seabed mapping participants or the ArcticNet technicians. In any case, the unit was not tampered with due to unfamiliarity while the UNB team usually adjusted the K-sync depending on the surveyed depth.

During Legs 2b and 3, the K-Sync worked properly as it diminished the possible interferences between various sonars mounted on the ship. Familiarized users aboard were able to help with the understanding of the optimal settings for different type of surveys, water depths and sounding configuration (Nistad et al., 2014). While getting into deeper water (>3900m), the EM302 had problems tracking the seafloor. After investigation, it was found that the depth source on the K-Sync was wrong, since the K-Sync machine relied on the EM302 to initiate the pings sequence between every sonars. Manual depth configuration on the K-Sync controller helped for better mapping capabilities in deep waters.

CTD Rosette. CTD profiles were an essential component of accurate bathymetry data. They provided a measure of the speed of sound that was used to correct for refraction effects incurred by sound propagating in the water column. A strategy was developed where the Rosette operator would provide averaged CTD profiles as Seabird (.cnv) files to the seabed mapping participants. Post-processing was required to apply the CTD-Rosette profiles to survey lines run prior to the CTD-Rosette deployment.

23.2.2 Coverage

Now in its 11th year, the *Amundsen* multibeam datasets have increased to the point where current tracks will necessarily overlap past tracks. This is beneficial from a quality control point of view since it generates areas where data consistency can be verified. However, it would seem obvious that it is more beneficial to follow the edges of past surveys in order to increase yearly coverage. This, however, proved more difficult than anticipated. Some reasons for this are listed below in no particular order:

- Any deviation from the shortest route to survey uncharted areas requires time which will be taken away from the rest of the ArcticNet scientific program;
- There is an incompatibility between the habit of mariners to follow past routes, which provides a sense of security in poorly surveyed area, and the objective of charting unsurveyed areas;
- In 2014, the 2003-2013 multibeam coverage was displayed on an ESRI ArcGIS map with the ship's position displayed in real time. Understandably, ArcGIS is not a navigation software and mariners relied on their existing Electronic Charts Systems[2] (ECS) for navigation. The UNB possessed an Aldebaran license, a navigation software, on which they displayed past coverage. In 2014, it proved impossible to come up with an identical solution;
- The limited power of the seabed mapping team to influence the chosen route;
- Ice conditions preventing the ship to follow an intended route.

Some solutions to the previously mentioned problems might be to plan routes a few months before the start of the ArcticNet cruise, if not already done so, with inspection of past coverage. An investigation of the Transas and Nobeltec ECS might reveal possibilities to integrate third party coverage without interfering with the fundamental role of the equipment as an aid to navigation.

23.2.3 Navigation software and communication with the bridge

CHS provided the cruise participants with a version of Aldebaran. After many attempts to use this navigation software during Leg 1, many issues would make it unsuitable to meet the needs in term of navigation. A GPS module in ArcGIS 10.1 was found to be a good alternative to display in real time the ships course as well as electronic charts (.kap), 2003 to 2012 *Amundsen* multibeam coverage and planned stations. This program was running on a computer in the acquisition room and the display was shared to the bridge. This methods allowed for a better route planning in term of time saving versus multibeam

[2] CCGS *Amundsen* is equipped with two ECS: One from Transas and one from Nobeltec.

coverage («mowing the lawn»). This is particularly valuable for station transits surveyed more frequently.

Measured depth in real-time were directly compared to existing charts. Any anomaly was declared to CHS for immediate update in the charts. In some cases wl were asked to be run, the coordinates were given directly to the bridge and input into SIS (see section 2.1) for displaying the real-time along track coverage.

23.3 Preliminary results

23.3.1 Dataset integration

During Leg 1, efforts were put into place to integrate the existing 2003 to 2013 dataset with newly acquired 2014 data. Given the different processing softwares and methodologies between UNB and Laval University/CHS, this required a substantial effort. Preliminary results are shown in the following figures.

Figure 23.1 shows an overlay of newly acquired bathymetric datasets of the eastern portion of Lancaster Sound over pre-existing 2003–2013 datasets as basemaps. Figure 23.2 shows the grid generated from pre-existing 2003–2013 datasets and newly acquired 2014 datasets. Parts of the unlaying basemaps are still visible since the grid was generated with data limited in extent as compared to the extent of the basemaps. Figure 23.3 shows a zoomed in portion of Figure 23.2 in order to highlight the level of achievable consistency within the 2003-2013 and 2014 datasets. Note that a portion of the UNB basemaps for which no multibeam data was found in the 2003-2013 datasets is visible.

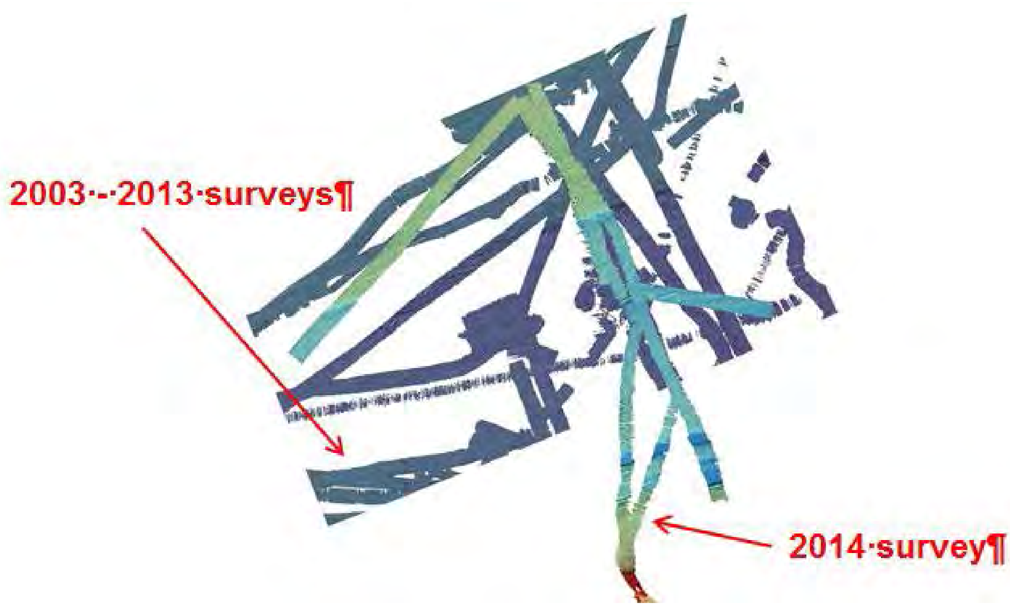

Figure 23.1. Grid of the 2014 EM302 bathymetry coverage superimposed on the UNB basemaps. The area depicted is the eastern end of Lancaster Sound.

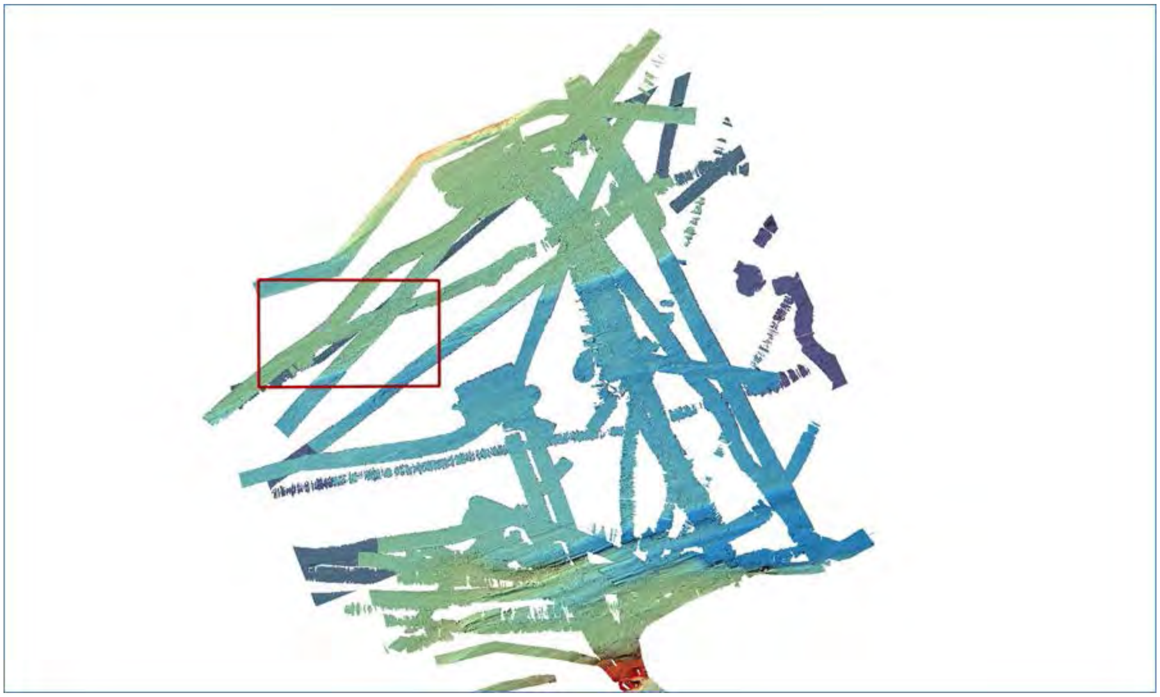

Figure 23.2. Grid of the 2003 to 2014 EM302/EM3002 bathymetry coverage for the eastern portion of Lancaster Sound. The UNB basemaps are still visible underneath due to the limited extent of the generated grid. The area within the polygon is depicted in Figure 23.3.

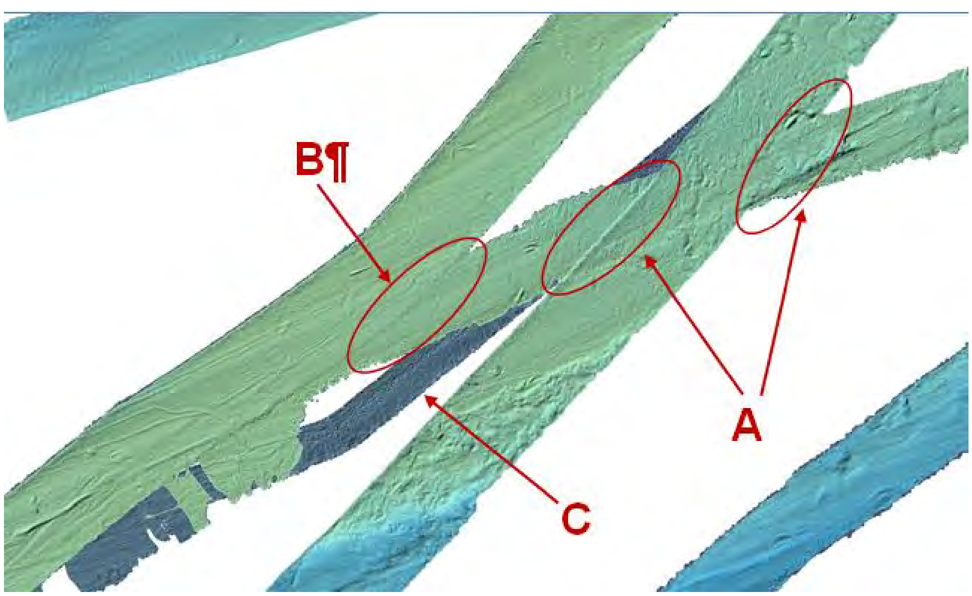

Figure 23.3. Area depicted in the polygon of Figure 23.2. Sections A show overlap edges between 2003-2013 and 2014 datasets. Section B shows an overlap edge within the 2003-2013 datasets. Section C shows a portion of the UNB basemaps for which no multibeam data was found.

23.3.2 Special projects – Leg 1

Aside from continuous transit mapping, the seabed mapping participants were involved in the following special projects:

1. Bathymetric mapping for deep water coral sites (East of Baffin Island);
2. Two MVP transects (Eastern Lancaster Sound and east of Baffin Bay);
3. Bathymetric mapping for potential CASQ coring sites (Various sites);
4. Two ice island mapping (PII-A-1-f and PII-K).

The ice island mapping projects proved particularly interesting and challenging. The 30 kHz EM302 was not the most appropriate survey tool for close-range vertical structure mapping. Two ice island circumnavigations were performed: the PII-A-1-f and PII-K Ice Islands. No adjustment to the EM302 settings was made during the mapping of the PII-A-1-f Ice Island. This, unfortunately, resulted in very poor data collection of the sidewalls. On the PII-K Ice Island, adjustments were made and it was possible to map part of the vertical structure (Figure 23.4). Recomendations as to what do to in future ice island mapping was compiled in Nistad (Section 6).

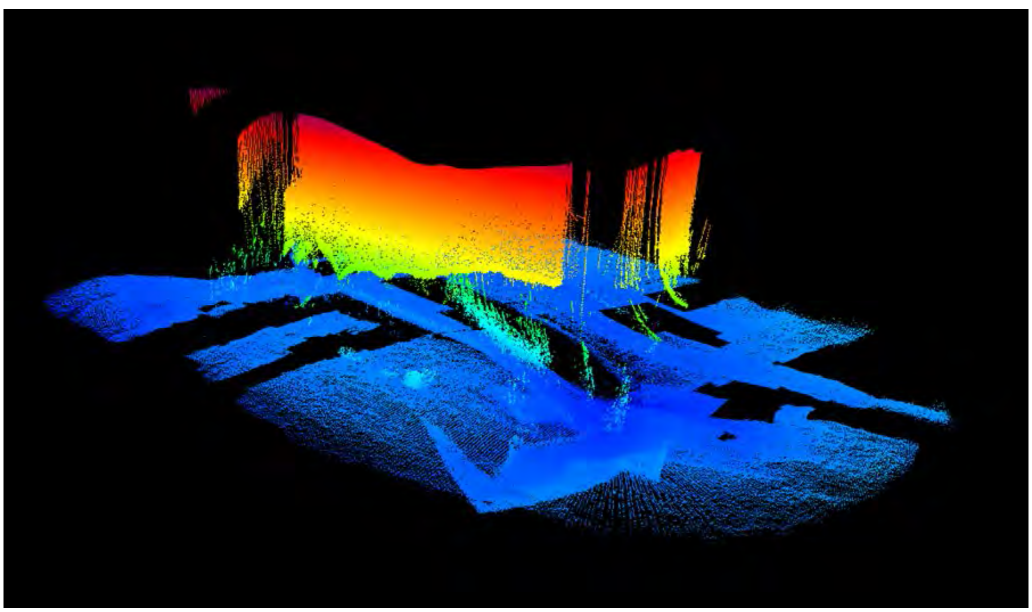

Figure 23.4. 3D point cloud of PII-K Ice Island and underlying topography collected with the EM302. The coloring is by depth.

Improvements can be made to the PII-K dataset by processing the water column data. Following discussions with Mrs. Anna Crawford, it was suggested to submit this potential improvement possibility as a component of a Master's thesis project in the hydrographic department of the HafenCity University Hamburg.

23.3.3 Special projects – Leg 2

During Leg 2b, seabed mapping participants were involved in a special project of mooring imaging. After mooring deployments, the seabed mapping team suggested to survey the mooring sites in order to verify the buoy depths and the mooring position in the water column (Figure 23.5), as it had been done during Leg 2a. Optimal runtime settings are listed in Beaudoin (2011) and Nistad (2014).

The Water Column display/Sonar Mode in SIS was also used in real-time to support instrument deployment (piston and box cores, nets, CTD, etc.). Navigation officers were able to see these instruments as they were going into the water. Finally, artifacts in water column scattering were still visible. Backscatter calibration tests could help eliminate those artifacts.

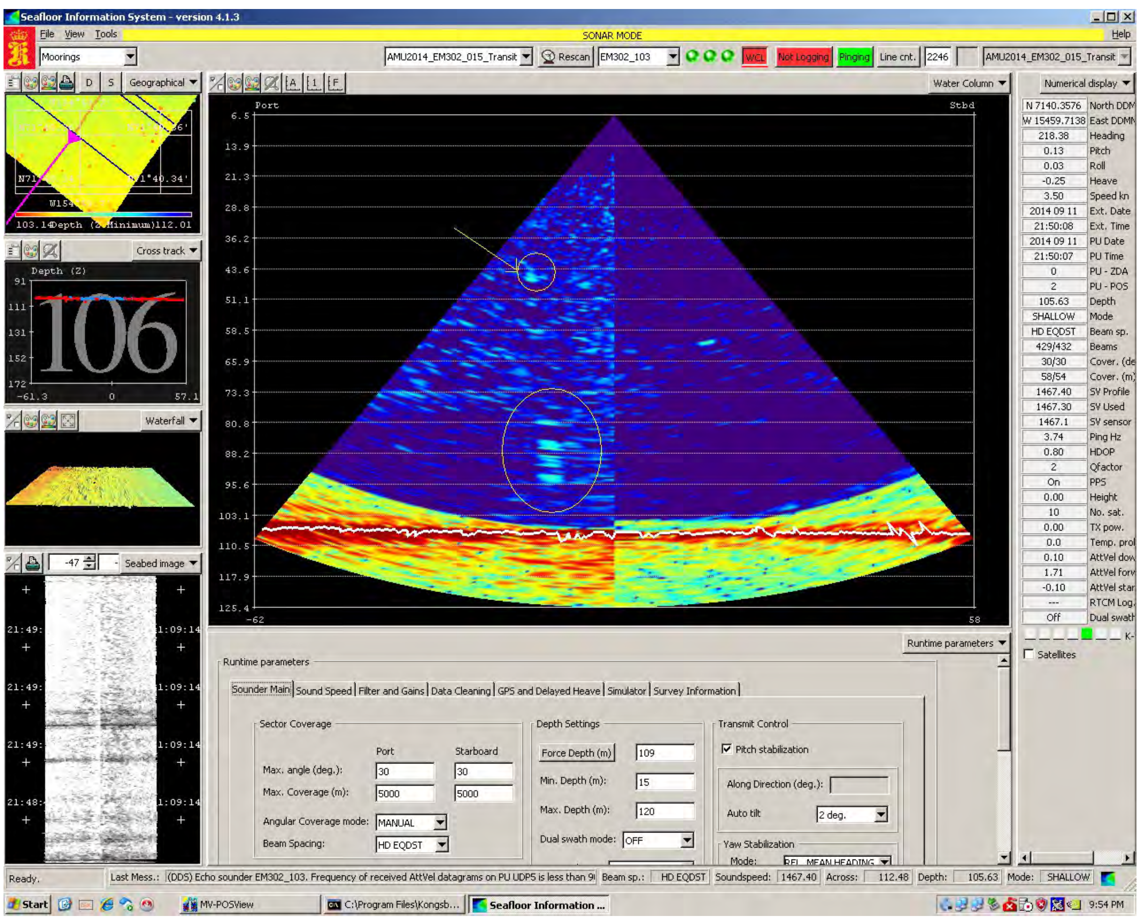

Figure 23.5. Screengrab of the real-time water column image of BCE mooring site.

23.3.4 Special projects – Leg 3

23.3.5 Scott Inlet, Clarke and Gibbs fjords

7 hours were dedicated to multibeam mapping of Scott Inlet and Clarke fjord. Unfortunatly, the sea conditions were not good enough to map the Scott Inlet (Scott Trough). So, it was decided to map both Clarke and Gibbs fjords instead. The 7 hours of mapping were conducted between coring Stations LGM AMU2014-001 and LGM AMU2014-002 (Figure 23.6). The mapping resulted in an extension of already mapped area in Clarke fjord and a mapping of the head of Gibbs fjord. At the head of Gibbs fjord, interesting features were observed, like an early holocene sandur now underwater (due to Holocene sea level rising). That sandur was characterized by the presence of a channel, what seemed to be alluvial terraces and some mass movement scars. Moraines and grounding- line fans were also observed.

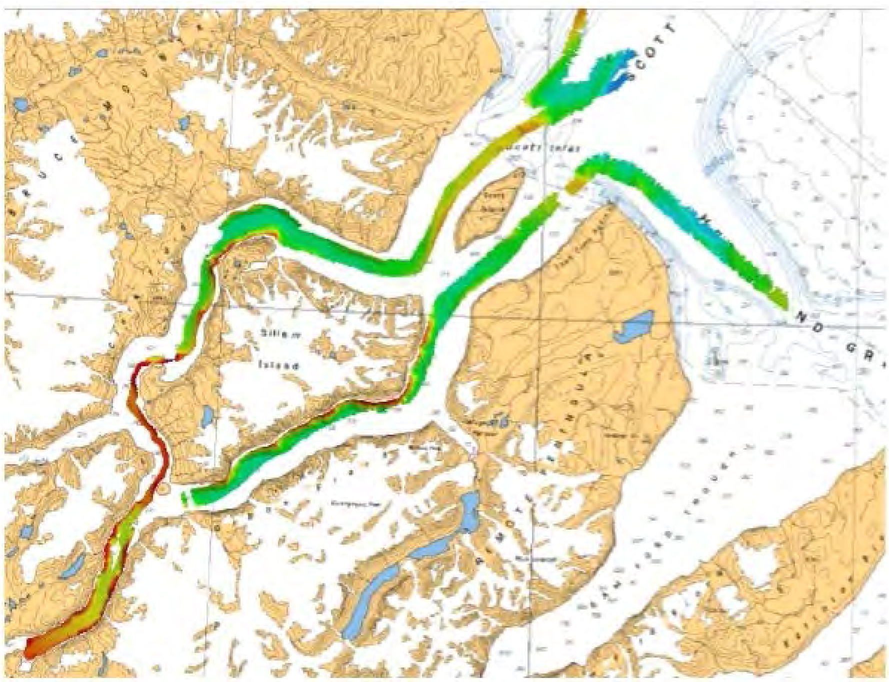

Figure 23.6. Leg 3 mapping data in Clarke and Gibbs fjords.

In both fjords, where coring sites were planned, sub-bottom surveys were conducted to validate the choice of the coring sites. At the coring sites, the team helped the coring crew since two of the cores were for Etienne Brouard PhD study.

23.3.6 Merchants Bay and Big Nose fjord

Prior to mapping the Merchants Bay, the team helped for route planning and stations accessibility by providing new navigation maps to the chief scientist and to the wheelhouse. The planning of the route, to the coring station in Big Nose fjord, led to a mapping survey of the access to Big Nose fjord. 15 hours were dedicated to mapping Merchants Bay area in a way to bring the ship to the Big Nose fjord coring station. The mapping revealed an area characterized by bedrock outcrops and few sedimentary basins. In Big Nose fjord, the conditions and the few data on navigability led to minor new coverage.

23.3.7 Akpait fjord

As for Clarke and Gibbs fjord, sub-bottom surveys were conducted to validate the choice of the coring sites. The conditions and the few data on navigability led to minor new coverage.

23.3.8 Iqaluit mass movements

As in Akpait fjord, a sub-bottom survey was conducted to validate the choice of the coring site.

23.3.9 Falk-Flectcher Pass

While heading out of Frobisher Bay, a line of mapping was done for the study of a new maritime passage to Iqaluit : the Falk-Fletcher pass (Figure 23.7). From the Ocean Mapping Group data and recommandations, the black line for the approach of the Falk-Fletcher pass was ran.

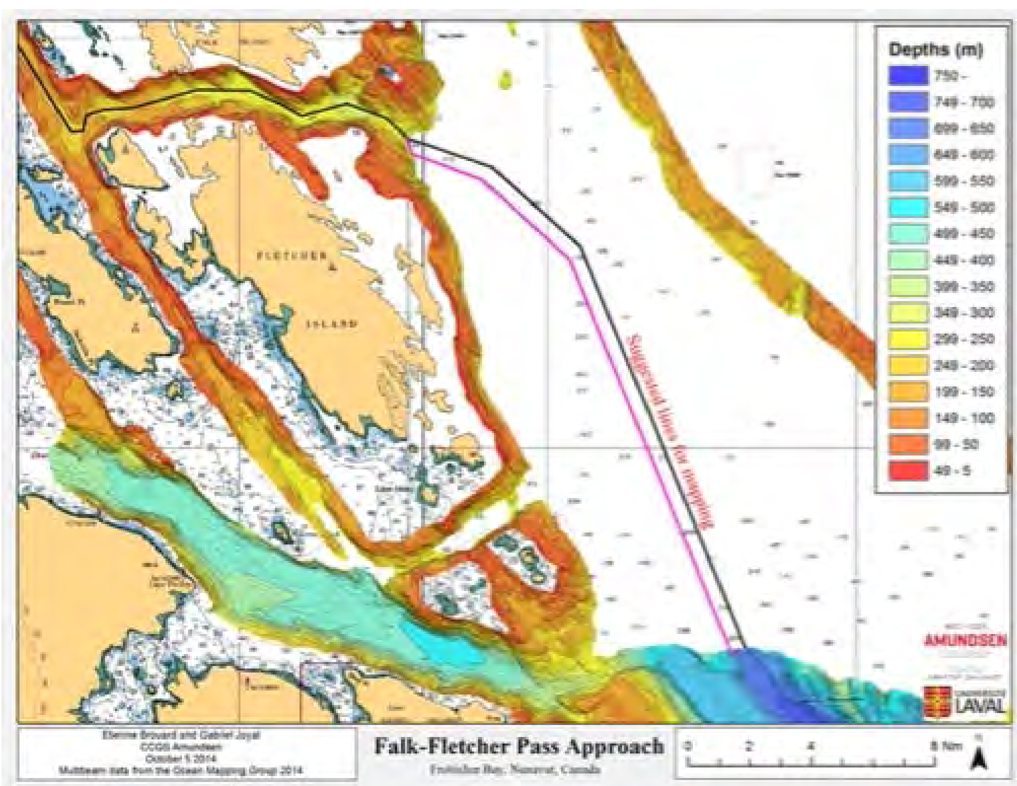

Figure 23.7. Falk-Fletcher pass suggested mapping. The black line is the one that was ran.

23.4 Comments and recommendations

23.4.1 Leg 1

Seabed mapping participants should familiarize themselves with the Field Procedures Manual developed during Leg 1 (Nistad and Thornhill 2014). This document contains useful technical observations, procedures and hints pertaining to the operation the seabed mapping equipment.

Special emphasis should be placed on performing the transmission sector adjustment procedure during the course of Leg 2 (see section **EM302 – Seabed image**).

The seabed mapping role transition from the University of New Brunswick to a Laval University/CHS partnership has proven to be challenging as new methods needed to be developed and new partners needed to work collaboratively. Data collection and processing has been described by CHS in a mission report.

Last minute assessment of the seabed mapping infrastructure equipment has denoted potential flaws which should be addressed in future *Amundsen* cruises in order to avoid failures in the course of cruises when limited material may make certain repairs unfeasible.

A strategy that minimizes resurveying existing coverage while minimizing the time dedicated to scientific objectives should be developed.

23.4.2 Leg 2

Further dataset integration efforts need to be put in place in order to continue integrating multibeam bathymetry, seabed image and sub-bottom profile datasets in an easily accessible fashion.

Except for small software and hardware issues, Leg 2b mapping projects were very successful. Future work should include a constant update of the fieldwork procedures, as well as data integration investigation. Quasi real-time processing of multibeam data should be continued in order to rapidly identify possible errors in the acquisition system. Transits between stations should be prepared in advance in order to cover greater areas instead of re-surveying lines.

Also, the team will try, during Leg 3, to produce a document for reorganization of the lab space for next further surveys.

Finally, backscatter calibration lines must be run in deep water (>1500m) in the Baffin Bay during Leg 3.

23.4.3 Leg 3

Except for small software and hardware issues, Leg 3 mapping projects were very successful. Future work should include a constant update of the fieldwork procedures, as well as data integration investigation.

References

Beaudoin, J. (2013) SVP Editor Software Manual. UNH/CCOM.

Beaudoin, J. (2011). Optimizing EM302 Settings for Water Column Imaging. Multibeam Advisory Committee, 9 pages.

Nistad J., Thornhill, D., Joyal, G. (2014). CCGS Amundsen Seabed Mapping Field Procedures Manual. Version 2.3.

Nistad, J. (2014). A Hydrographer's Observations of Ice Island Mapping. Field Notes.

Nistad J., Thornhill, D. (2014). CCGS *Amundsen* Seabed Mapping Field Procedures Manual. Version 2.1.

24 Seafloor Geology Mapping and Sediment Sampling – Leg 2a

ArcticNet Phase 3 – Marine Biological Hotspots: Ecosystem Services and Susceptibility to Climate Change.
http://www.arcticnet.ulaval.ca/pdf/phase3/marine-ecosystem-services.pdf
ArcticNet Phase 3 – The Canadian Arctic Seabed: Navigation and Resource Mapping.
http://www.arcticnet.ulaval.ca/pdf/phase1/16.pdf

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24.1 Introduction

The objectives of the seafloor geology program aboard the CCGS *Amundsen* were to collect new data for seafloor sediments from the Beaufort Sea shelf and upper slope, the Banks Island shelf, and Amundsen Gulf. Data acquisition involved the retrieval of new sediment samples (sediment cores) and the collection of new geophysical data (multibeam echosounder and sub-bottom profiler). Geophysical data was collected in collaboration with the Canadian Hydrographic Service and the University of Laval (Patrick Lajeunnesse).

Research is aimed at improving knowledge of the seafloor geology of the western Canadian Arctic Archipelago and the Beaufort Sea. A better understanding of the age, character, origin, and geotechnical properties of seafloor sediments will inform estimates of the type and distribution of geohazards. As well, this knowledge will place important new constraints on the history of glacial and postglacial sedimentation, which will further constrain estimates of past environmental variability (i.e. ice sheets, sea ice, sea level, permafrost, paleoceanography, paleoecology). Greater knowledge of the distribution, age, and dynamics of seafloor geohazards in the Beaufort Sea will contribute to National Energy Board regulatory policies and environmental impact assessments of hydrocarbon exploration and development.

24.2 Methodology

24.2.1 Multibeam echosounder

The hull-mounted Kongsberg EM302 30 kHz multibeam echosounder provided new, detailed bathymetric data for the length of Leg 2a.

24.2.2 Subbottom profiler

Subbottom profiling was achieved using a hull-mounted Knudsen 320R 3.5 kHz system, which ran continuously for the length of Leg 2a.

24.2.3 Piston Corer

The piston corer onboard the CCGS *Amundsen* follows the blueprints of the AGC Long Corer, supplied by the GSCA. This system is comprised of a large core head that attaches to 3 m x 106 mm ID core barrels that are attached with external couplings secured by set screws. Onboard the CCGS *Amundsen*, up to 3 barrels can be used with this system, yielding a core sample of up to 9 m in length. A transparent plastic core liner is inserted into the core barrels for each sample to retain the core when it is removed from the core barrel. The whole round samples obtained by this system have a diameter of 99.2 mm and are cut into 1.5 m lengths for ease of transportation. A 115 kg trigger weight corer with a 1.5 m aluminum barrel is used as the trigger weight for this system. The sample diameter of the trigger weight cores is also 99.2 mm.

24.2.4 Box Corer

Push cores were obtained from sediment recovered by the CCGS *Amundsen*'s box corer. Push cores were collected using transparent plastic core liner with a diameter of 99.2 mm, while a small air compressor is used to create a vacuum, thus minimizing sediment disturbances during the insertion of the core liner through the sediment.

24.3 Preliminary results

24.3.1 Multibeam echosounder and subbottom profiler data

Multibeam echosounder and subbottom profiler data were collected continuously for the length of Leg 2a. Data quality was consistently good, except where sea ice or high sea state caused bottom mistracking and loss of coverage. Track lines through Dolphin and Union Strait and Coronation Gulf reveal widespread ice-scoured bedrock, which is consistent with adjacent terrestrial geomorphology indicating the former presence of a large ice stream in the channel during the last glaciation. In eastern Amundsen Gulf, the data reveal further evidence for large ice streams, in the form of mega-scale glacial lineations, as well as multiple sedimentary basins where thick sequences of postglacial sediment have been deposited. These sedimentary basins may be sampled using the piston corer during future fieldwork. In western Amundsen Gulf, subbottom profiler data was used to identify the distribution of widespread, multiple glaciogenic sedimentary units, which record oscillations of the former ice stream margin during the last glaciation. The age of these past oscillations of the ice stream terminus is important for interpreting the record of ice-rafted debris in sediment cores from the Beaufort Sea, and for geophysical models of past ice sheet dynamics which are used to improve estimates of future ice sheet mass loss in Greenland and Antarctica. On the Banks Island Shelf, multibeam echosounder and subbottom profiler data was used to clearly identify the western limit of continental ice sheets during the last glaciation. A dedicated multibeam echosounder and subbottom profiler survey was completed in outer Mackenzie Trough.

24.3.2 Sediment coring

A total of nine piston cores were collected during Leg 2a. Two sediment cores from Amundsen Gulf yielded sediments that will constrain the timing of the last deglaciation and will inform estimates of widespread ice-rafted debris in other sediment cores raised from the Beaufort Sea. Improved age estimates for the regional seafloor geology will complement ongoing stratigraphic correlations between sediment cores, geophysical data, and terrestrial geology from the Canadian Arctic Mainland and the western Canadian Arctic Archipelago.

Two sediment cores from the Banks Island shelf yielded sediments that will constrain the past limit of glaciation on the shelf the timing of ice sheet retreat. New results suggest that a continental ice sheet inundated the Banks Island shelf during the last glaciation, which is contrary to long-standing hypotheses of former ice sheet limits in the western Canadian Archipelago based largely on terrestrial observations. The recognition of expanded ice sheet margins in this region clarifies knowledge of the paleoenvironmental evolution of the Canadian Arctic and has important implications for assessing the history of sedimentation on the adjacent continental slope.

Four piston cores from the Beaufort Sea shelf and slope will be used to improve knowledge of the geotechnical properties of the seafloor in this region, where hydrocarbon exploration is currently ongoing.

A single piston core from the continental slope seaward of outer Mackenzie Trough will be used to clarify the regional seafloor geology, which, based on preliminary multibeam echosounder data, is hypothesized to differ from that of the slope to the east.

Each piston core site during Leg 2a was also sampled using the box corer. Two push cores were collected from each deployment of the box core. The eighteen push cores will be used to complement the stratigraphy of the nine piston cores.

24.4 Comments and recommendations

Piston cores collected throughout Leg 2a consistently yielded moderate core recovery of 3 to 5 m in length. A heavier core head may facilitate improved penetration of the piston core barrels through the seafloor sediments and yield sediment cores closer to the 9 m-long capacity of the current piston coring system. Further, in one case the piston corer was deployed despite the ship being approximately 500 m off station. The resulting core, therefore, did not sample the targeted stratigraphy and its use geologically is compromised.

25 Benthic diversity and functioning across the Canadian Arctic – Legs 1, 2 and 3

ArcticNet Phase 3 – Marine Biological Hotspots: Ecosystem Services and Susceptibility to Climate Change.
http://www.arcticnet.ulaval.ca/pdf/phase3/marine-ecosystem-services.pdf

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25.1 Introduction

It is widely 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, which coincides with a reduction of benthic prey populations. According to a widely accepted 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 a phytoplankton-zooplankton dominance.

Moreover, benthic fauna plays a key role in the recycling of organic matter at the seafloor as it can both participate in organic matter decomposition and channel this organic matter to higher trophic levels. It has been suggested that the shift in primary producers inferred by global warming will impact on both the quantity and the quality of food exported towards the sediment. This may lead to possible changes on the structure and function of benthic ecosystems since polar benthic heterotrophs depend on allochtonous organic material for their energetic requirements.

In the context of the potential benthic community changes, it is essential to establish benchmarks in biodiversity and understand the functioning of the benthic community at key locations in the Canadian Arctic prior to the expected changes in ice cover, ocean chemistry and climate and 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, we have the opportunity to document pristine conditions before ocean changes and exploitation occurs.

The main objectives were to:

- Describe and compare the biodiversity in different locations of the Canadian Arctic in relation to environmental variables;
- Investigate the origin and sources of organic matter assimilated by the Arctic fauna using stable isotopes.

25.2 Methodology

The box corer was deployed to quantitatively sample diversity, abundance and biomass of mega- and macroendobenthic fauna (Table 25.1 to 25.4).

- Benthic diversity: sediments of usually a surface area of 0.125 m^2 and 10-15 cm in depth were collected and passed through a 0.5 mm mesh sieve and preserved in a 4 % formaldehyde solution for further identification in the laboratory (1 sample/BC);
- Sediment grain size: the top 5 cm was collected using a 60 mL truncated syringe and samples were frozen at -20°C (1 sample/BC);
- Organic carbon content: the top 1 cm was collected using a 60 mL truncated syringe and samples were frozen at -20°C (1 sample/BC);
- Sediment content pigments: the top 1 cm was collected using a 10 mL truncated syringe and samples were frozen at -80°C (3 samples/BC);
- Meiofauna assemblages: the top 1 cm was collected using a 60 mL truncated syringe and samples were preserved in formaldehyde solution (5 samples/BC);
- Meiofauna – stable isotopes: the top 1 cm was collected using a 60 mL truncated syringe and samples were frozen at -20°C (1 sample/BC);
- Sediments – stable isotopes: the top 1 cm was collected using a 60 mL truncated syringe and samples were frozen at -20°C (1 sample/BC);
- Surface water: water in the box core was filtered on GF/F filters and kept at -80°C for particulate organic matter compound specific isotope analysis (1 sample/BC).

The Agassiz trawl was deployed to collect mega- and macroepibenthic fauna (Table 25.5 to 25.8). Specimens were identified on board to the lowest possible taxonomic level, counted, weighted and frozen at -20°C for compound specific isotope analysis.

Specimens were also collected from the beam trawl, which was deployed at 12 stations during Leg 2 (Table 25.9 and 25.10).

Water samples (10 m above bottom) were taken from the CTD-Rosette at the same stations than the trawl; water was filtered on GF/F filters and kept at -80°C for particulate organic matter compound specific isotope analysis (Table 25.11 to 25.14). All samples will be transported off the ship for analyses in the lab at the Université du Québec à Rimouski.

All samples will be transported off the ship for analyses in the lab at the Université du Québec à Rimouski.

Table 25.1. Box coring stations during Leg 1.

Station	Date	Latitude (N)	Longitude (W)	Depth (m)	Diversity	Grain size	Organic content	Pigments	Meio-assemblage	Meio isotopes	Sediment isotopes	Filtration
Full-323	17/07/2014	74°09.866	080°31.362	778	1	1	1	3	5	1	1	3
Basic-301	19/07/2014	74°06.612	083°25.520	672	1	1	1	3	5	1	1	3
Full-304	20/07/2014	74°13.964	091°28.108	314	1	1	1	3	5	1	1	3
Full-305	22/07/2014	74°19.672	094°51.260	191	1	1	1	3	5	1	1	no[1]
Basic-200	27/07/2014	73°16.897	063°37.939	1450	1	1	1	3	5	1	1	3
Basic-200	27/07/2014	73°16.907	063°38.007	1445	G. Massé & A. Rochon							3
Basic-204	28/07/2014	73°15.675	057°53.219	987	1	1	1	3	5	1	1	3
Basic-204	28/07/2014	73°15.666	057°53.264	995	G. Massé & A. Rochon							3
Basic-210	29/07/2014	75°24.372	061°39.750	1149	1	1	1	3	5	1	1	3
Basic-210	29/07/2014	75°24.574	061°39.695	1152	G. Massé & A. Rochon							3
Full-115	30/07/2014	76°18.998	071°07.196	656	1	1	1	3	5	1	1	3
Full-115	31/07/2014	76°18.897	071°06.687	657	G. Massé & A. Rochon							3
Basic-111	31/07/2014	76°18.376	073°13.156	594	1	1	1	3	5	1	1	3
Full-108	01/08/2014	76°16.274	074°36.417	447	1	1	1	1	1	1	1	no[1]
Basic-105	01/08/2014	76°19.558	075°48.123	343	1	1	1	3	5	1	1	no[1]
Full-101	01/08/2014	76°21.293	077°33.200	360	1	1	1	3	1	1	1	3
Full-101	02/08/2014	76°21.307	077°32.673	365	G. Massé & A. Rochon							3
Full-KEN1	03/08/2014	81°22.313	063°56.708	560	1	1	1	3	5	1	1	3
Basic-KEN3	04/08/2014	80°79.548	067°30.112	406	rocky bottom, no box core							
Basic-KANE1	04/08/2014	79°99.307	069°77.727	239	rocky bottom, no box core							
Casq-KANE2b	04/08/2014	79°30.922	070°50.982	218	1	1	1	3	1	1	1	3
Casq-KANE2b	04/08/2014	79°31.137	070°53.287	217	G. Massé & A. Rochon							no
Basic-KANE3	05/08/2014	79°34.612	071°85.782	215	rocky bottom, no box core							
Basic-KANE5	05/08/2014	79°00.153	073°20.457	250	rocky bottom, no box core							
Basic-120	06/08/2014	77°32.588	075°70.413	558	rocky bottom, no box core							
Basic-309	10/08/2014	72°58.494	096°02.536	335	1	1	1	3	5	1	1	2
Basic-310	10/08/2014	71°29.510	097°69.785	50	rocky bottom, no box core							
Basic-312	11/08/2014	69°10.269	100°41.636	66	1	1	1	3	5	1	1	3
Full-314	12/08/2014	68°58.234	105°28.276	84	1	1	1	3	5	1	1	3

[1] no surface water in the box core

Table 25.2. Box coring stations during Leg 2a.

Station	Date	Latitude (N)	Longitude (W)	Depth (m)	Diversity	Grain size	Organic content	Pigments	Meio-assemblage	Meio isotopes	Sediment isotopes	Filtration
Basic-405	17/08/2014	70°38.422	123°02.279	608	1	1	1	3	5	1	1	3
Basic-407	18/08/2014	71°00.380	126°04.010	392	1	1	1	3	5	1	1	3
Basic-437	19/08/2014	71°47.180	126°29.980	318	1	1	1	3	5	1	1	3
Full-408	20/08/2014	71°18.747	127°34.942	183	rocky bottom, no sample							
Basic-420	21/08/2014	71°03.082	128°30.759	38	rocky bottom, no sample							
Basic-435	22/08/2014	71°04.770	133°38.200	297	1	1	1	3	5	1	1	3
Basic-434	23/08/2014	70°10.947	133°32.988	46	1	1	1	3	5	1	1	3
Full-421	24/08/2014	71°27.580	133°54.170	1165	1	1	1	3	5	1	1	3
Basic-460	25/08/2014	72°08.896	130°48.945	961	1	1	1	3	5	1	1	3
Basic-482	02/09/2014	70°31.457	139°22.954	826	1	1	1	3	5	1	1	3
Basic-470a	04/09/2014	69°21.960	138°13.968	48	1	1	1	3	5	1	1	3
Basic-472	06/09/2014	69°36.632	138°13.360	125	1	1	1	3	5	1	1	3

Table 25.3. Box coring stations during Leg 2b.

Station	Date	Latitude (N)	Longitude (W)	Depth (m)	Diversity	Grain size	Organic content	Pigments	Meio-assemblage	Meio isotopes	Sediment isotopes	Filtration
Basic-1040	10/09/2014	71°14.820	157°09.900	47	Rocky bottom, no box core							
Basic-1042	10/09/2014	71°24.560	157°28.891	128	1	1	1	3	3	1	1	3
Basic-1044	11/09/2014	71°34.713	157°50.423	65	1	1	1	3	3	1	1	3
Basic-1038	12/09/2014	71°34.371	155°45,672	164	Rocky bottom, no box core							
Full-1034	13/09/2014	71°54.500	154°57.900	326	Rocky bottom, no box core							
Basic-1030	14/09/2014	72°12.360	153°55.740	2061	Bad weather, no box core							
Basic-1085	16/09/2014	75°03.680	167°08.300	249	1	1	1	3	3	1	1	3
Full-1100	18/09/2014	75°04.158	161°15.592	1987	Box core problem*, no sampling							
Basic-1107	19/09/2014	74°36.236	155°49.853	3859	Too much depth, no box core							
Basic-1115	20/09/2014	72°42.592	152°43.100	3770	Too much depth, no box core							
Basic-1130	21/09/2014	73°00.986	143°26.044	3232	Too much depth, no box core							
Basic-435	23/09/2014	71°04.701	133°38.120	294	Cancelled							

*First box core: cable entangled + twisted trap. Second box core: twisted trap, not triggered.

Table 25.4. Box coring stations during Leg 3.

Station	Date	Latitude (N)	Longitude (W)	Depth (m)	Diversity	Grain size	Organic content	Pigments	Meio-assemblage	Meio isotopes	Sediment isotopes	Filtration
Full-PCBC-2 #A	30/09/2014	71°05.319	071°50.663	696	1	1	1	3	3	1	1	0
Full-PCBC-2 #B	30/09/2014	71°05.245	071°50.748	696	1	1	1	3	3	1	1	0
Full-PCBC-2 #C	30/09/2014	71°05.181	071°50.573	695	1	1	1	3	3	1	1	0
Basic-Gibbs	01/10/2014	70°45.862	072°15.591	442	1	1	1	3	3	1	1	3
Basic 180	03/10/2014	67°28.400	061°42.300	185	Too rocky, no sampling							

Table 25.5. Agassiz trawl stations during Leg 1.

		Start			End				
Station	Date	Latitude (N)	Longitude (W)	Depth (m)	Latitude (N)	Longitude (W)	Depth (m)	Duration	Comment
Basic-323	18/07/2014	74°09.927	080°32.159	770	74°08.958	080°36.134	781	3 min	
Full-301	19/07/2014	74°09.892	083°40.968	667	Winch problem, no sample				
Full-304	20/07/2014	74°23.400	091°49.480	312	Too much ice, no sample				
Full-305	22/07/2014	74°18.881	094°48.452	193	74°19.057	094°49.652	188	2 min	
Basic-200	27/07/2014	73°16.796	063°37.807	1449	73°16.209	063°35.526	1457	5 min 30 s	
Basic-204	28/07/2014	73°15.667	057°52.749	988	73°15.561	057°50.184	981	5 min	
Basic-210	29/07/2014	75°24.484	061°40.710	1163	75°24.792	061°40.809	1119	5 min	Empty
Full-115	30/07/2014	76°18.710	071°06.261	656	76°18.870	071°06.380	662	4 min	
Basic-111	31/07/2014	76°18.313	073°14.444	596	76°18.987	073°15.184	606	3 min	
Full-108	31/07/2014	76°16.356	074°36.428	448	76°16.258	074°36.418	449	4 min	
Basic-105	01/08/2014	76°19.780	075°48.471	345	76°20.298	075°52.567	331	4 min	
Full-101	01/08/2014	76°21.202	077°34.905	340	76°21.159	077°32.081	377	4 min	
Full-KEN1	03/08/2014	81°22.363	063°55.928	549	81°24.179	064°00.159	549	4 min	
Basic-KEN3	04/08/2014	80°47.904	067°16.001	409	80°47.918	067°13.929	408	3 min	
Basic-KANE1	04/08/2014	79°59.493	069°45.466	246	80°00.387	069°46.607	246	3 min	
Basic-KANE3	05/08/2014	79°20.627	071°51.310	213	79°20.345	071°49.042	214	3 min	
Basic-KANE5	06/08/2014	79°00.204	073°12.659	249	79°00.340	073°11.692	246	3 min	
Basic-120	06/08/2014	77°19.418	075°43.332	563	77°19.206	075°42.655	565	3 min	
Basic-309	10/08/2014	72°58.296	096°02.739	335	72°58.588	096°03.386	329	3 min	

Station	Date	Start			End			Duration	Comment
		Latitude (N)	Longitude (W)	Depth (m)	Latitude (N)	Longitude (W)	Depth (m)		
Basic-310	11/08/2014	71°17.651	097°41.762	134	71°17.115	097°41.625	125	3 min	
Basic-312	11/08/2014	69°10.213	100°41.790	65	69°10.453	100°40.658	60	3 min	
Full-314	12/08/2014	68°58.177	105°28.039	75	68°58.037	105°27.949	78	3 min	

Table 25.6. Agassiz trawl stations during Leg 2a.

Station	Date	Start			End			Duration	Comment
		Latitude (N)	Longitude (W)	Depth (m)	Latitude (N)	Longitude (W)	Depth (m)		
Basic-405	17/08/2014	70°38.291	123°02.976	606	70°39.505	123°00.014	617	3 min	
Basic-407	18/08/2014	71°00.260	126°03.380	394	70°59.150	126°01.540	396	5 min	
Basic-437	19/08/2014	71°47.100	126°29.180	316	71°47.090	126°26.600	290	4 min	
Full-408	20/08/2014	71°18.790	127°35.010	206	71°18.900	127°37.350	196	3 min	
Basic-420	21/08/2014	71°02.810	128°30.540	40	71°02.890	128°29.930	46	3 min	Empty
Basic-435	22/08/2014	71°04.750	133°38.260	302	71°03.860	133°38.270	272	4 min	
Basic-434	23/08/2014	70°11.069	133°32.257	47	70°11.413	133°32.255	47	3 min	
Full-421	24/08/2014	71°27.380	133°53.310	1135	71°27.010	133°52.560	1162	5 min	
Basic-460	25/08/2014	72°08.809	130°49.158	962	72°08.574	130°48.881	962	3 min	
Basic-482	02/09/2014	70°31.498	139°23.412	828	70°30.888	139°25.258	809	3 min	
Basic-470a	04/09/2014	69°22.018	138°14.150	49	69°22.182	138°14.512	48	3 min	
Basic-472	06/09/2014	69°36.746	138°13.092	125	69°37.057	138°13.560	127	3 min	

Table 25.7. Agassiz trawl stations during Leg 2b.

Station	Date	Start			End			Duration	Comment
		Latitude (N)	Longitude (W)	Depth (m)	Latitude (N)	Longitude (W)	Depth (m)		
Basic-1040	10/09/2014	71°14.724	157°10.120	47	71°14.584	157°09.661	45	2 min	
Basic-1042	11/09/2014	71°24.620	157°29.622	127	71°24.428	157°28.023	127	2 min	Big sampling
Basic-1044	11/09/2014	71°34.641	157°50.029	66	71°34.504	157°49.582	65	2 min	
Basic-1038	12/09/2014	71°34.208	155°45.510	158	71° 33.235	155°46.268	158	2min	
Basic-1034	13/09/2014	71°54.351	154°57.580	460	71° 53.318	154°55.949	433	3 min	Lot of rocks, little sampling

Station	Date	Start			End			Duration	Comment
		Latitude (N)	Longitude (W)	Depth (m)	Latitude (N)	Longitude (W)	Depth (m)		
Basic-1030	14/09/2014	72°12.360	153°55.740	2061					Too deep and bad weather
Basic-1085	16/09/2014	75°03.641	167°07.863	249	75°02.928	167°06.420	272	3min	
Full-1100	18/09/2014	75°04.158	161°15.592	1987					Too deep
Basic-1107	19/09/2014	74°36.236	155°49.853	3859					Too deep
Basic-1115	20/09/2014	72°42.592	152°43.100	3770					Too deep
Basic-1130	21/09/2014	73°0.986	143°26.044	3232					Too deep
Basic-435	23/09/2014	71°04.701	133°38.120	294					Cancelled

Table 25.8. Agassiz trawl stations during Leg 3.

Station	Date	Start			End			Duration	Comment
		Latitude (N)	Longitude (W)	Depth (m)	Latitude (N)	Longitude (W)	Depth (m)		
Full PCBC-2	30/09/2014	71°05.106	071°50.326	599	71°05.009	071°48.723	695	5min	
Basic-Gibbs	01/10/2014	70°46.345	072°15.242	442	70°14.987	072°14.987	439	3min	
Basic 180	03/10/2014	67°28.400	061°42.300	185					Too rocky, no sampling

Table 25.9. Beam trawl stations during Leg 2a.

Station	Date	Start			End			Duration	Comment
		Latitude (N)	Longitude (W)	Depth (m)	Latitude (N)	Longitude (W)	Depth (m)		
Basic-407	18/08/2014	71°00.050	126°04.000	397	70°56.300	125°58.000	398	20 min	Basic-407
Beam Trawl 1	19/08/2014	71°11.380	126°53.430	316	71°09.020	126°53.850	310	30 min	Beam Trawl 1
Full-408	20/08/2014	71°19.390	127°34.960	212	71°21.210	127°36.280	227	30 min	Full-408
Basic-460	25/08/2014	72°09.110	130°49.430	973	72°09.530	130°48.290	1039	30 min	Basic-460
Basic-470a	04/09/2014	69°21.817	138°12.618	50	69°22.626	138°13.729	51	20 min	Basic-470a
Nutrient-476	06/09/2014	69°58.793	138°38.952	265	69°59.029	138°36.320	266	30 min	Nutrient-476

Table 25.10. Beam trawl stations during Leg 2b.

Station	Date	Start			End			Duration	Comment
		Latitude (N)	Longitude (W)	Depth (m)	Latitude (N)	Longitude (W)	Depth (m)		
Basic-	11/09/2014	71°24.304	157°29.221	128	71°24.246	157°25.109	127	20 min	Basic-1042

Station	Date	Start			End			Duration	Comment
		Latitude (N)	Longitude (W)	Depth (m)	Latitude (N)	Longitude (W)	Depth (m)		
1042									
Basic-1044	11/09/2014	71°34.669	157°50.344	66	71°37.370	157°46.958	68	20min	Basic-1044
Basic-1038	12/09/2014	71°34.363	155°45.045	160	71°32.901	155°44.996	126	20 min	Basic-1038
Basic-1034	13/09/2014	71°54.455	154°57.989	436	71°52.650	154°55.156	436	15 min	Basic-1034
Basic-1085	16/09/2014	75°03.475	167°08.679	253	75°02.133	167°05.135	284	20 min	Basic-1085
Basic-435	23/09/2014	71°04.611	133°37.652	290	71°04.555	133°38.232	289	20min	Basic-435

Table 25.11. CTD-Rosette stations during Leg 1.

Station	Date	Bottom Latitude (N)	Bottom Longitude (W)	Cast depth (m)	Volume filtered
Basic-323	18/07/2014	74°09.390	080°29.304	780	3 x 2 L
Full-301	19/07/2014	74°05.992	083°23.635	650	3 x 2 L
Full-304	20/07/2014	74°14.089	091°30.038	300	3 x 2.5 L
Full-305	22/07/2014	74°19.331	094°52.601	177	3 x 2.5 L
Basic-200	27/07/2014	73°16.747	063°37.816	1456	2 x 3.5 L 1 x 3.3 L
Basic-204	28/07/2014	73°15.662	057°53.206	984	2 x 3 L
Basic-210	29/07/2014	75°24.000	061°39.257	1014	1 x 2.895 L 1 x 3 L
Full-115	30/07/2014	76°19.532	071°09.845	663	3 x 2.5 L
Basic-111	31/07/2014	76°18.395	073°13.140	582	3 x 2 L
Full-108	31/07/2014	76°16.180	074°36.114	437	3 x 2.5 L
Basic-105	01/08/2014	76°18.998	075°46.753	329	3 x 2 L
Full-101	01/08/2014	76°22.532	077°24.056	353	3 x 2 L
Full-KEN1	03/08/2014	81°22.014	063°56.381	542	2 x 3.5 L
Basic-KEN3	04/08/2014	80°47.969	067°17.893	392	1 x 4 L 1 x 3.76 L 1 x 3.885 L
Basic-KANE1	04/08/2014	79°59.882	069°45.413	235	2 x 4 L 1 x 3.975 L
Basic-KANE3	05/08/2014	79°21.005	071°51.908	202	3 x 3.5 L
Basic-KANE5	06/08/2014	79°00.064	073°12.133	238	3 x 3.5 L
Basic-120	06/08/2014	77°19.369	075°42.156	550	2 x 3.5 L
Basic-309	10/08/2014	72°57.966	096°03.684	314	2 x 2 L
Basic-310	11/08/2014	71°17.701	097°42.049	116	3 x 3.5 L
Basic-312	11/08/2014	69°10.588	100°41.113	50	3 x 1.5 L
Full-314	12/08/2014	68°58.249	105°27.941	69	3 x 2 L

Table 25.12. CTD-Rosette stations during Leg 2a.

Station	Date	Bottom Latitude (N)	Bottom Longitude (W)	Bottom depth (m)	Cable length (m)
Basic-405	16/08/2014	70°38.286	123°02.287	610	605
Basic-407	18/08/2014	71°00.216	126°04.613	398	384

Station	Date	Bottom Latitude (N)	Bottom Longitude (W)	Bottom depth (m)	Cable length (m)
Basic-437	19/08/2014	71°47.201	126°29.676	311	311
Full-408	20/08/2014	71°18.744	127°34.568	209	197
Basic-420	21/08/2014	71°03.036	128°30.697	40	32
Basic-435	21/08/2014	71°04.729	133°37.710	301	291
Basic-434	23/08/2014	70°10.734	133°33.361	45	35
Full-421	24/08/2014	71°27.150	133°53.740	1171	1105
Basic-460	25/08/2014	72°09.432	130°49.082	983	981
Basic-482	02/09/2014	70°31.550	139°22.996	830	821
Basic-470a	04/09/2014	69°21.959	138°13.965	47	37
Basic-472	06/09/2014	69°36.414	138°13.130	129	114

Table 25.13. CTD-Rosette stations during Leg 2b.

Station	Date	Bottom Latitude (N)	Bottom Longitude (W)	Bottom depth (m)	Cable length (m)
Basic-1040	10/09/2014	71°14.794	157°10.001	47	39
Basic-1042	11/09/2014	71°24.601	157°29.246	125	117
Basic-1044	11/09/2014	71°34.673	157°50.432	65	55
Basic-1038	12/09/2014	71°34.379	155°45.780	165	157
Basic-1034	13/09/2014	71°54.590	145°57.869	446	442
Basic-1030	14/09/2014	72°12.452	153°56.982	2068	1700
Basic-1085	16/09/2014	75°30.694	167°08.484	242	236
Full-1100	18/09/2014	75°40.141	161°15.889	1983	1500
Basic-1107	19/09/2014	No sampling			
Basic-1115	20/09/2014	No sampling			
Basic-1130	21/09/2014	No sampling			
Basic-435	23/09/2014	No sampling			

Table 25.14. CTD-Rosette stations during Leg 3.

Station	Date	Bottom Latitude (N)	Bottom Longitude (W)	Bottom depth (m)	Cable length (m)
Full PCBC-2	30/09/2014	71°05.383	71°50.963	696	697
Basic-Gibbs 2	01/10/2014	70°46.169	72°15.541	444	437

25.3 Preliminary results

At this point, we do not know exactly if spatial and temporal variability of benthic diversity is governed by sediment type, food availability or other environmental variables. Samples collected for compound specific isotope analysis require further analysis. For detailed results, identification of organisms and sediment analyses will be carried on in home labs.

25.4 Comments and recommendations

We did not deploy the box core at Stations KEN3, KANE1, KANE3, KANE5, 120 and 310 (Leg 1); 408 and 420 (Leg 2a); 1040, 1038 and 1034 (Leg 2b); 180 (Leg 3) because the bottom was too rocky; using a benthic camera might be a good alternative to get data at these stations. During Legs 2b and 3, only few stations were sampled because of the depth, and the rocky bottom near Barrow.

It might be important to ensure an appropriate annual maintenance of the box corer. As suggested in the Precision Box Corer Manual, all moving parts should be checked to make sure they move smoothly and easily. A lubrificant such as WD-40 may be used to loosen fittings and standard grease should be pumped into the grease nipple on the top of the central column. This maintenance should not be done onboard to avoid contamination of samples.

An appropriate depth profiler system may be useful when the box corer is deployed at greater depths to avoid cable risks to become entangled.

26 Water column and benthic sampling as a part of the Distributed Biological Observatory Pacific Region Effort – Leg 2b

ArcticNet Phase 3 – Marine Biological Hotspots: Ecosystem Services and Susceptibility to Climate Change.
http://www.arcticnet.ulaval.ca/pdf/phase3/marine-ecosystem-services.pdf

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Cruise participant Leg 2b: Lee Cooper[1]
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26.1 Introduction

Several marine sites in the Pacific Arctic sector that support very high biological biomass and stand as foraging points for apex predators have been reoccupied during multiple international cruises. To more systematically track the broad biological response to sea ice retreat and associated environmental change, an international consortium of scientists have developed a coordinated Distributed Biological Observatory (DBO) that includes selected biological measurements at multiple trophic levels on select transect lines. These measurements are being made simultaneously with hydrographic surveys and satellite observations. For this cruise, the DBO5 (Barrow Canyon line) was sampled for sediment parameters and macroinfaunal populations, with coincident data on water column nutrients, chlorophyll, and O18. Specifically, this project focused on temperature and salinity data, zooplankton species composition, and marine mammal and seabird observations. For the remainder of the cruise, the goals were to collect water, sediment and benthic macroinfaunal data from multiple stations.

26.2 Methodology

26.2.1 Water

Subsamples of small water volumes (10 mL) were collected from the Rosette bottles at all Nutrient, Basic and Full stations for 18O analyses as a water mass tracer. Samples were stored at room temperature for post-cruise mass spectrometric analyses at CBL. Water samples collected by the hydrographic team at 10 m intervals to 60 m depth were also analysed, in addition to the chlorophyll maximum layer, which was sampled starting at the 3rd station an on. Thanks to Matt Arkett, Pascal Guillot, Pierre Coupel, and David Babb for collecting water from the CTD, filtering, and preparing samples for measurements. For the DBO5 Barrow Canyon line only, nutrient samples were collected at the same standard depths as chlorophyll.

26.2.2 Sediment/macroinfauna

We used a 0.1 m^2 van Veen grab to collect surface sediments, which were then subsampled for sediment chlorophyll *a* determination and other sediment parameters (grain size, carbon and nitrogen isotopes of organic matter and total organic carbon: nitrogen). For sediment chlorophyll collections, two replicates of 1-cm surface sediment samples were collected with 10 cc syringes, extruded into plastic centrifuge tubes, and 10 mL 90% acetone was added to the samples and mixed. These samples were then stored in the dark in the refrigerator (4°C) for 12 hours to extract the chlorophyll. The supernatant was analysed for chlorophyll *a* measures on a turner Designs AU-10 fluorometer on the ship. Sediment samples were also collected in Whirl-pak bags for grain size and carbon/nitrogen content, packaged and frozen for post-cruise analyses at CBL. The remaining sediment from the first van Veen and from a 2nd van Veen were sieved through a 1-mm stainless steel screen box on a stand with ambient seawater. The remaining animals on the screen were preserved in 10% buffered seawater formalin. For the DBO5 hotspot station (Station BarC5=ArcticNet#1042), a total of 4 quantitative grabs were collected for macrofauna only and preserved as described previously. Benthic samples were collected with the van Veen grab at 5 stations on the DBO5 Barrow Canyon line and at other locations where depths were less than 500 m depth (Table 26.1).

Table 26.1. Sample matrix of Grebmeier/Cooper data collections. Note that for the station latitude and longitude, the value at the bottom of the CTD cast for that station was used. Key: O-18=Oxygen-18/Oxygen-16 ratios, Chl H_20=Chlorophyll water, Nuts=water nutrients, Sed chl=Sediment chlorophyll, Sed TOC/phi=Sediment total organic carbon/grain size phi, vv=van Veen grab, x(2)=two vv replicates.

Cruise	Station Number	Station Name	Date (UTC)	Latitude °N (CTD)	Longitude °W (CTD)	Station Depth (m)	O-18	Chl H20	Nuts	Sed Chl	Sed TOC/phi	VV grab
AMU14	1040	BarC1-Basic	9/10/14	71 14.820	157 09.900	47	x	-	x	x	x	x (2)
AMU14	1041	BarC3-Basic	9/10/14	71 19.800	157 19.920	91	x	-	x	x	x	x (2)
AMU14	1042	BarC5-Basic	9/10/14	71 24.601	157 29.246	125	x	x	x	x	x	x (4)
AMU14	1043	BarC7-Basic	9/11/14	71 29.784	157 40.154	82	x	x	x	x	x	x (2)
AMU14	1044	BarC9-Basic	9/11/14	71 34.680	157 50.432	65	x	x	x	x	x	x (2)
AMU14	1036	Nutrient	9/12/14	71 43.567	155 24.767	174	x	-	ULaval			
AMU14	1038	Basic	9/12/14	71 39.379	155 45.329	165	x	x	ULaval	x	x	x (2)
AMU14	1034	Full	9/13/14	71 54.590	154 57.869	446	x	x	ULaval	x	x	x (2)
AMU14	1032	Nutrient	9/14/14	72 3.302	154 37.31	1311	x	x	ULaval			
AMU14	1030	Basic	9/14/14	72 12.452	153 57.413	2068	x	x	ULaval	x	x	nd
AMU14	NORPAC 4	Nutrient	9/16/14	75 12.370	169 49.531	302	x	x	ULaval			
AMU14	1085	Basic	9/16/14	75 3.694	167 8.484	242	x	x	ULaval	x	x	x (2)
AMU14	NORPAC 5	Nutrient	9/17/14	75 4.264	164 22.026	593	x	x	ULaval			
AMU14	1100	Full	9/18/14	75 4.141	161 15.889	1983	x	x	ULaval			
AMU14	1105	Nutrient	9/19/14	74 47.45	157 34.078	1281	x	x	ULaval			
AMU14	1107	Basic	9/19/14	74 37.342	155 59.16	3847	x	x	ULaval			
AMU14	1110	Nutrient	9/20/14	74 19.853	148 17.255	3799	x	x	ULaval			
AMU14	1115	Basic	9/21/14	73 56.693	147 23.764	3172	x	x	ULaval			
AMU14	1125	Nutrient	9/21/14	73 0.254	144 41.004	3550	x	x	ULaval			
AMU14	435	Basic-mod	9/23/14	71 4.688	133 38.119	289	x	x	ULaval			x (2)

26.3 Preliminary results

Most of the samples will be processed after the cruise. However, the water column chlorophyll (chl) *a* data was determined and is presented in Table 26.2. Overall, the highest chorophyll *a* standing stock was at the center of Barrow Canyon on the Chukchi outer continental shelf. Lower integrated Chl *a* was observed on the Chukchi Slope and over the Chukchi Borderland region, with the lowest levels observed in shallow water overlying the deep Canada Basin.

Table 26.2. Water column chlorophyll (chl *a*) and integrated chl *a* data collected during the cruise. Note that the station location, date and coordinates are given in Table 26.1.

Station Name ArcticNet	Depth (m)	Bottle Chlorophyll Reading (mg/m^3)	Integrated Chl-a (mg/m2)
1042	50	10.6	88.83
1042	40	24.2	
1042	36	54.1	
1042	30	32.6	
1042	20	66.4	
1042	10	53.5	
1042	0	53.6	
1043	50	9.33	55.81
1043	40	20.5	
1043	30	58.9	
1043	26	52.8	
1043	20	28.4	
1043	10	16	
1043	0	16	
1044	50	3.67	28.10
1044	40	4.07	
1044	30	6.31	
1044	20	31.5	
1044	17	29.2	
1044	10	17	
1044	0	17	
1038	50	8.9	49.21
1038	40	9.71	
1038	30	12.3	
1038	22	13.4	
1038	20	24.4	
1038	10	50.97	
1038	0	50.97	
1034	50	7.25	39.53
1034	40	17.8	
1034	30	29.1	
1034	26	22.9	
1034	20	22.1	
1034	10	18.6	
1034	0	18.6	
1032	50	9.25	31.15
1032	40	6.52	
1032	30	7.49	
1032	20	21.5	
1032	10	30.8	
1032	0	30.8	
1030	50	8.85	57.01
1030	40	17	
1030	30	35	
1030	20	49.2	
1030	10	24.6	
1030	0	24.6	
NORPAC4	50	17.7	20.89
NORPAC4	40	19.2	
NORPAC4	34	11.6	
NORPAC4	30	9.53	
NORPAC4	20	7.98	
NORPAC4	10	5.05	
NORPAC4	0	5.05	
1085	50	20.6	23.84
1085	40	22.7	
1085	30	5.53	
1085	20	9.35	
1085	10	7.81	
1085	0	7.81	
NORPAC5	50	8.68	18.13
NORPAC5	45	12.2	
NORPAC5	40	9.49	
NORPAC5	30	8.51	
NORPAC5	20	8.34	
NORPAC5	10	8.72	
NORPAC5	0	8.72	
1100	70	4.97	18.40
1100	60	11.1	
1100	50	9.1	
1100	40	5.57	
1100	30	3.7	
1100	20	5.03	
1100	10	6.01	
1100	0	6.01	
1105	70	7.74	12.568
1105	60	8.08	
1105	50	5.48	
1105	40	2.6	
1105	30	2.73	
1105	20	2.54	
1105	10	4.08	
1105	0	4.08	
1107	75	4.8	8.53
1107	70	5.72	
1107	60	3.77	
1107	40	2.23	
1107	30	2.45	
1107	20	1.92	
1107	10	1.64	
1107	0	1.64	
1110	75	4.8	8.66
1110	65	5.72	
1110	60	3.77	
1110	40	2.23	
1110	30	2.45	
1110	20	1.92	
1110	10	1.69	
	0	1.69	
1115	70	3.37	9.90
1115	60	3.63	
1115	50	3.6	
1115	40	2.9	
1115	30	2.54	
1115	20	3.43	
1115	10	4.65	
1115	0	4.65	
1125	70	3.52	11.12
1125	55	5.22	
1125	50	3.39	
1125	40	2.06	
1125	30	1.6	
1125	20	3.4	
1125	10	6.9	
1125	0	6.9	
1130	100	1.81	14.90
1130	90	3.7	
1130	70	5.22	
1130	50	3.06	
1130	30	2.8	
1130	10	4.33	
1130	0	4.33	
435	60	4.78	12.02
435	50	4.3	
435	40	3.96	
435	30	3.78	
435	20	5.82	
435	10	6.53	
435	0	6.53	

26.4 Comments and recommendations

We are grateful for the invitation by Dr. Louis Fortier to participate in the Leg 2b ArcticNet effort in the Pacific Arctic region. Our laboratory space was adequate and our sampling efforts went as planned. We also thank Catherine Lalande for assistance during the cruise and for post-cruise cargo storage and shipment logistics.

27 ROV coral and sponge dives in Eastern Baffin Bay – Leg 1a

ArcticNet Phase 3 – The Canadian Arctic Seabed: Navigation and Resource Mapping.
http://www.arcticnet.ulaval.ca/pdf/phase3/seabed-mapping.pdf

Project leader: Evan Edinger[1] (eedinger@mun.ca)
Cruise participants Leg 1: Evan Edinger[1] and Bárbara de Moura Neves[1]
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27.1 Introduction

This report describes the surveys for corals and sponges in Baffin Bay realized in 15-16 July 2014 using the *Amundsen*'s Remotely Operated Vehicle (ROV).

The objectives of the dives were to:

- Identify hotspots of coral and sponge diversity and abundance;
- Measure and compare the size-frequency distribution of corals between the dive locations and to compare them with video data on corals observed off Grand Banks and Flemish Cap;
- Collect dead or subfossil corals if they were encountered.

27.2 Methodology

Four ROV dives were initially planned: Home Bay (1), Scott Inlet (2), and Pond Inlet (1) (Figure 27.1). Because of time and weather limitations, only two ROV dives were accomplished, one in Home Bay and one in Scott Inlet. The third planned dive, near Pond Inlet, was cancelled due to a combination of anticipated bad weather, challenging ice conditions, and scheduling.

The *Amundsen*'s ROV is a Super-Mohawk, upgraded with a high definition (HD) camera (1Cam Alpha, Sub C Imaging, 24.1 megapixels) and two lasers for size indication. The FH video recording mode (second best resolution) was used since using the best resolution would have reduced the camera storage capacity. This ROV does not have a container for keeping samples, so we used a SCUBA mesh bag instead (Figure 27.2). The mesh bag was held by one of the ROV arms, while the other arm was used to collect samples. A spare sampling bag was attached to the ROV cage in the first dive (Home Bay). At the bottom of each mesh bag metal weighs were added (~150 g each) with a hole in the center. These weights were attached to the bag by means of a tie-wrap (Figure 27.2).

A multibeam survey was realized near the Scott Inlet dive site, but it differed from the planned multibeam survey due to time limitations, and the new track could not be entirely completed.

A CTD and rosette casts were made before each dive, recording temperature, salinity, density, dissolved oxygen, sound velocity, and current speed using an ADCP on the rosette.

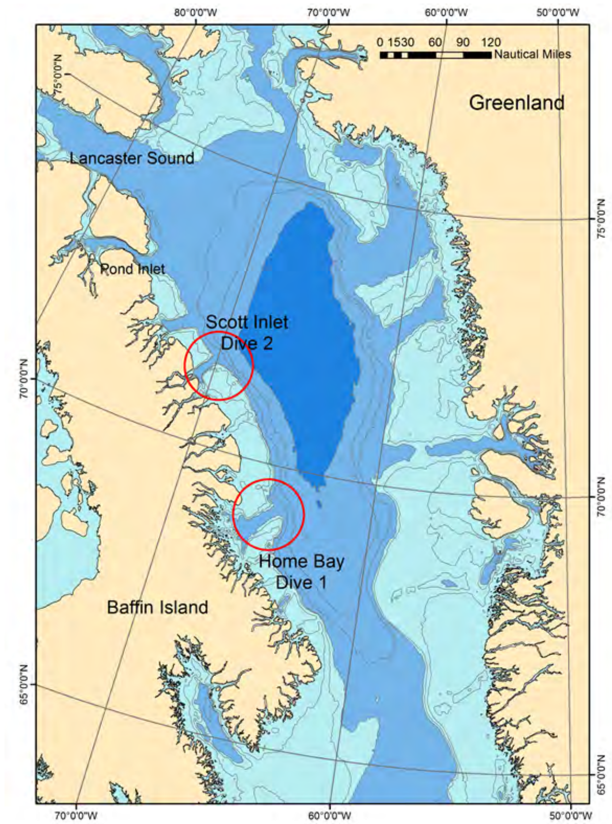

Figure 27.1. Study sites: Home Bay dive location and Scott Inlet dive location.

Figure 27.2. Sample bag used for sampling by the ROV. Weights were used to keep the bag straight in the water.

27.2.1 Dive 1 – Home Bay

The dive at Home Bay site took place 15 July. Weather conditions were good and despite the presence of ice at this location (Figure 27.3), the dive took place without complications. Water temperature at ~ 700 m was ~1.2 °C (Figure 27.4).

Figure 27.3. View of the Home Bay dive station at the day of dive.

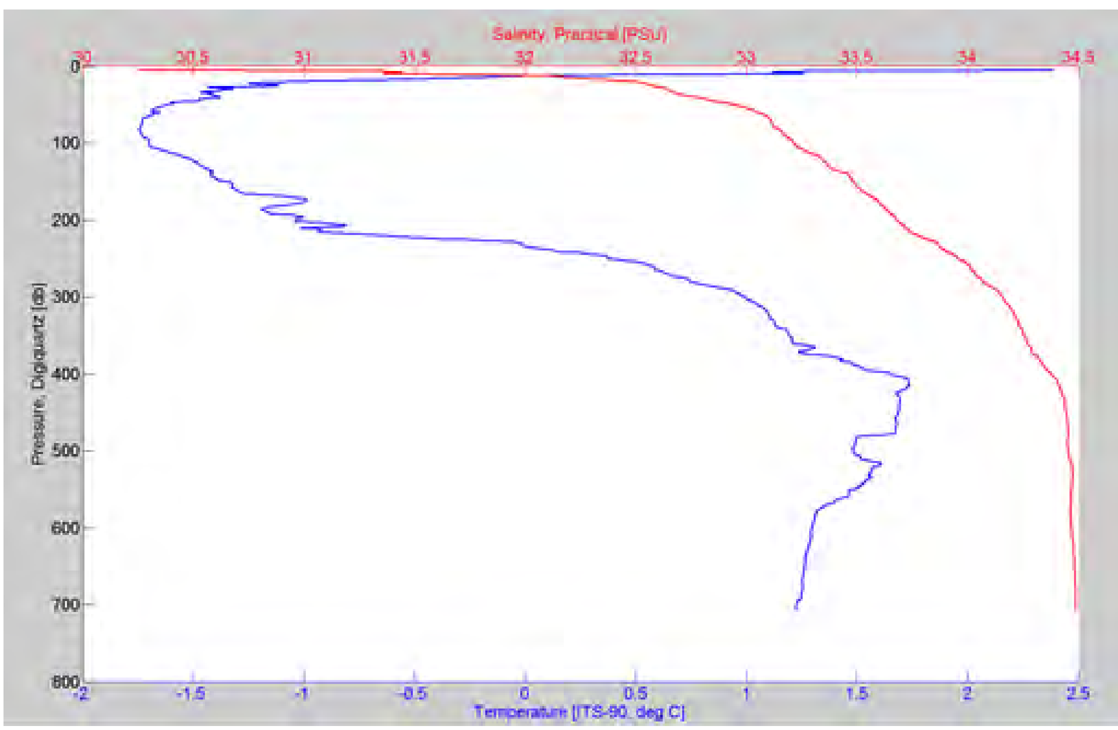

Figure 27.4. Temperature and salinity plots for the Home Bay dive site at the day of dive.

The dive followed a transect length of about 2.2 km (Figure 27.5), at 700-750 m water depth, and lasted about 9 hours. The accomplished transect showed in Figure 26.5 was mapped by plotting the ROV position for every ten minutes of dive, and it was not yet filtered to remove movements that are not part of the transect, such as looking for a lost bag, which explains some of the peculiar paths in the line. For this dive, two sampling bags were brought to the dive site. One of the bags was hold by the ROV arms, while the other bag was attached to the ROV cage.

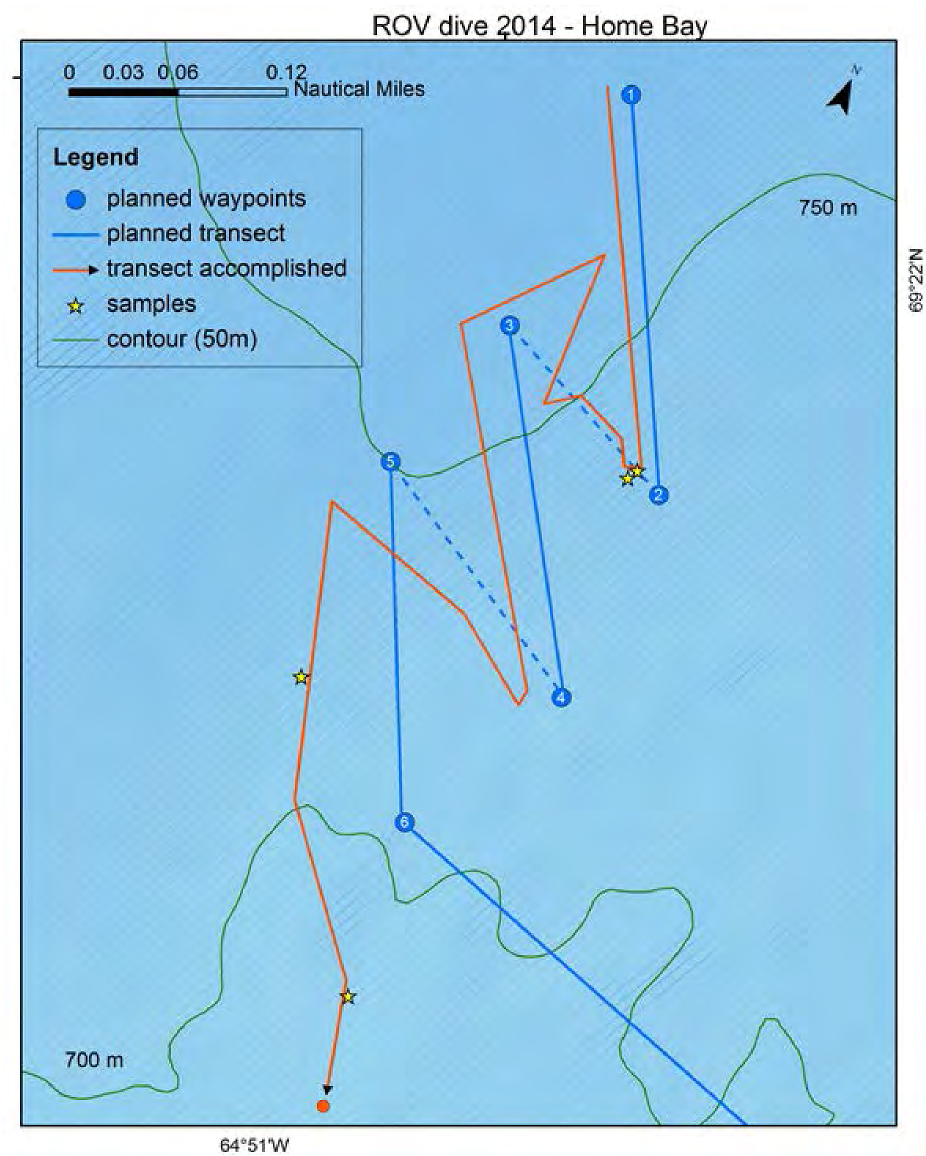

Figure 27.5. Map of Home Bay showing planned versus accomplished transects (with location determined every 10 minutes), and sampling sites. Orange dot represents the end of the dive.

27.2.2 Dive 2 – Scott Inlet

For this dive, only one bag was carried out by the ROV. This bag was shortened in length to avoid contact between the bag weights and the ROV propellers (See the Results section for Dive 1 below). Furthermore, in this dive, four weights were used instead of the three used in the first dive.

Weather conditions in Scott Inlet were good at the dive site, and there was no ice surrounding the target site (Figure 27.6). Temperature at ~600 m was ~1.2 °C (Figure 27.7).

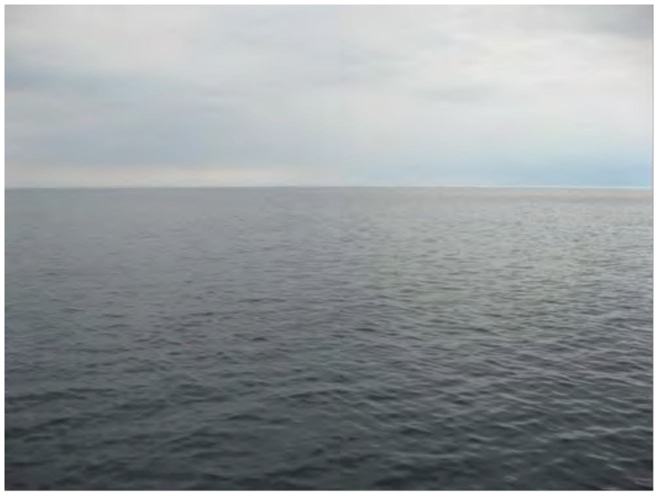

Figure 27.6. View of the Scott Inlet ROV dive site at the day of dive.

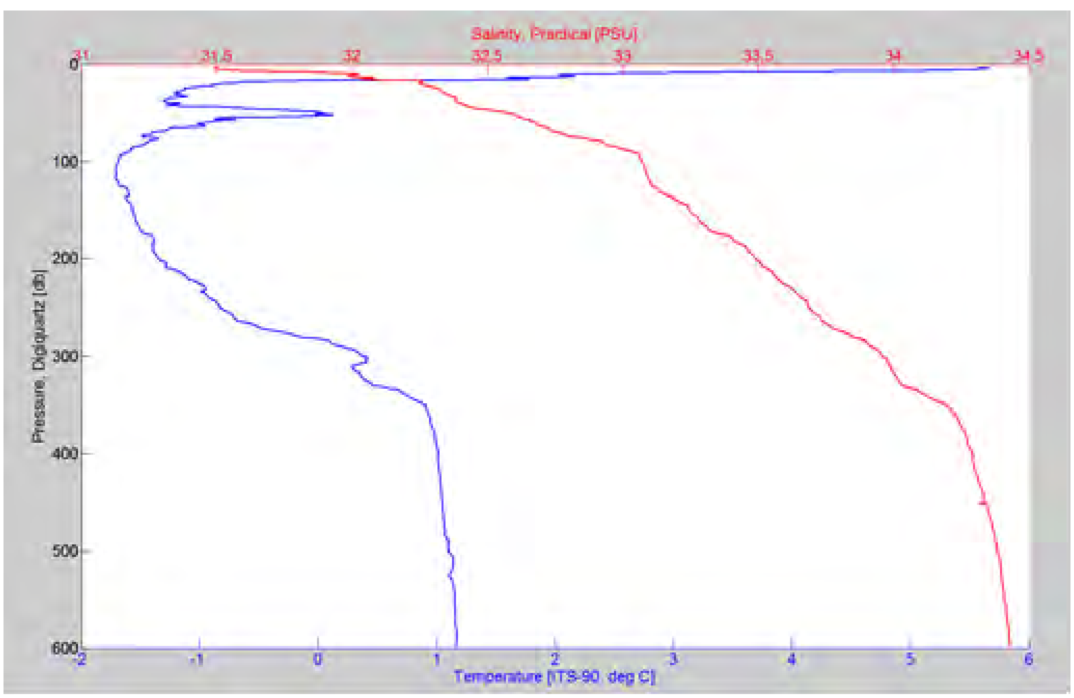

Figure 27.7. Temperature and salinity profiles for the Scott Inlet ROV dive site at the day of dive.

The Scott Inlet site was in 600-475 m water depth, and the dive at this location also lasted about 9 hours. It followed a transect 2.7 km long (Figure 27.8). Like for the dive in Home Bay, the accomplished transect showed in Figure 27.8 was mapped by plotting the ROV position for every ten minutes of dive, and it was also not yet filtered to remove movements that are not part of the transect.

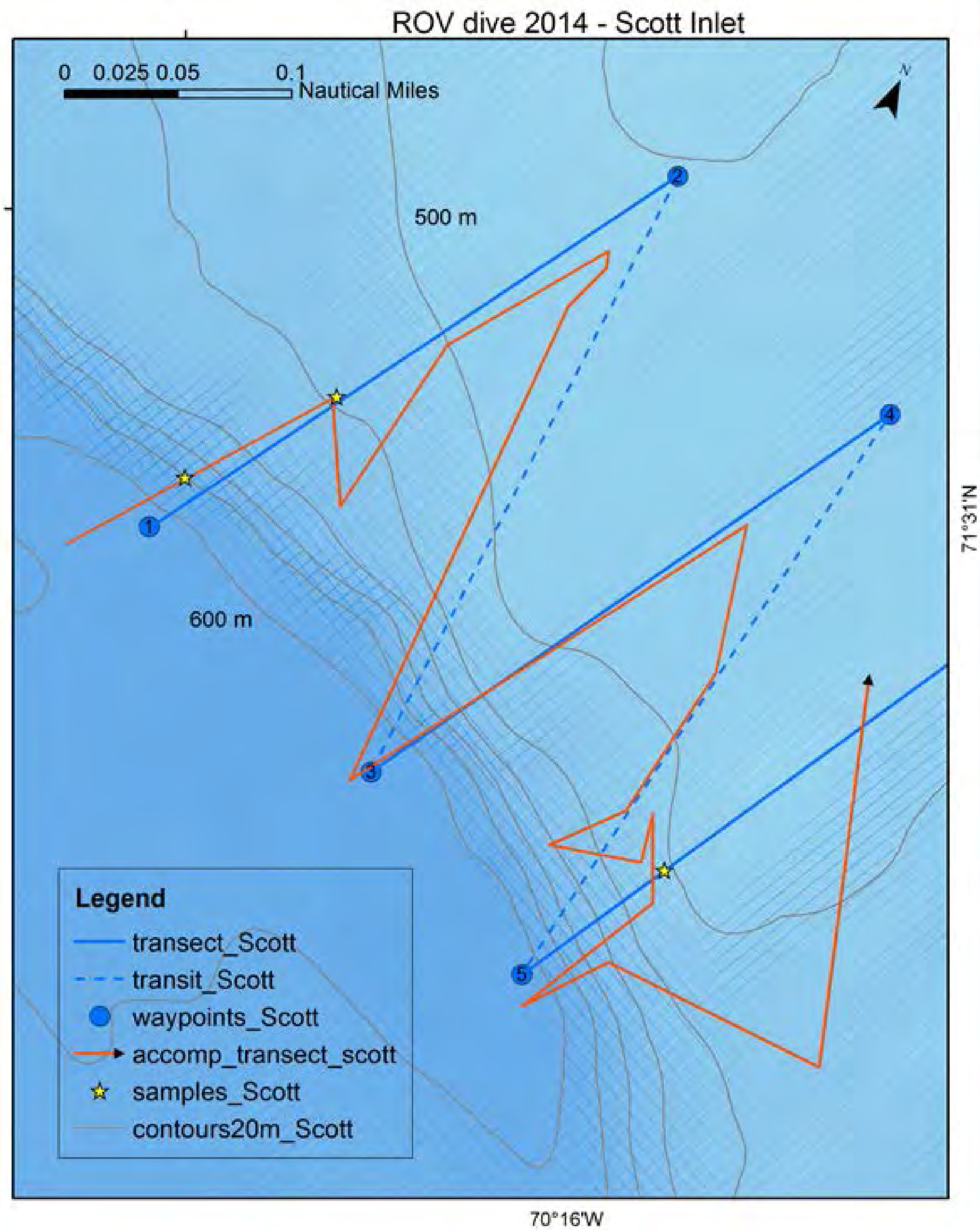

Figure 27.8. Map of the Scott Inlet ROV dive location showing planned versus accomplished transects (with location determined every 10 minutes), and sampling sites.

27.2.3 Procedures after the dives

All collected samples were photographed, tagged, put in a plastic bag and frozen at -20 °C. Subsamples from the two dives were given to Dr. Christian Nozais (Université du Québec à Rimouski – UQAR) for stable isotope analysis. These samples were also frozen at -20 °C. A fragment of the carnivorous white sponge (*Cladorhiza* sp.) was also fixed in ethanol 70%.

27.3 Preliminary results

27.3.1 Dive 1 – Home Bay

General geology. This site is a trough-mouth fan, with some geological similarities to the Disko Fan site visited during the *Amundsen* 2013 expedition, but with a lot more cobbles and boulders, and sandy mud in between (Figure 27.9). The dive plan covered from the center of a channel of one of the rill and gully features in the fan up past the highest slope areas, and eventually up the general slope onto the flatter areas between channels. The steepest slopes encountered here were about 30 degrees, but the steep areas were not always the rockiest.

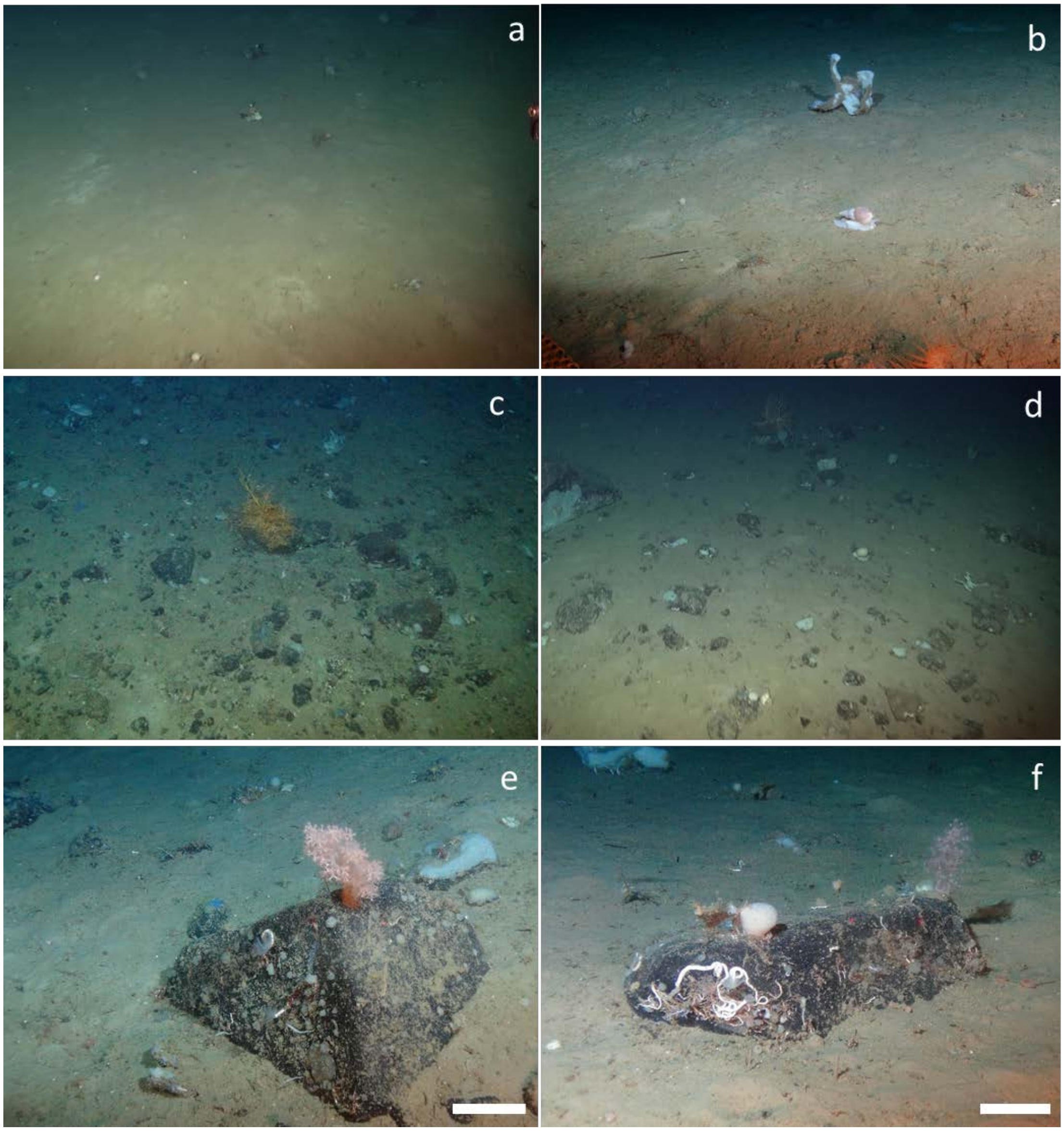

Figure 27.9. Bottom types observed in the Home Bay ROV dive site: a-b) muddy bottom, c-d) gravel, e-f) boulders. White bars = 10 cm.

Fauna. The extensive cobbles and boulders were covered by sponges (Figure 27.10a-c) and by very abundant *Gorgonocephalus* basket stars (Figure 27.10f), which were some of the most conspicuous organisms observed in this dive. One of the sponges observed growing on mud is a club shaped species of the carnivorous sponge *Chondrocladia* (Cladorhizidae family) (Figure 27.10d), which bears translucent inflated spheres (Van Soest et al. 2012). The stalked sponge *Stylocordila* sp. was also observed (Figure 27.10e).

Other common invertebrates include sea anemones, sea stars, and snails (Figure 27.10g-h). Among corals, only the sea pen *Umbellula* sp. (perhaps two different species) (Figure 27.10i) and soft corals (family Nephtheidae) (Figure 27.10j) were observed.

Among fish species, relatively few individuals were seen except for the Greenland Halibut *Reinhardtius hippoglossoides* (Figure 27.10a), which was common. Other fishes included rough-head grenadiers (family Macrouridae), skates (probably the Arctic Skate *Amblyraja hyperborea*), and the Silver Rockling *Gaidropsarus argentatus* (Figure 27.11a-c).

Sampling. Five samples of sponges/fragments were collected using the ROV arms. These were:

- Probably the papillate *Polymastia* sp. (Figure 27.12a-b);
- Unidentified elongated white sponge (Figure 27.12c-d);
- The carnivorous *Chondrocladia* sp. (Figure 27.12e-f);
- Fragments of two unidentified white sponges (Figure 27.12g-h).

Problems encountered. The bag attached to the ROV cage got entangled to the ROV cable and the dive was interrupted in order to solve this problem. The bag was removed from the cage and hold by one of the ROV arms with the other bag. This second bag was subsequently lost. At the end of this dive, it was seen that the weights in the bag were in contact with the ROV propellers; therefore bags should be heavier and shorter to avoid this contact.

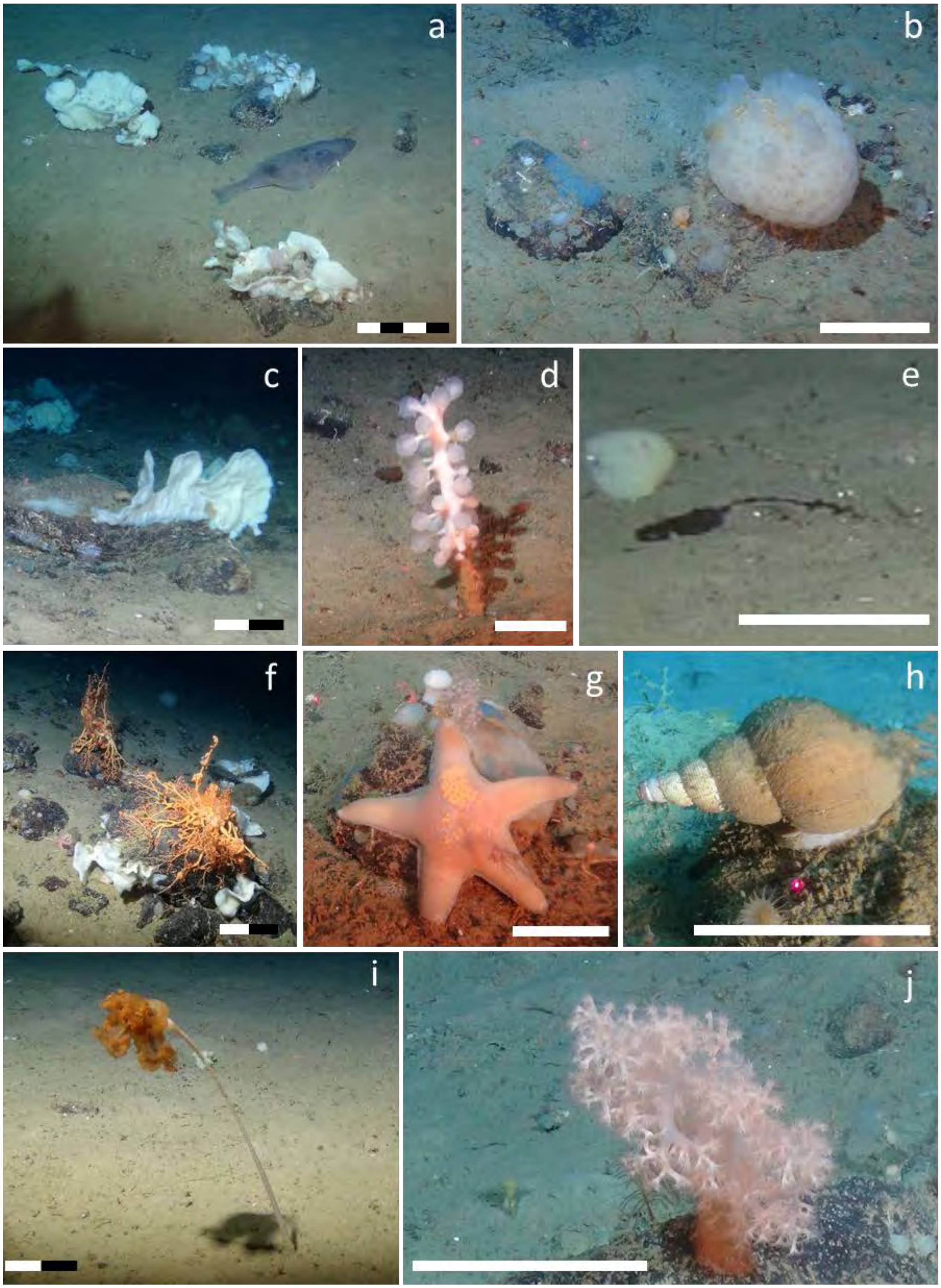

Figure 27.10. Fauna observed in the Home Bay ROV dive site: a) unidentified sponges and flatfish (probably Greenland Halibut), b) white sponge *Polymastia* sp., c) unidentified sponge, d) *Chondrocladia* sp., e) *Stylocordila* sp., f) *Gorgonocephalus* sp. and sponges, g) unidentified sea star, small soft coral and sea anemone, h) unidentified snail and small sea anemone, i) *Umbellula* sp., j) soft coral (Family Nephtheidae). Laser points are 10 cm apart. White bars = 10 cm.

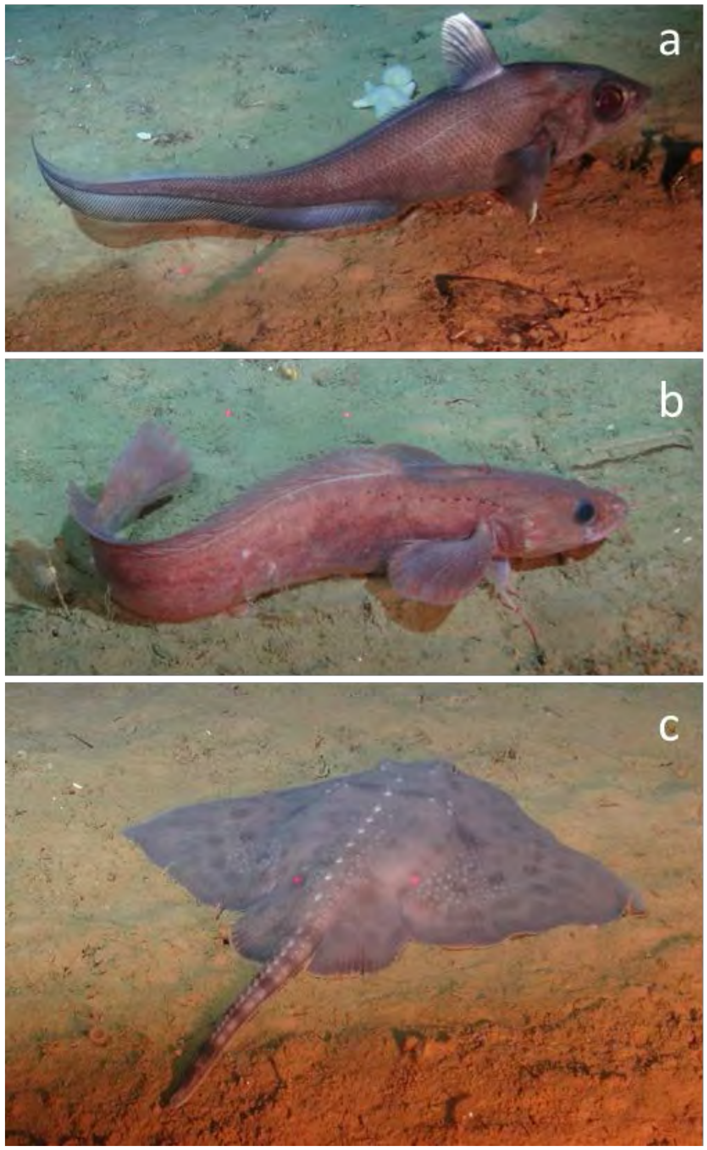

Figure 27.11. Fishes observed in the Home Bay ROV dive site: a) roughhead grenadier, b) the silver rockling *Gaidropsarus argentatus*, c) skate (probably the Arctic skate *Amblyraja hyperborea*).

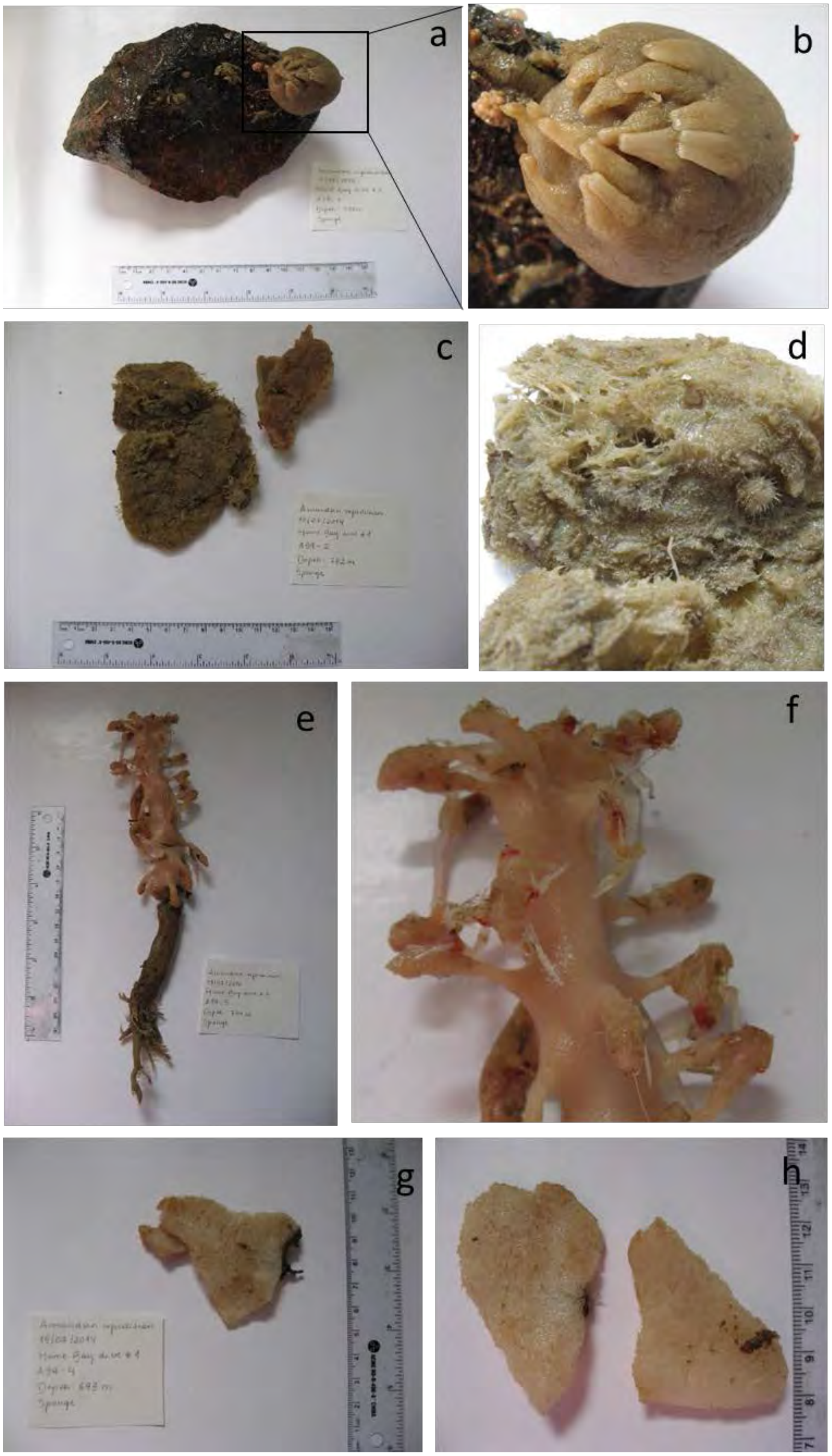

Figure 27.12. Sponges sampled at the Home Bay ROV dive site: a-b) *Polymastia* sp., c-d) fragments of unidentified sponge, e-f) *Chondrocladia* sp., g-h) fragments of two individual unidentified white sponges (h has two fragments of the same sponge). Ruler = 15 cm.

27.3.2 Dive 2 – Scott Inlet

General geology. Previously collected multibeam and sub-bottom profile data indicated that the bottom is composed of bedrock. This site goes over a large bedrock massif in the Scott Inlet Trough, but it is not part of a trough mouth fan. This is one of two large bedrock massifs identified in the Scott Trough (see Moir et al. 2012). The area has also been studied previously due to the natural hydrocarbon seeps there and apparent authigenic carbonates (calcareous cements formed in place), but it had never before been surveyed with a drop video camera or an ROV.

The dive started near the base of the cliff on the landward side of one of the bedrock massifs, along what may be a fault line. The rock was somewhat friable in many parts of the cliff, although fresh exposures were hard and solid to the touch of the ROV arm (Figure 27.13). On the top of the bedrock massif, a veneer of sand gravel, cobbles, and boulders covered the bedrock, which was occasionally (but rarely) visible through that veneer (Figure 27.13).

Fauna. Sponges were somewhat abundant on the cliff, including many tree-like white sponges, the carnivorous species *Cladorhiza* sp. (Cladorhizidae family) (confirmed by Dr. Henry Reiswig, University of Victoria, BC). This sponge can be easily mistaken for a coral due to its tree-like shape (Figure 27.14a), and it was only identified as a sponge when analyzed under the microscope (see Figure 27.16). These sponges, which were seen as quite small individuals on the vertical cliff face, were much larger on the large boulders above the cliff, with some individuals nearly 1 m high (Figure 27.14b). Samples were sent to Dr. Reiswig in an attempt to identify the sponge at the species level. The carnivorous club sponge *Chondrocladia* sp. seen in Home Bay (dive 1) was also seen in Scott Inlet rooted in the soft sediment (Figure 27.14c). On the other hand, *Cladorhiza* was only seen in the Scott Inlet location, which is known to be influenced by the presence of hydrocarbon seeps. This might be related to the fact that certain carnivorous sponges are often associated to chemosynthetic communities (Vacelet 2007). If this is the reason why *Cladorhiza* sp. is found in Scott Inlet but not in Home Bay, it remains to be investigated.

The most abundant fauna at this site were sea anemones, including the Venus flytrap anemone (*Actinoscyphia aurelia*) (Figure 27.14d), abundant small anemones that were only well visible when zooming in the camera (Figure 27.14e), and probably *Actinauge* sp. No *Desmophyllum*, nor any *Desmophyllum* graveyards were observed. Among corals, only soft corals (family Nephtheidae) (Figure 27.14f) and the sea pen *Umbellula* sp. were observed (up to about 50-60 cm tall) (Figure 27.14g). Unstalked crinoids were also seen in this dive (probably *Poliometra prolixa*) (Figure 27.14h). Unidentified tube-dwelling anemones (order Ceriantharia) were also seen. Differently from the Home Bay dive area, no basket stars (*Gorgonocephalus* sp.) were seen in Scott Inlet. Fishes included Greenland Halibut also observed in Home Bay, the spotted wolffish (*Anarhichas minor*) (Figure 27.15a), and redfish (probably *Sebastes* sp.) seen hiding in the eroded crevices of the rock face (Figure 27.15b). Ctenophores and jellyfishes were commonly seen in the water column.

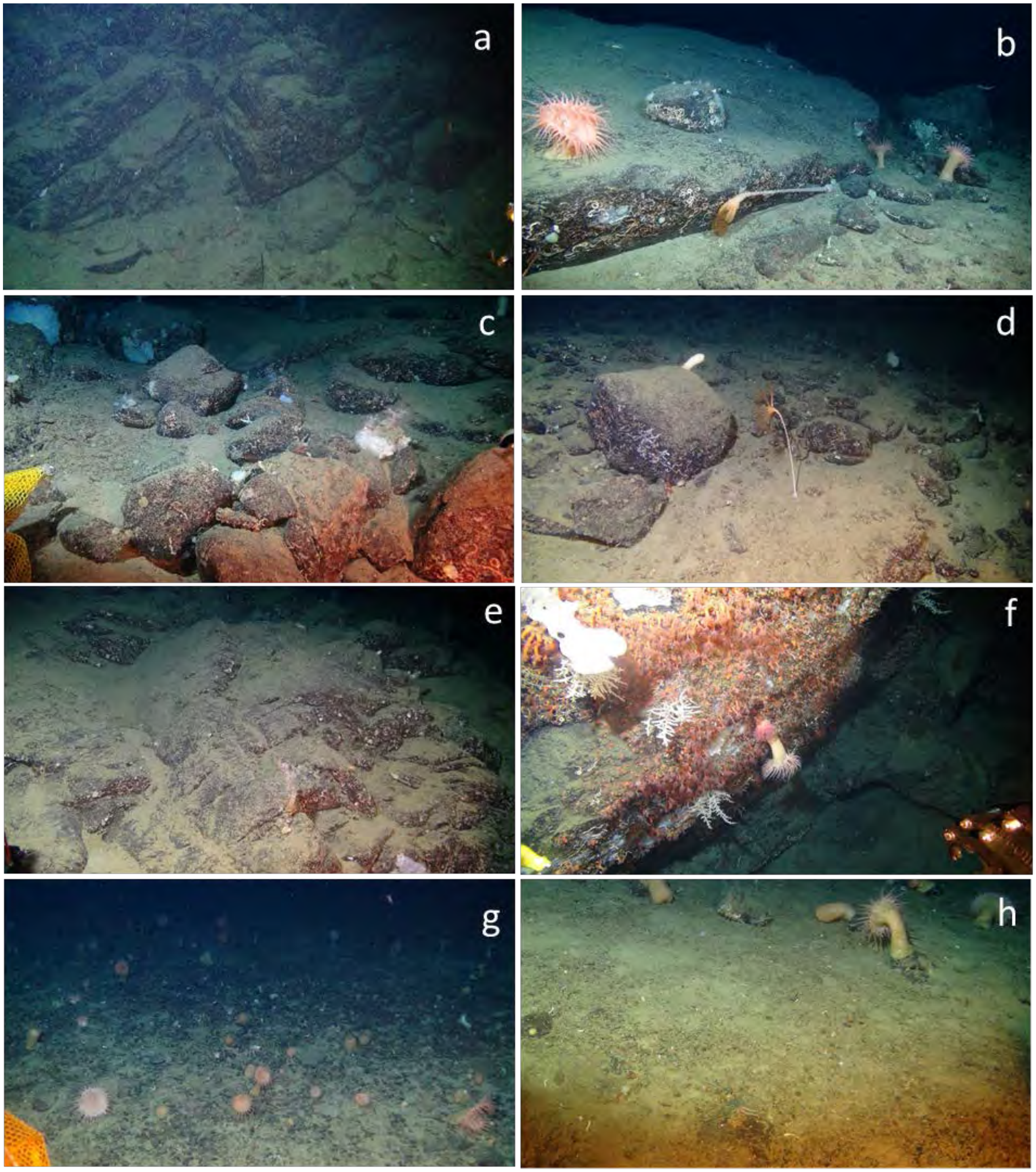

Figure 27.13. The rocky environment of the Scott Inlet ROV dive site.

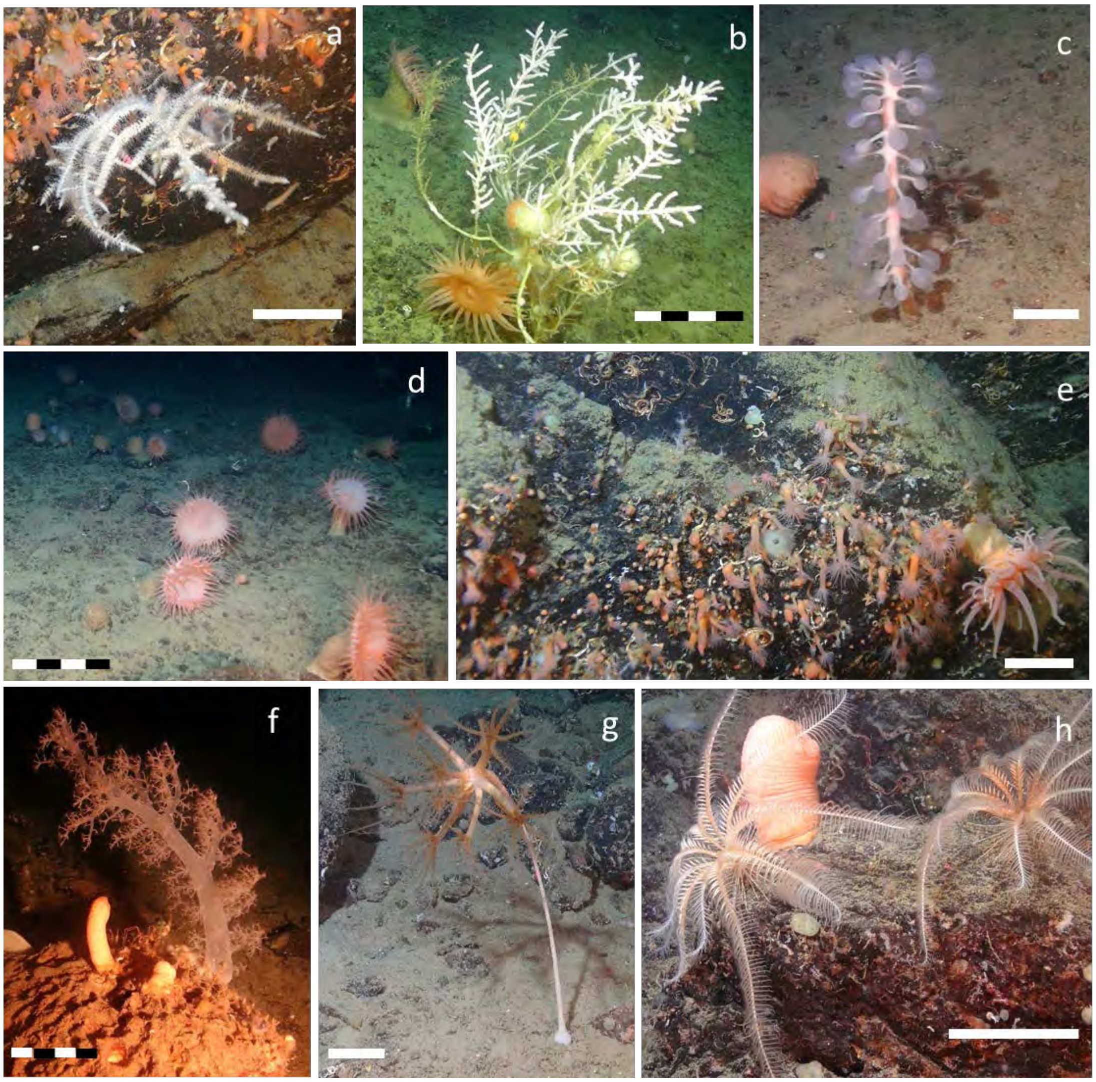

Figure 27.14. Invertebrates observed in the Scott Inlet ROV dive site: a-b) the carnivorous sponge *Cladorhiza* sp., c) the carnivorous sponge *Chondrocladia* sp., d) concentration of sea anemones *Actinoscyphia aurelia*, e) small sea anemones on the bedrock wall, f) soft coral (family Nephtheidae), g) sea pen *Umbellula* sp., h) crinoids (probably *Poliometra prolixa*) and anemone. White bars = 10 cm.

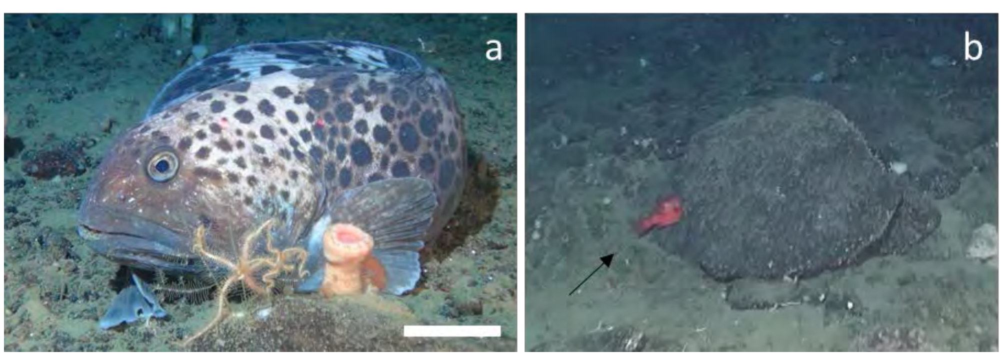

Figure 27.15. Fish observed in the Scott Inlet ROV dive site: a) spotted wolfish (*Anarhichas minor*), b) redfish hiding behind boulder (arrow). White bar = 10 cm.

Notes. Oil was seen by the ship crew, which could or not be related to the cold seeps known to occur at this site. During the Scott Inlet dive, the bridge noted an oil slick on the surface of the water. The bridge was informed that there were natural hydrocarbon seeps in the area, and that they might be quite close to the dive site, given the possible fault near the site, but the ROV was checked for leaks just in case. The ROV pilots confirmed during and after the ROV that the ROV had not leaked oil.

Sampling. We sampled three of the white carnivorous sponges (*Cladorhiza* sp.), although we only recovered fragments (Figure 26.16), due to problems with the sample bag. Some of the samples got lost while the ROV was moving. Figure 26.16 also shows the spicules from *Cladorhiza* sp.

Figure 27.16. Fragments of the carnivorous sponge *Cladorhiza* sp. collected in the Scott Inlet ROV dive site (a-e) and spicules from the same sponge (f-g). Ruler = 15 cm.

Problems encountered. During this dive there were problems related to the navigation system between the ROV and the ship. Also, the ROV umbilical got entangled around a boulder while we were sampling, which combined with the problem with the navigation led to a large amount of time lost during the dive.

27.4 Comments and recommendations

27.4.1 Difficulties encountered and suggestions of improvement

Problems related to each individual dive were already detailed in the previous sections. In general, the use of the dive bag, although essential for sample collection, was very time consuming and several issues related to the bag led to delays and waste of dive time. The design of a more appropriate container in the ROV is one of the logical future steps in order to use the *Amundsen* ROV to its maximum capacity as a scientific ROV.

The presence of a CTD and an ADCP in the ROV would also be very valuable, by providing access to more localized data across transect.

There were also issues with the positioning system during the dives, and some sort of positioning system quality check would be appropriate. Furthermore, the navigation software (WorkBoat) was not very efficient for post-dive analyses. At the moment, the extraction of positioning data from WorkBoat is done manually, and a simpler and more efficient way of exporting this data would be better.

27.4.2 Conclusions and future directions

The two surveyed areas showed an abundant and rich epifauna. But despite the availability of substrate, no gorgonians, scleractinians, or black corals were observed. Only soft corals and the sea pen *Umbellula* sp. were observed in both dive sites. This finding actually corresponds to the information available from DFO and fisheries observer data on the types of corals previously caught in the Baffin Bay region.

The first objective of identifying hotspots of coral and sponge diversity and abundance, was successful. The second objective on the size-frequency distribution of corals can still be attained, although it will be limited to soft corals and *Umbellula* sp. Sponges can also be included in the size-frequency distribution study, particularly the carnivorous ones. The feasibility of such study is yet to be evaluated. The third objective of sampling subfossil corals was not attained, since these were not found.

Sponges were abundant and seemed diverse, with at least two types of carnivorous sponges readily identified to the family level. It will be important to start identifying the sponges recovered in trawls to species – the hidden diversity of sponges may be much greater than the hidden diversity of corals, partly due to our lack of taxonomic knowledge. Furthermore, the sponges seen during our surveys might represent the northernmost record for certain species.

References

Moir PN, Oakey GN, Bennett R, Dickie K, Williams G, Budkewitsch P, Decker V, Fowler MG, Obermajer M, Haggart JW. 2012. Natural oil seeps on the Baffin Shelf, Nunavut, Canada: Geology and Geochemistry of the Scott Inlet Seep. Geological Survey of Canada, Scientific Presentation 12, 2012; 1 sheet, doi:10.4095/291575.

Vacelet, J. (2007) Diversity and evolution of deep-sea carnivorous sponges. Porifera research: biodiversity, innovation and sustainability. Série Livros, 28, 107–115.

Van Soest RWM, Boury-Esnault N, Vacelet J, Dohrmann M, Erpenbeck D, et al. (2012) Global Diversity of Sponges (Porifera). PLoS ONE 7(4).

28 Sediment sampling and nano- and microplankton sampling – Leg 1b

ArcticNet Phase 3 – Marine Biological Hotspots: Ecosystem Services and Susceptibility to Climate Change. http://www.arcticnet.ulaval.ca/pdf/phase3/marine-ecosystem-services.pdf
ArcticNet Phase 3 – The Canadian Arctic Seabed: Navigation and Resource Mapping. http://www.arcticnet.ulaval.ca/pdf/phase3/seabed-mapping.pdf

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Cruise participants Leg 1b: Guillaume Massé[1], André Rochon[2], Kaarina Weckstrom[3], Audrey Limoges[4] and Jade Falardeau[4]

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28.1 Introduction

The objectives of the coring program during Leg 1b were to collect Holocene sediment sequences to document the evolution of paleoproductivity along an ice margin, in prevision of the Green Edge Program that will start in 2015. Diatoms, dinoflagellate cysts and coccoliths will be used to characterize paleoproductivity and to document the penetration of Atlantic water masses in northern Baffin Bay and Nares Strait during the Holocene. Nanoplankton samples will be used to document the modern penetration of Atlantic water masses in the study area. Microplankton samples will also be used to document the modern distribution of dinoflagellates throughout the Canadian high Arctic as part of a sampling effort that started in 2004.

28.2 Methodology

The selection of coring sites for Leg 1b was based on 3.5 KHz sub-bottom profiles collected during the ArcticNet 2013 campaign, and coordinates provided by Green Edge collaborator Antoon Kujper (Geological Survey of Denmark), which were based on 3.5 KHz profiles collected during a Polarstern expedition in 2011. A total of 4 sites were selected based on sediment thickness and characteristics observed on the profiles. It was the second time that sediment sampling using the CASQ (Calypso square) corer was done onboard the CCGS *Amundsen* following the successful attempts in 2009 during the MALINA sampling campaign. The CASQ corer was then deployed using two 3 m-long sections, for a total of 6 meters in length.

In 2014, a three sections 9 m-long coring was attempted. The deployment of the 9 m-long corer was first tested with success during the sea trials in the St. Lawrence Estuary in June 2014 prior to departure. Following this, it was decided to use a 3 section corer at two of the four selected coring sites (Table 28.1) during Leg 1b where sediment thickness was important enough, notably at Stations 204 in northern Baffin Bay, and 124 in the northern sector of the North Water (NOW) polynya, both along the Greenland margin. Unfortunately, due to bad weather, Station 124 could not be reached and there were not enough sediment at Station 200. However, an additional station was cored in Kennedy Channel (Station KANE2b). Each CASQ core was accompanied by a boxcore. Prior to coring a 2-hr survey took place to select the most appropriate coring site.

Table 28.1. Box, CASQ nanoplankton (coccoliths) and microplankton (dinoflagellates) sampling stations. More details on coring sampling can be found below.

Station	Latitude (N)	Longitude (W)	Water depth (m)	Sampling device	Length
200	73°16.893	063°38.063	1448	Boxcore	48 cm
	73°16.690	063°38.180	1460	Plankton net	0-50 m
204	73°15.646	057°53.264	995	Boxcore	46 cm
	73°15.663	057°53.987	987	CASQ	734 cm
	73°15.738	057°53.748	986	Plankton net	0-50 m
210	75°24.574	061°39.695	1152	Boxcore	45 cm
	75°24.317	061°39.357	1155	CASQ	596 cm
115	76°18.863	071°06.748	655	Boxcore	38 cm
	76°20.046	071°12.962	675	Plankton net	0-50 m
108	76°16.224	074°35.642	444	Plankton net	0-50
101	76°21.284	077°32.574	365	Boxcore	47cm
	76°22.717	077°23.671	361	Plankton net	0-50 m
KEN 1	81°21.959	064°11.710	496	Plankton net	0-50 m
KEN 3	80°47.864	067°19.100	404	Plankton net	0-50 m
KANE 1	79°59.343	069°45.895	295	Plankton net	0-50 m
KANE 2b	79°31.140	070°53.287	217	Boxcore	39.5 cm
	79°30.908	070°49.742	220	CASQ	425 cm
KANE 3	79°21.734	071°51.728	221	Plankton net	0-50 m
KANE 5	79°00.378	073°12.360	244	Plankton net	0-50 m
120	77°19.416	075°41.567	561	Plankton net	0-50 m
335	74°25.594	098°48.649	126	Plankton net	0-50 m
309	72°57.243	096°09.664	339	Plankton net	0-50 m
	72°58.494	096°02.536	335	Boxcore	Surface
310	71°17.723	097°41.465	136	Plankton net	0-50
312	69°10.405	100°41.075	65	Plankton net	0-25
	69°10.269	100°41.636	66	Boxcore	Surface
314	68°58.059	105°28.179	76	Plankton net	0-50

In each boxcore, 2 large push cores (20 cm diameters) and 2 small ones (10 cm diameter) were collected, in addition to surface samples for diatoms, coccoliths, dinoflagellates and dinoflagellate cysts. For the CASQ cores, 4 large U-channel (10 cm wide) and 2 small U-Channels (2 cm wide) were collected at different levels inside the core and along the entire length of the core. Shells, when present, were collected and placed in Whirl-pack bags for ^{14}C dating.

For coccoliths, between 3 and 12 litres of water where collected from the Rosette at different depths to document the presence of Atlantic water masses in the study area. The water was filtered on polycarbonate membranes, which were then dried and kept at room temperature prior to microscopy analysis (Table 28.2).

Table 28.2. Detailed information the samples collected for the Coccolith advection survey.

Station ID	Latitude (N)	Longitude (W)	Depth (m)	Cast	Depth /btl	Depth /btl	Depth /btl	Depth /btl	Depth /btl	Depth /btl
200	73°17.4138	063°36.515	1470	23	0 /81	10 /79	50/29	150 /12L	400/12L	
204	73°15.666	057°53.165	987	24	0 /81	11 /79	27/29	75 /7.5L	400/7.5L	
206	74°04.363	059°02.663	184	26	0 /81	10 /79	DCM /29	75 /7.5L	150/7.5L	
210	75°24.323	061°39.316	1154	28	0 /81	10 /79	DCM /29	75 /7.5L	150/7.5L	
115	76°19.257	071°09.968	657	32	0 /81	10 /79	DCM /29	56 /28	320/82,29	Fond /7,3
108	76°16.052	074°35.952	448	42	0 /7	10 /3	DCM /2	Tmin /28,29,11	Tmax /79,80,81	Fond /82,84
101	76°22.246	077°24.660	383	52	0 /7		DCM /2	Tmin /28,29,11	Tmax /79,80,81	Fond /82,84
KEN1	81°21.604	063°57.361	530	53		10 /3	DCM /2	Tmin /28,29,11	Tmax /79,80,81	
KANE1	79°59.584	069°46.636	239	59	0 /7	10 /3	DCM /2	Tmin /28,29,11	Tmax /79,80,81	Fond /82,84
KANE3	79°20.767	071°51.469	215	62	0 /7		DCM /2	Tmin /28,29,11	Tmax /79,80,81	
KANE4	79°00.292	070°30.648	356	64	0 /7	10 /3	DCM /2	Tmin /28,29,11	Tmax /79,80,81	Fond /82,84
KANE5	79°00.092	073°12.274	250	73	0 /7		DCM /2	Tmin /28,29,11	Tmax /79,80,81	
120	77°19.553	075°42.248	558	75	0 /7	10 /3	DCM /2	Tmin /28,29,11	Tmax /79,80,81	

Plankton samples were collected in the upper 50 m of the water column using a 25 cm diameter and 75 cm-long, 20µm plankton net. A vertical tow was realized at Basic and Full stations (Table 28.1). The ~50 mL plankton samples were kept in amber glass bottles and fixed with 2 mL buffered formaldehyde.

28.2.1 Description of core samples

Station 200
Date: 27-07-2014
Deployment time: 18:23
Coordinates deployment: 73°16.893’ N, 63°38.063’W
Depth: 1448 m
Time bottom: 18:45

Coordinates bottom: 73°16.907’N, 63°38.007’W
Time on deck: 19:09

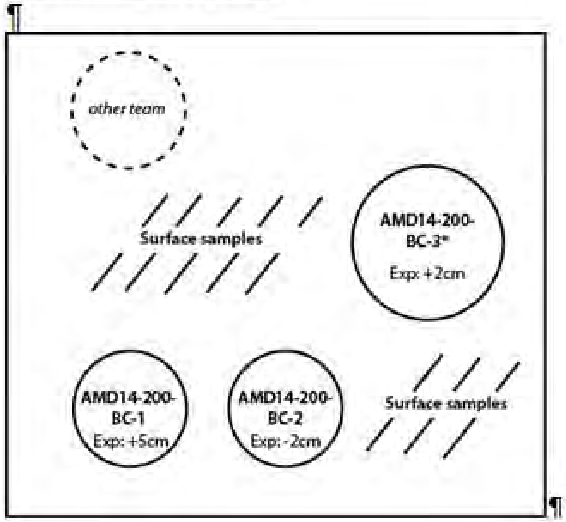
Type: BOX CORE
Apparent penetration: ~0.4 m
Number surface samples: 4 (Dinoflagellates, Dinocysts, DNA, Diatoms)
Number push cores: 3

# samples	Expansion	Length	Diameter
AMD14-200-BC-1	+ ~5 cm	48 cm	9 cm
AMD14-200-BC-2	+ ~5 cm	42 cm	9 cm
AMD14-200-BC-3[a]	+ ~2 cm	31 cm	15 cm

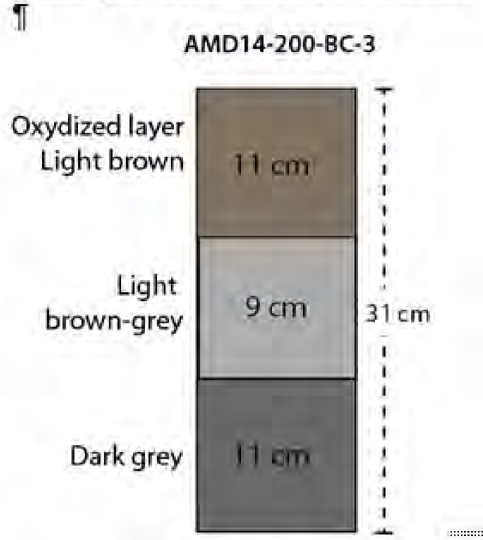
[a] Pushcore subsampled onboard

Comments Subsampling:
0-31 cm → 31 samples/ type of analysis (Dating, Diatoms, Dinocysts, Foraminifera, Biomarkers)
Foraminifera: “Rose Bengual” added to samples from 0 to 10 cm

Position in box core



Description core AMD14-200-BC-3:



Station: 204
Date: 28-07-2014
Deployment time: 18:50
Coordinates deployment: 73°15.682' N, 57°53.138'W
Depth: 986 m

Time bottom: 19:10
Coordinates bottom: 73°15.663'N, 57°53.165'W
Depth: 987 m
Time side ship: 19:38
Time on deck: 20:09

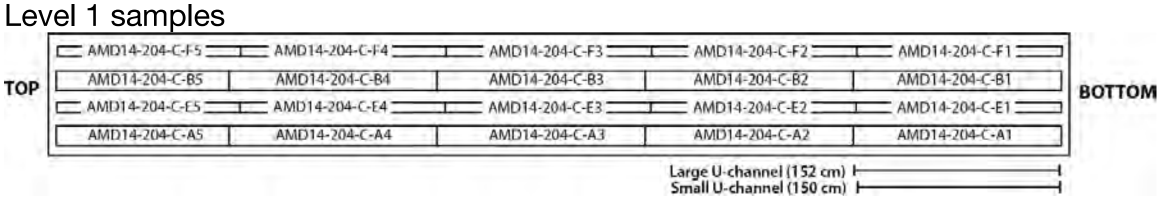
Type: **CASQ**
Apparent penetration: 8 m
Total length archive: **7.34 m**

Comments:
The surface sediment in contact with the corer's lid was removed (first 2 cm) before u-channel sampling to avoid contamination by older and/or recent sediments.
Number U-channels: 40 (20 large; 20 small) → 8 series
2 levels, 5 sections

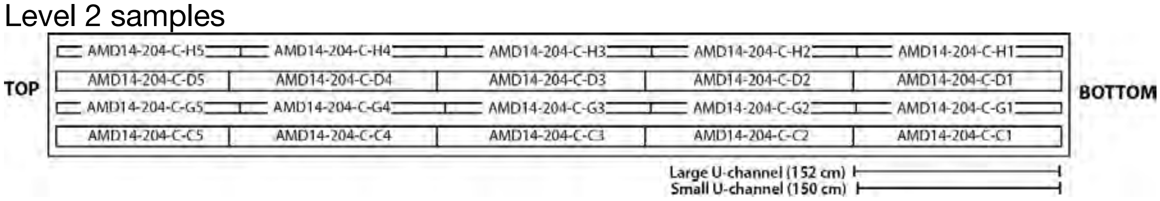
Level 1 # samples	Length	Type
AMD14-204-C-A1	152 cm	Large
AMD14-204-C-A2	152 cm	Large
AMD14-204-C-A3	152 cm	Large
AMD14-204-C-A4	152 cm	Large
AMD14-204-C-A5	126 cm	Large
AMD14-204-C-B1	152 cm	Large
AMD14-204-C-B2	152 cm	Large
AMD14-204-C-B3	152 cm	Large
AMD14-204-C-B4	152 cm	Large
AMD14-204-C-B5	126 cm	Large
AMD14-204-C-E1	150 cm	Small
AMD14-204-C-E2	150 cm	Small
AMD14-204-C-E3	150 cm	Small
AMD14-204-C-E4	150 cm	Small
AMD14-204-C-E5	134 cm	Small
AMD14-204-C-F1	150 cm	Small
AMD14-204-C-F2	150 cm	Small
AMD14-204-C-F3	150 cm	Small
AMD14-204-C-F4	150 cm	Small
AMD14-204-C-F5	134 cm	Small
Level 2 # samples	**Length**	**Type**
AMD14-204-C-C1	152 cm	Large
AMD14-204-C-C2	152 cm	Large
AMD14-204-C-	152 cm	Large

C3		
AMD14-204-C-C4	152 cm	Large
AMD14-204-C-C5	126 cm	Large
AMD14-204-C-D1	152 cm	Large
AMD14-204-C-D2	152 cm	Large
AMD14-204-C-D3	152 cm	Large
AMD14-204-C-D4	152 cm	Large
AMD14-204-C-D5	126 cm	Large
AMD14-204-C-G1	150 cm	Small
AMD14-204-C-G2	150 cm	Small
AMD14-204-C-G3	150 cm	Small
AMD14-204-C-G4	150 cm	Small
AMD14-204-C-G5	134 cm	Small
AMD14-204-C-H1	150 cm	Small
AMD14-204-C-H2	150 cm	Small
AMD14-204-C-H3	150 cm	Small
AMD14-204-C-H4	150 cm	Small
AMD14-204-C-H5	134 cm	Small

Level 1 samples



Level 2 samples



Station: 204
Date: 28-07-2014
Deployment time: 17:01
Coordinates deployment: 73°15.644’ N, 57°53.213’W
Depth: 995 m

Time bottom: 17:15
Coordinates bottom: 73°15.666’N, 57°53.264’W
Time on deck: 17:35

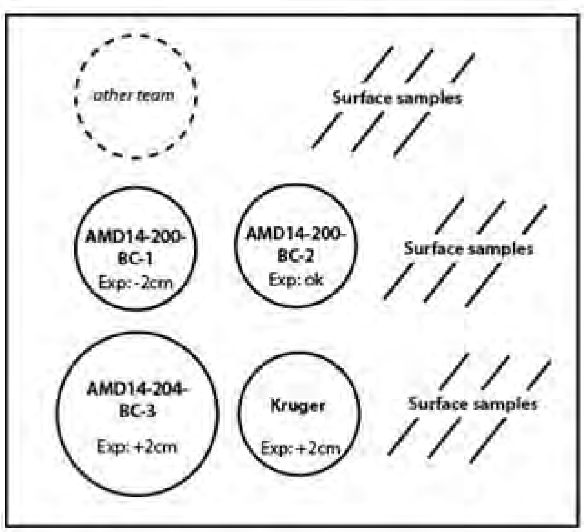
Type: **BOX CORE**
Apparent penetration: ~0.4 m
Number surface samples: 4→ Dinoflagellates, Dinocysts, DNA, Diatoms
Number push cores: 4

# samples :	Expansion:	Length :	Diameter :
Kruger	+ ~2 cm		9 cm
AMD14-204-BC-1	+ ~1.5 cm	56 cm	9 cm
AMD14-204-BC-2	ok	55 cm	9 cm
AMD14-204-BC-3[a]	+ ~2 cm	31 cm	15 cm

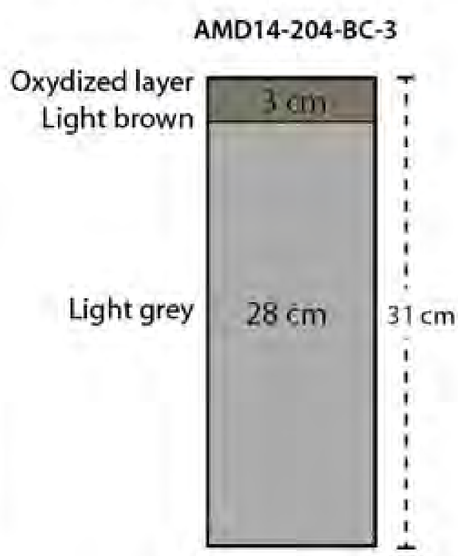
[a] Pushcore subsampled onboard

Comments Subsampling:
0-31 cm → 31 samples/ type of analysis (Dating, Diatoms, Dinocysts, Foraminifera, Biomarkers)
Foraminifera: “Rose Bengual” added to samples from 0 to 10 cm

Position in box core



Description core AMD14-204-BC-3:



Station: 210
Date: 29-07-2014
Deployment time: 18:52
Coordinates deployment: 75°24.317'N, 61°39.357'W
Depth deployment: 1155 m

Time bottom: 19:10
Coordinates bottom: 75°24.323'N, 61°39.316'W
Depth: 1154 m
Time side ship: 19:39

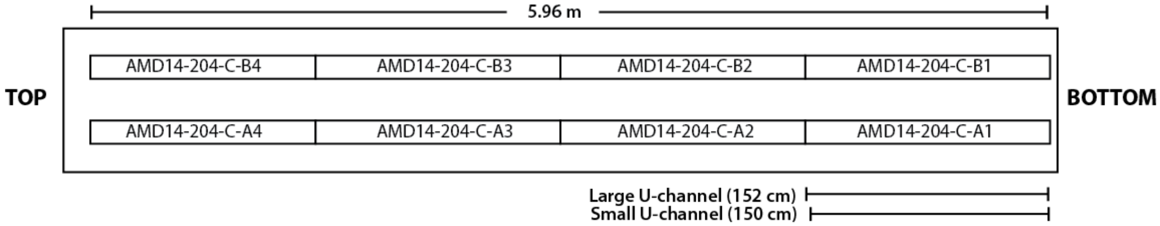
Type: **CASQ**
Apparent penetration: 6 m
Total length archive: **5.96 m**

Comments:
The sediment in contact with the corer's lid was removed (first 2 cm) before u-channel sampling to avoid contamination by older and/or recent sediments.
Whole sequence "laminated-like"; possibly turbidite events (?)
C4 TOP → disturbed

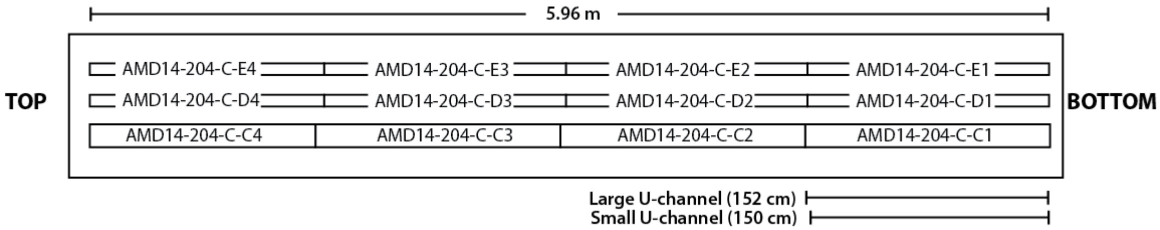
Number U-channels: 40 (20 large; 20 small) → 8 series
2 levels, 5 sections

Level 1 # samples	**Length**	**Typ**
AMD14-204-C-A1	152 cm	Large
AMD14-204-C-A2	152 cm	Large
AMD14-204-C-A3	152 cm	Large
AMD14-204-C-A4	140 cm	Large
AMD14-204-C-B1	152 cm	Large
AMD14-204-C-B2	152 cm	Large
AMD14-204-C-B3	152 cm	Large
AMD14-204-C-B4	140 cm	Large
Level 2 # samples	**Length**	**Type**
AMD14-204-C-C1	152 cm	Large
AMD14-204-C-C2	152 cm	Large
AMD14-204-C-C3	152 cm	Large
AMD14-204-C-C4	140 cm	Large
AMD14-204-C-D1	150 cm	Small
AMD14-204-C-D2	150 cm	Small
AMD14-204-C-D3	150cm	Small
AMD14-204-C-D4	146 cm	Small
AMD14-204-C-E1	150 cm	Small
AMD14-204-C-E2	150 cm	Small
AMD14-204-C-E3	150 cm	Small
AMD14-204-C-E4	146 cm	Small

Level 1



Level 2



Station: 210
Date: 29-07-2014
Deployment time: 22:35
Coordinates deployment: 75°24.464'N, 61°39.374'W
Depth deployment: 1162 m

Time on bottom: 22:53
Coordinates bottom: 75°24.574'N, 61°39.695'W
Depth on bottom: 1152 m
Time on deck: 23:14

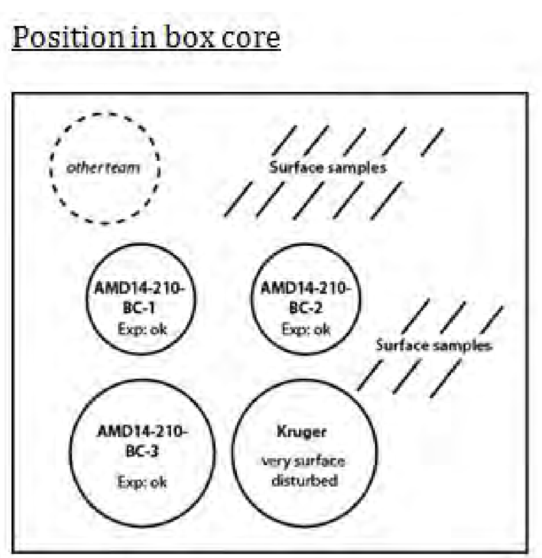
Type: **BOX CORE**
Apparent penetration: ~0.4 m

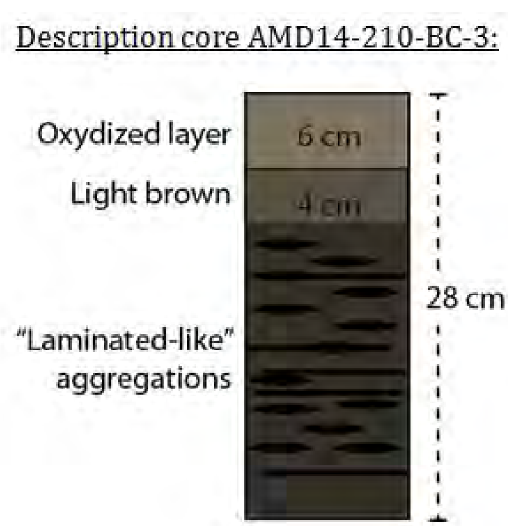
Number surface samples: 4→ Dinoflagellates, Dinocysts, DNA, Diatoms
Number push cores: 4

# samples :	Expansion:	Length :	Diameter :
Kruger	ok	28 cm	15 cm
AMD14-204-BC-1	ok	45,5 cm	9 cm
AMD14-204-BC-2	ok	45 cm	9 cm
AMD14-204-BC-3[a]	ok	29 cm	15 cm

[a] Pushcore subsampled onboard

Comments Subsampling:
0-29 cm →29 samples/ type of analysis (Dating, Diatoms, Dinocysts, Foraminifera, Biomarkers)
Foraminifera: "Rose Bengual" added to samples from 0 to 10 cm





Station: 115
Date: 30-07-2014
Deployment time: 00:14
Coordinates deployment: 76°18.863'N, 71°06.748'W
Depth deployment: 655 m

Time on bottom: 00:24
Coordinates bottom: 76°18.891'N, 71°06.687'W
Depth on bottom: 657 m
Time on deck: 00:33

Type: **BOX CORE**
Apparent penetration: ~0.4 m

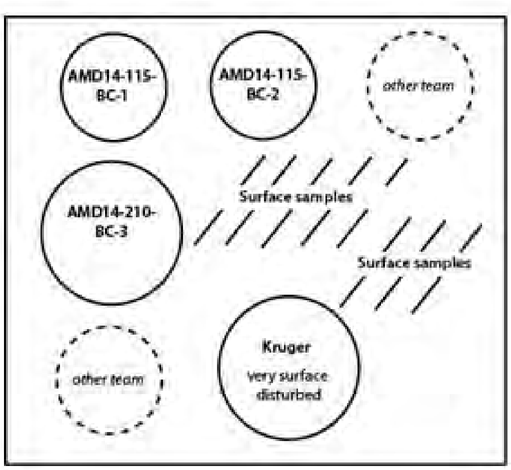
Number surface samples: 4→ Dinoflagellates, Dinocysts, DNA, Diatoms
Number push cores: 4

# samples :	Expansion:	Length :	Diameter :
Kruger	ok	28 cm	15 cm
AMD14-115-BC-1	ok	37,5 cm	9 cm
AMD14-115-BC-2	ok	38 cm	9 cm
AMD14-115-BC-3[a]	ok	32 cm	15 cm

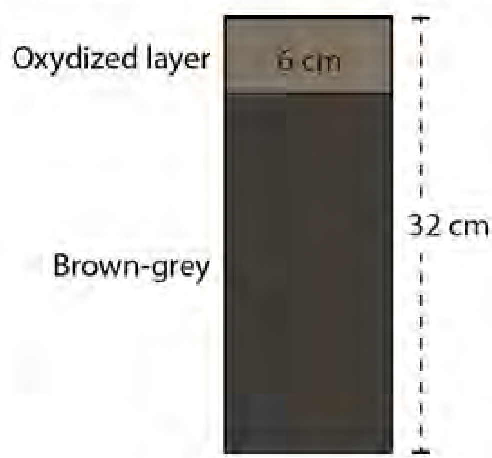
[a] Pushcore subsampled onboard

Comments Subsampling:
0-32 cm →32 samples/ type of analysis
(Dating, Diatoms, Dinocysts, Foraminifera, Biomarkers)
Foraminifera: "Rose Bengual" added to samples from 0 to 10 cm

Position in box core



Description core AMD14-115-BC-3:



Station: 101
Date: 01-08-2014
Deployment time: 00:28
Coordinates deployment: 76°21.284'N, 77°32.574'W
Depth deployment: 365 m

Time on bottom: 00:34
Coordinates bottom: 76°21.307'N, 77°32.673'W
Depth on bottom: 365 m
Time on deck: 00: 40

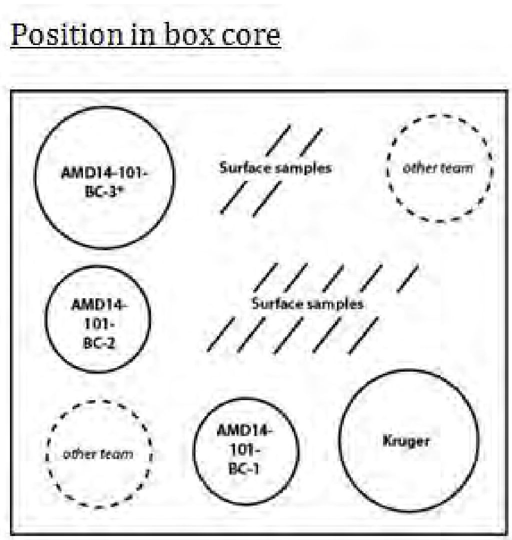
Type: **BOX CORE**
Apparent penetration: ~0.4 m

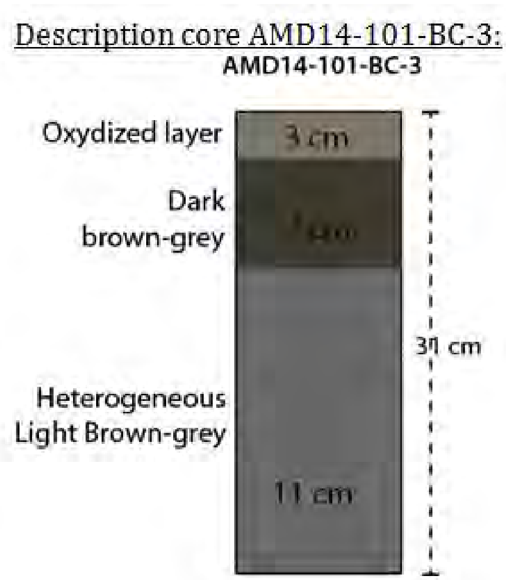
Number surface samples: 4→ Dinoflagellates, Dinocysts, DNA, Diatoms
Number push cores: 4

# samples	Expansion	Length	Diameter
Kruger	ok	28 cm	15 cm
AMD14-115-BC-1	ok	47 cm	9 cm
AMD14-115-BC-2	ok	45 cm	9 cm
AMD14-115-BC-3[a]	ok	31 cm	15 cm

[a] Push core subsampled onboard

Comments Subsampling:
0-31 cm →31 samples/ type of analysis (Dating, Diatoms, Dinoflagellates, Foraminifera, Biomarkers)
Foraminifera: "Rose Bengual" added to samples from 0 to 10 cm





Station: Kane 2B
Date: 04-08-2014
Deployment time: 20:29
Coordinates deployment: 79°30.908’N, 70°49.742’W
Depth deployment: 218 m

Time bottom: 20:35
Coordinates bottom: 79°30.903’N, 70°49.810’W
Depth: 220 m
Time side ship: 20:45

Type: **CASQ**
Apparent penetration: 5 m
Total length archive: **4.25 m**

Comments:
The sediment in contact with the corer’s lid was removed (first 2 cm) before u-channel sampling to avoid contamination by older and/or recent sediments.
Presence of shells and rocks on the removed surface.

Shells (cm from top):
Surface level 1
- 59 cm
- 62 cm
- 123 cm
- 139 cm
- 152 cm
- 186 cm

Rocks (cm from top):
Surface level 1
- [304-307]
- [315-317]
- [318-321]
- [384-389]
- [402-204]
- [406-408]

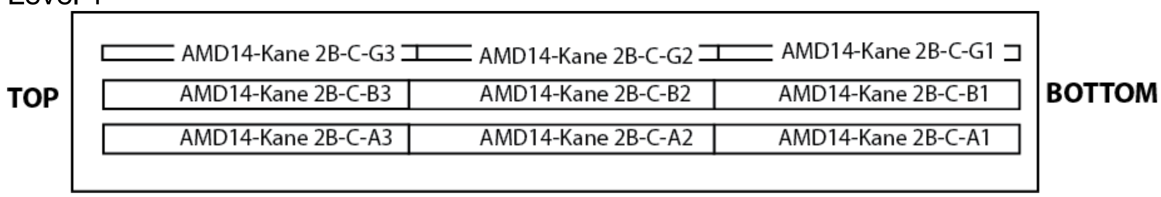
Rocks (cm from top):
Surface level 2:
- 229
- [230-239]
- 265
- 272
- 303
- [378-401]
- 397-406
- [399-404]

Number U-channels: 24 (18 large; 6 small) → 8 series
3 levels, 3 sections

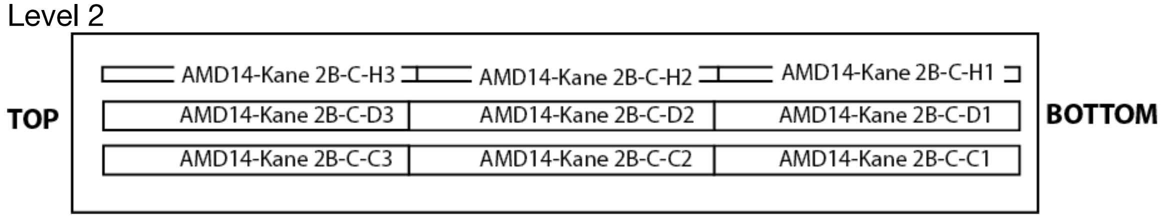
Level 1 # samples	**Length**	**Type**
AMD14-Kane 2B-C-A1	152 cm	Large
AMD14-Kane 2B-C-A2	152 cm	Large
AMD14-Kane 2B-C-A3	121 cm	Large
AMD14-Kane 2B-C-B1	152 cm	Large
AMD14-Kane 2B-C-B2	152 cm	Large
AMD14-Kane 2B-C-B3	121 cm	Large
AMD14-Kane 2B-C-G1	150 cm	Small
AMD14-Kane 2B-C-G2	150 cm	Small
AMD14-Kane 2B-C-G3	125 cm	Small
Level 2 # samples	**Length**	**Type**
AMD14-Kane 2B-C-C1	152 cm	Large
AMD14-Kane 2B-C-C2	152 cm	Large
AMD14-Kane 2B-C-C3	121 cm	Large
AMD14-Kane 2B-C-D1	152 cm	Large

AMD14-Kane 2B-C-D2	152 cm	Large
AMD14-Kane 2B-C-D3	121 cm	Large
AMD14-Kane 2B-C-G1	150 cm	Small
AMD14-Kane 2B-C-G2	150 cm	Small
AMD14-Kane 2B-C-G3	125 cm	Small
Level 3 # samples	Length	Type
AMD14-Kane 2B-C-E1	152 cm	Large
AMD14-Kane 2B-C-E2	152 cm	Large
AMD14-Kane 2B-C-E3	121 cm	Large
AMD14-Kane 2B-C-F1	152 cm	Large
AMD14-Kane 2B-C-F2	152 cm	Large
AMD14-Kane 2B-C-F3	121 cm	Large

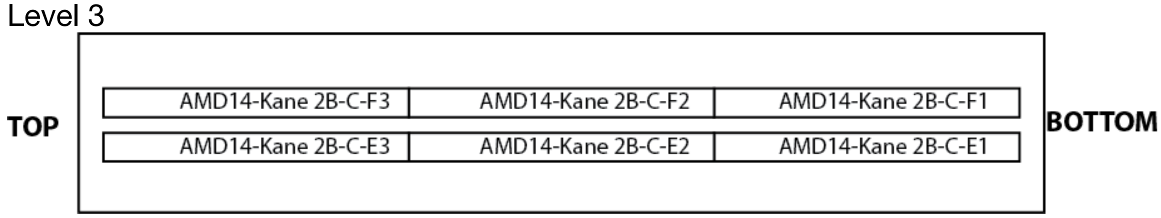
Level 1



Level 2



Level 3



Station: Kane 2B
Date: 01-08-2014
Deployment time: 23:13
Coordinates deployment: 79°31.113'N; 70°53.163'W
Depth deployment: 218 m

Time on bottom: 23:19
Coordinates bottom: 79°31.140'N; 70°53.287'W
Depth on bottom: 217 m
Time on deck: 23:25

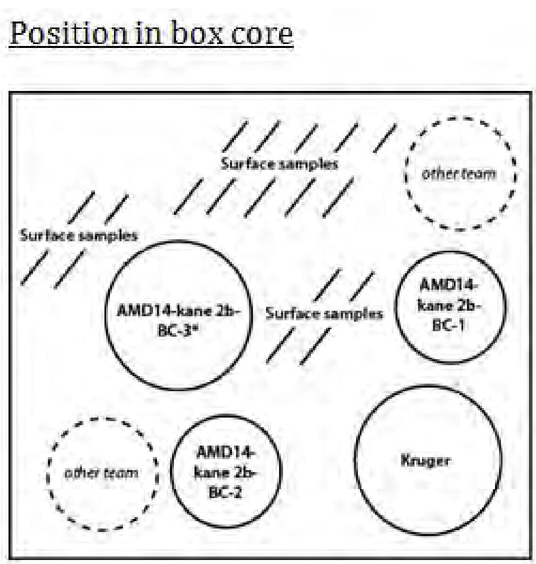
Type: **BOX CORE**
Apparent penetration: ~0.4 m

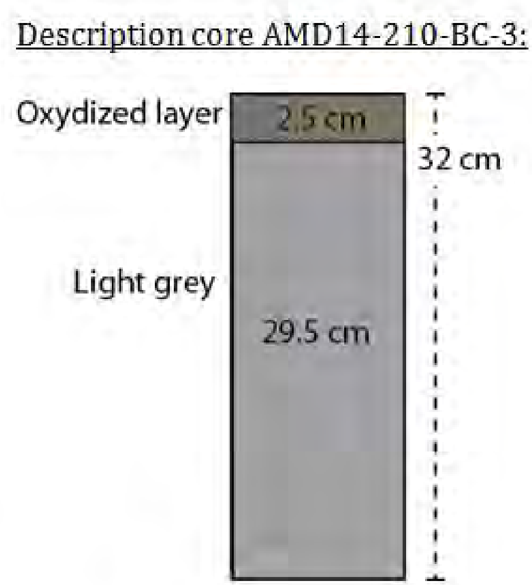
Number surface samples: 4→ Dinoflagellates, Dinocysts, DNA, Diatoms
Number push cores: 4

# samples :	Expansion:	Length :	Diameter :
Kruger	ok	28 cm	15 cm
AMD14-115-BC-1	ok	36.5 cm	9 cm
AMD14-115-BC-2	ok	39.5 cm	9 cm
AMD14-115-BC-3[a]	ok	32 cm	15 cm

[a] Pushcore subsampled onboard

Comments Subsampling:
0-32 cm →32 samples/ type of analysis
(Dating, Diatoms, Dinoflagellates, Foraminifera, Biomarkers)
Foraminifera: "Rose Bengual" added to samples from 0 to 10 cm





29 Geology and paleoceanography – Leg 2a

ArcticNet Phase 3 – The Canadian Arctic Seabed: Navigation and Resource Mapping
http://www.arcticnet.ulaval.ca/pdf/phase3/seabed-mapping.pdf

Project leader: Jean-Carlos Montero-Serrano[1] (jeancarlos_monteroserrano@uqar.ca)
Cruise participants Leg 2a: Charles-Édouard Deschamps[1] and Matthieu Jaegle[1]
[1] Institut des sciences de la mer (ISMER) – Université du Québec à Rimouski (UQAR), 310 Allée des Ursulines, Rimouski, QC, G5L 3A1, Canada.

29.1 Introduction

The objectives of the coring program during Leg 2a of the ArcticNet sampling campaign were to collect Holocene sediment sequences to (1) reconstruct changes in sediment provenance and transport related to climate variability (2) document Holocene change in both deep-water mass provenance and rate of deep-Arctic circulation (3) provide new insights on the potential linkages between Atlantic advection, Pacific water into Arctic and sea ice variability (4) document the natural multi-decadal climate oscillation and their relationships with the observed changes in the North Atlantic thermohaline circulation (5) document Holocene centennial to millennial changes in Earth's magnetic field intensity and direction and (6) establish a Holocene high-resolution magnetostratigraphy for the Western Arctic Ocean.

29.2 Methodology

The selection of coring sites for Leg 2a was based on 3.5 KHz sub-bottom profiles collected during the Healey 2013 campaign, and coordinates provided by GSC (Geological Society of Canada) collaborator Edward King (GSC). A total of 5 sites were selected (Table 29.1) based on sediment thickness and characteristics observed on the profiles and deeper or equal than 1 000 meters along the continental shelf.

Table 29.1 Initially planned UQAR sites.

Piston Corer Operations		
Station ID	**Latitude (N)**	**Longitude (N)**
AMD0214-01	72°59.621	129°41.153
AMD0214-02	71°33.918	133°39.291
AMD0214-03	71°17.028	134°30.244
AMD0214-04	71°25.798	148°28.613
AMD0214-05	71°41.466	151°21.641
Box Corer operations		
Station ID	**Latitude (N)**	**Longitude (N)**
AMD2014-01	72°59.621	129°41.153
AMD2014-02	71°33.918	133°39.291
AMD2014-03	71°17.028	134°30.244

Station ID	Latitude (N)	Longitude (N)
AMD2014-04	71°25.798	148°28.613
AMD0214-05	71°41.466	151°21.641
Niskin sample		
Station ID	**Latitude (N)**	**Longitude (N)**
AMD0214-01	72°59.621	129°41.153
AMD0214-05	71°41.466	151°21.641

In order to recover sediment, piston core and box core were used. Piston core samples were cut in 1.5 m sections and stored into a cold room. For each box core, 3 push cores and surface sediment were collected and stored in cold room. In addition, water samples were collected at different depths corresponding to the Pacific water, Atlantic water and Arctic intermediate water.

Figure 29.1. Deployment of the piston core.

Table 29.2. Sampled sites.

Station number	Latitude (N)	Longitude (N)	Water depth (m)	Sampling device	Length (cm)
AMD0214-02	71°22.910	133°34.040	998	Piston Core	680.5
	71°22.970	133°34.340	1000	Box Core	55
AMD0214-03NEW	70°33.032	137°31.910	1051	Piston Core	760
	70°33.055	137°31.997	1048	Box Core	55
	70°33.285	137°32.514	1070	CTD-rosette	-

Station AMD0214-01

Cancelled. Too much sea ice at the original coring site. Survey has been done south and north of the position without finding any potential coring site.

Station AMD0214-02 (24/08/2014)

Original coring site needed to be cancelled because of sea ice condition. Prior to survey, another coring site was found.

Table 29.3. Details of the samples collected at station AMD0214-02.

Piston core		Box core	
Sample	**Length (cm)**	**Sample**	**Length (cm)**
AMD0214-02 TWC	132,0	AMD0214-02 BC-A	59,5
Catcher	27,0	AMD0214-02 BC-B	51,0
AMD0214-02 AB	149,0	AMD0214-02 BC-C	54,5
AMD0214-02 BC	157,5		
AMD0214-02 CD	146,5		
AMD0214-02 DE	68,5		
Lenght PC	548,5		
Total lenght	**680,5**		

Figure 29.2. Position of the push cores within box core AMD0214-02.

Station AMD0214-03NEW (01/09/2014)

Station AMD0214-03 was removed because of a depth error on survey. A new coring site was found (AMD0214-03NEW).

Table 29.4. Details of the samples collected at Station AMD0214-03NEW.

Piston core		Box core	
Sample	**Length (cm)**	**Sample**	**Length (cm)**
AMD0214-03 TWC AB	100,5	AMD0214-03 BC-A	45
AMD0214-03 TWC BC	74,0	AMD0214-03 BC-B	39
Catcher	50,0	AMD0214-03 BC-C	41
AMD0214-03 AB	151,5		
AMD0214-03 BC	156,0		

Piston core		Box core	
Sample	**Length (cm)**	**Sample**	**Length (cm)**
AMD0214-03 CD	153,5		
AMD0214-03 DE	74,5		
Lenght PC	585,5		
Total lenght	760,0		

Figure 29.3. Position of the push cores within box core AMD0214-03NEW.

Water samples were taken at 50, 100, 250, 400, 700 and 1000 m depths.

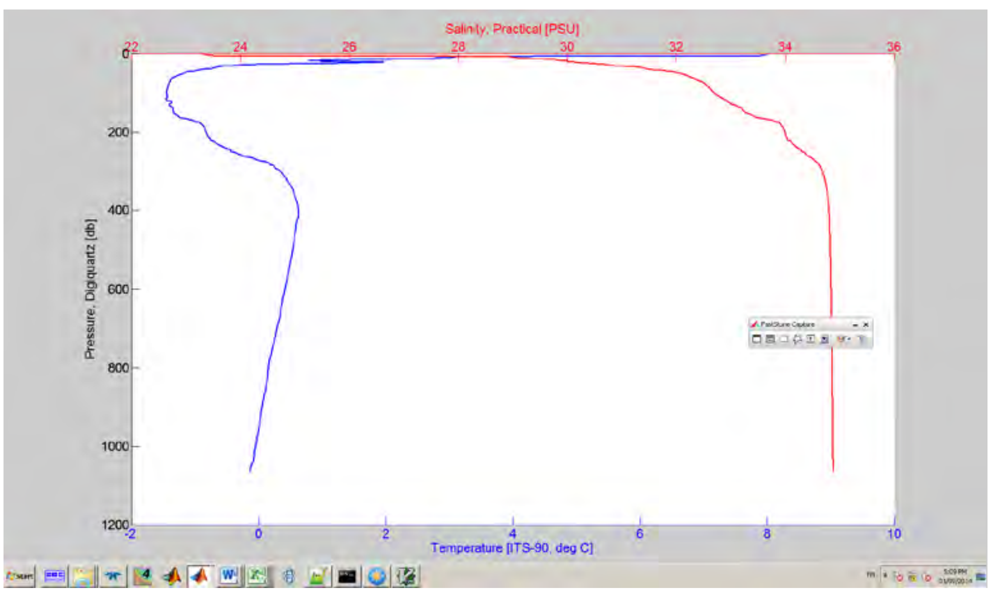


Figure 29.4. Vertical profile of the water column at Station AMD0214-03NEW.

AMD0214-04

Cancelled. Not enough time.

AMD0214-05

Cancelled. Not enough time.

30 Piston coring operations – Leg 3

ArcticNet Phase 3 – The Canadian Arctic Seabed: Navigation and Resource Mapping
http://www.arcticnet.ulaval.ca/pdf/phase3/seabed-mapping.pdf

Project leaders: Don Forbes[1] (dforbes@nrcan.gc.ca), Trevor Bell[2] (tbell@mun.ca) and Patrick Lajeunesse[2] (patrick.lajeunesse@ggr.ulaval.ca)
Cruise participants Leg 3: Donald Forbes[1], Robbie Bennett[1], Robert Murphy[1], Robert Deering[2] and Étienne Brouard[3]
[1] *Geological Survey of Canada (Atlantic), P.O. Box 1006, Darthmouth, NS, B2Y 4A2, Canada.*
[2] *Department of Geography, Memorial University of Newfoundland, St. John's, NL, A1B 3X9, Canada.*
[3] *Université Laval, Département de géographie, Pavillon Abitibi-Price, 2405 rue de la Terrasse, Québec, QC, G1V 0A6, Canada.*

30.1 Introduction

The objective of piston coring operations onboard CCGS *Amundsen* during Leg 3 was to collect the longest sediment samples possible at selected piston core sites. See related chapters in this cruise report for information on the scientific goals for each piston core site.

30.2 Methodology

The piston corer operated 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 obtains a core sample with an ID of 99.2 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 1800 lbs. The core head is connected to the barrel string using a "half" coupling. A maximum of 3 barrels can comprise the barrel string on the *Amundsen* due to the deck layout, 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. 10.008 cm) 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, oneway valve and weight stand. Additional lead weights (donut shaped) may be added around the weight stand. The overall weight of the TWC can vary but it is approximately 300 to 400 lbs (140 to 180 kg). The *Amundsen* TWC had a 213cm long barrel and weighed 250lbs.

Figure 30.1. Piston corer being retrieved on CCGS *Amundsen*.

30.3 Preliminary results

Sample recovery was considered good to excellent considering the sediment types at the selected core locations. All of the cores were collected in areas that have been influenced by glacial sedimentation in the past and therefore the piston corer encountered very stiff silty clay or sand at most locations. These types of sediments are difficult to core as the high cohesion present in these units causes a blockage inside the barrels during the coring process, which prevents additional sediment from entering the corer. Trigger weight core performance was poor likely due to hard sediments or drop stones at the seafloor.

Table 30.1 shows the collection information for each piston core collected during Leg 3.

Table 30.1. Information for each piston core collected during Leg 3.

Core #	Expedition #	Sample #	Latitude (N)	Longitude (N)	Water depth (m)	Location
1	LGM AMU 2014	1	71°05.323	071°50.758	696	Clark and Gibbs Fjords
2	LGM AMU 2014	2	70°45.773	072°15.327	441	Clark and Gibbs Fjords
3	2014805	1	66°57.046	062°16.732	83	Big Nose Fiord
4	2014805	2	66°53.341	061°49.441	145	Akpait Fiord
5	2014805	3	66°52.973	061°44.609	114	Akpait Fiord
6	2014805	4	63°38.428	068°37.207	135	Frobisher Bay

30.4 Comments and recommendations

The plastic core liner used during Leg 3 was brittle and cracked often during the coring process or during cutting of the sample on deck. The liner could be part of a bad batch of liner that was defective from the manufacturer or liner could be too old, which would contribute to brittleness. An inventory of liner and its age would be beneficial for future piston coring operations.

The storage of smaller piston corer parts in the cage and plastic boxes on the foredeck is less than ideal. The plastic boxes have been damaged by strapping them to the cage and no longer closed tightly, therefore filling with water frequently. The cage is difficult and sometimes dangerous to remove and deposit equipment into. Another storage solution instead of the cage and boxes would be advisable if it is possible.

Two core cutters (or nose cones) were damaged during coring operations. One of these cutters is damaged beyond repair. The number and condition of core cutters will need to be assessed prior to future coring operations.

31 Schools on Board – Leg 3

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31.1 Introduction

As an outreach program of ArcticNet, a Network of Centres of Excellence of Canada that focuses on potential impacts of climate change on the North's environment and people, Schools on Board's Arctic Field Program takes small teams of high school students and teachers on board the *CCGS Amundsen* to experience and participate in ArcticNet's annual scientific expedition. Over the years, the field program has taken participants in the Beaufort Sea, through the famed Northwest Passage, along Baffin Island, and through the spectacular Labrador Fjords.

31.2 Activities and outreach

While on board the CCGS *Amundsen*, students were involved in a variety of sampling activities and participated in a variety of lectures and workshops delivered by scientists on board (Table 31.1).

Table 31.1. Summary of Schools on Board activities provided by scientists on board Leg 3.

Name	Position	Activity
Don Forbes	Chief Scientist	Lecture (various geological topics) participated in conference call
Robert Deering	MSc Student	Lecture: Sea level rise
Robbie Bennet	GSC	Piston core demonstration
Robert Murphy	GSC	Piston core demonstration
Etienne Brouard	PhD Student	Demonstration of equipment
Gabriel Joyal	EM302 Operator	Lecture and activity: Sea Floor Mapping Demonstration of equipment
Line Bourdages	CTD-Rosette Operator	Lecture 1: Earth's Energy Budget Lecture 2: Physical Oceanography Demonstration of Rosette
Sylvain Blondeau	CTD-Rosette Operator	Demonstrations of Rosette
Cyril Aubry	Research Assistant	Lecture: Bioacoustics Sampling and Lab work: Zooplankton
Jordan Grigor	PhD Student	Lecture: Arctic Marine Food Web/Zooplankton Sampling and Lab work: Zooplankton

Name	Position	Activity
Karley Campbell	PhD Student	Lecture: Phytoplankton/Food chain activity Lab work: filtration
Masayo Olgi	Researcher	Lecture: Atmospheric Investigations Sampling: Radiosonde launches
Kensuke Komatsu	PhD Student	Lecture: Radiosonde/data collection Sampling: Radiosonde launches
Gord Chamberlain, Flavia de Paula Ribeiro de Fonseca Flavia	Research Assistant MSc. Student	Sampling: Box core Lab: Zooplankton sorting
Laurence Paquette	MSc. Student	Lecture: Introduction to Benthos Sampling: Agassiz trawl/Box Core
Noemie Friscourt	MSc. Student	Lecture: Introduction to Benthos Sampling: Agassiz trawl/Box Core
Mark Maftei	Environment Canada	Lecture: Ross's Gull
Laurence Pivot, Gilles Rapaport	Media	Lecture: Gilles showed examples of his illustrations Laurence provided a short writing workshop
Jean-Pierre Aubé	Artist	Lecture: Examples of his work

In addition to the science, students were fully immersed in all aspects of life on the ship and were integrated with the science team.

Leg	Station ID	Station Type	Local Date	Local Time	UTC to local	Latitude (N)	Longitude (W)
1a	n-a	Mapping	11/Jul/2014	05h10	-4	53°11.900	055°15.300
1a	Home Bay	ROV	15/Jul/2014	04h16	-4	69°22.036	064°51.849
1a	Scott Inlet	ROV	16/Jul/2014	06h19	-4	71°30.519	070°17.613
1a	323	Full	17/Jul/2014	17h11	-4	74°09.437	080°28.384
1a	300	Nutrient	18/Jul/2014	02h10	-4	74°18.993	080°30.260
1a	322	Nutrient	18/Jul/2014	04h13	-4	74°29.749	080°30.146
1a	324	Nutrient	18/Jul/2014	19h23	-4	73°58.973	080°28.463
1a	325	CTD+MVP	18/Jul/2014	21h35	-4	73°49.065	080°29.483
1a	301	Full	19/Jul/2014	08h00	-4	74°06.158	083°22.936
1a	346	CTD	20/Jul/2014	11h00	-4	74°08.878	091°34.514
1a	304	Full	20/Jul/2014	12h30	-4	74°14.438	091°32.238
1a	n-a	Ice	20/Jul/2014	21h40	-4	74°16.900	091°38.400
1a	305	Full	22/Jul/2014	04h49	-4	74°19.067	094°54.464
1a	305A	Nutrient	22/Jul/2014	19h03	-4	74°12.974	094°12.918
1a	305B	Nutrient	22/Jul/2014	23h10	-4	74°13.736	095°54.435
1a	305C	Nutrient	23/Jul/2014	00h45	-4	74°21.583	095°48.584
1a	305E	Nutrient	23/Jul/2014	03h54	-4	74°35.343	095°03.701
1a	n-a	Ice	25/Jul/2014	08h30	-4	73°59.600	075°49.900
1b	200	Basic	27/Jul/2014	06h38	-4	73°16.668	063°38.175
1b	204	Basic	28/Jul/2014	06h50	-4	73°16.076	058°14.246
1b	206	Nutrient	29/Jul/2014	01h10	-4	74°04.363	059°02.663
1b	208	CTD	29/Jul/2014	05h12	-4	74°44.454	059°59.351
1b	210	Basic	29/Jul/2014	10h35	-4	75°25.567	061°57.699
1b	210	Basic	29/Jul/2014	12h50	-4	75°24.378	061°38.912
1b	210	Basic	29/Jul/2014	12h55	-4	75°24.395	061°38.888
1b	212	CTD	30/Jul/2014	03h15	-4	75°37.986	064°36.115
1b	214	Nutrient	30/Jul/2014	08h16	-4	75°47.642	067°56.959
1b	115	Full	30/Jul/2014	13h45	-4	76°19.994	071°12.987
1b	114	CTD	31/Jul/2014	01h48	-4	76°19.498	071°47.109
1b	113	Nutrient	31/Jul/2014	03h00	-4	76°19.172	072°12.518
1b	112	CTD	31/Jul/2014	04h58	-4	76°19.095	072°42.317
1b	111	Basic	31/Jul/2014	07h07	-4	76°18.387	073°13.300
1b	110	Nutrient	31/Jul/2014	13h56	-4	76°17.919	073°37.676
1b	109	CTD	31/Jul/2014	15h44	-4	76°17.335	074°06.571
1b	108	Full	31/Jul/2014	17h03	-4	76°16.281	074°35.702
1b	107	Nutrient	01/Aug/2014	03h14	-4	76°16.933	074°58.795
1b	106	CTD	01/Aug/2014	04h51	-4	76°18.505	075°21.692
1b	105	Basic	01/Aug/2014	06h01	-4	76°19.085	075°46.495
1b	104	CTD	01/Aug/2014	13h08	-4	76°20.475	076°10.337
1b	103	Nutrient	01/Aug/2014	13h53	-4	76°21.217	076°34.411
1b	102	CTD	01/Aug/2014	15h05	-4	76°22.409	076°58.369
1b	101	Full	01/Aug/2014	15h59	-4	76°22.900	077°23.568
1b	KEN1	Full	03/Aug/2014	08h08	-4	81°21.959	064°11.710
1b	KEN2	Nutrient	03/Aug/2014	22h47	-4	81°04.731	065°50.169

Leg	Station ID	Station Type	Local Date	Local Time	UTC to local	Latitude (N)	Longitude (W)
1b	KEN3	Basic	04/Aug/2014	01h22	-4	80°47.864	067°19.100
1b	KEN4	Nutrient	04/Aug/2014	08h38	-4	80°24.000	068°48.200
1b	KANE1	Basic	04/Aug/2014	12h13	-4	79°59.411	069°45.664
1b	KANE2B	Coring	04/Aug/2014	20h29	-4	79°30.908	070°49.742
1b	KANE2	Nutrient	05/Aug/2014	00h40	-4	79°40.270	070°44.623
1b	KANE3	Basic	05/Aug/2014	03h02	-4	79°21.759	071°51.701
1b	KANE4	Nutrient	05/Aug/2014	09h12	-4	79°00.356	070°29.245
1b	134	CTD	05/Aug/2014	11h05	-4	78°59.986	071°17.973
1b	132B	CTD	05/Aug/2014	20h38	-4	78°59.983	072°17.058
1b	KANE5	Basic	05/Aug/2014	22h05	-4	79°00.369	073°12.356
1b	127	Nutrient	06/Aug/2014	05h42	-4	78°18.035	074°28.934
1b	120	Basic	06/Aug/2014	12h00	-4	78719.375	075°41.703
1b	335	Basic	08/Aug/2014	20h20	-4	74°25.689	098°50.189
1b	309	Basic	10/Aug/2014	05h06	-4	72°57.243	096°09.664
1b	310	Basic	10/Aug/2014	21h32	-4	71°17.723	097°41.465
1b	312	Basic	11/Aug/2014	15h55	-4	69°10.405	100°41.075
1b	314	Full	12/Aug/2014	08h00	-4	68°58.270	105°27.904
1b	315	Nutrient	12/Aug/2014	19h44	-6	68°50.784	107°30.282
1b	318	Nutrient	12/Aug/2014	22h00	-6	68°40.963	108°17.279
1b	317	Nutrient	12/Aug/2014	23h00	-6	68°45.679	108°24.536
1b	316	Nutrient	13/Aug/2014	00h05	-6	68°50.299	108°30.569
2a	405	Basic	16/Aug/2014	7h47	-5	70°38.200	123°02.660
2a	407	Basic	18/Aug/2014	06h01	-5	71°00.280	126°04.250
2a	n-a	Net+Cam	19/Aug/2014	02h10	-5	71°11.380	126°53.430
2a	437	Basic	19/Aug/2014	12h55	-5	71°47.170	126°29.770
2a	410	Nutrient	19/Aug/2014	20h32	-5	71°41.860	126°29.660
2a	411	CTD	19/Aug/2014	22h06	-5	71°37.710	126°42.090
2a	412	Nutrient	19/Aug/2014	23h10	-5	71°33.690	126°55.530
2a	413	CTD	20/Aug/2014	00h55	-5	71°29.660	127°08.600
2a	414	Nutrient	20/Aug/2014	01h57	-5	71°25.300	127°21.930
2a	GSC-4	Coring	20/Aug/2014	03h54	-5	71°20.960	126°47.720
2a	408	Full	20/Aug/2014	09h17	-5	71°18.780	127°34.490
2a	417	CTD	20/Aug/2014	20h24	-5	71°13.630	127°58.350
2a	418	Nutrient	20/Aug/2014	21h23	-5	71°09.750	128°10.350
2a	419	CTD	20/Aug/2014	22h26	-5	71°06.450	128°20.290
2a	420	Basic	20/Aug/2014	23h13	-5	71°03.070	128°30.740
2a	422	Nutrient	21/Aug/2014	14h32	-6	71°22.250	133°53.230
2a	423	CTD	21/Aug/2014	16h40	-6	71°16.340	133°51.440
2a	435	Basic	21/Aug/2014	19h33	-6	71°04.810	133°38.080
2a	BS-1	Mooring	22/Aug/2014	04h39	-6	70°48.840	134°50.630
2a	BR-K	Mooring	22/Aug/2014	09h05	-6	70°51.730	135°01.220
2a	Pingo	Mooring	22/Aug/2014	15h32	-6	70°51.590	134°59.450
2a	BS-2	Mooring	22/Aug/2014	17h15	-6	70°52.850	135°05.660
2a	Pingo	Mooring	22/Aug/2014	18h13	-6	70°52.770	135°06.140

Leg	Station ID	Station Type	Local Date	Local Time	UTC to local	Latitude (N)	Longitude (W)
2a	434	Basic	22/Aug/2014	23h11	-6	70°10.240	133°33.140
2a	433	CTD	23/Aug/2014	02h35	-6	70°17.350	133°34.890
2a	432	Nutrient	23/Aug/2014	03h30	-6	70°23.770	133°36.490
2a	431	CTD	23/Aug/2014	04h39	-6	70°29.580	133°37.150
2a	430	Nutrient	23/Aug/2014	05h36	-6	70°35.900	135°38.900
2a	429	CTD	23/Aug/2014	06h48	-6	70°41.820	133°40.390
2a	428	Nutrient	23/Aug/2014	07h39	-6	70°47.480	133°41.820
2a	427	CTD	23/Aug/2014	09h02	-6	70°52.770	133°43.280
2a	426	Nutrient	23/Aug/2014	10h10	-6	70°59.060	133°44.870
2a	BS-3	Mooring	23/Aug/2014	14h20	-6	70°55.540	135°14.300
2a	BR-G	Mooring	23/Aug/2014	17h30	-6	71°00.110	135°30.400
2a	421	Full	24/Aug/2014	00h20	-6	71°27.240	133°53.620
2a	0214-02	Coring	24/Aug/2014	14h42	-6	71°27.950	133°29.500
2a	460	Basic	25/Aug/2014	00h12	-6	72°08.820	130°48.880
2a	PCBC-3	Coring	26/Aug/2014	05h48	-6	72°26.540	129°26.760
2a	BR-3	Mooring	27/Aug/2014	07h35	-6	73°24.580	129°21.400
2a	BR-4	Mooring	28/Aug/2014	07h20	-6	73°13.210	127°02.840
2a	UP-Tempo-2	Ice	28/Aug/2014	14h43	-6	73°39.910	127°58.050
2a	PCBC-2	Coring	29/Aug/2014	14h31	-6	73°15.750	128°30.840
2a	UP-Tempo	Ice	29/Aug/2014	18h42	-6	73°16.890	128°33.450
2a	PCBC-8	Coring	31/Aug/2014	06h22	-6	70°39.780	136°18.360
2a	PCBC-12	Coring	31/Aug/2014	10h12	-6	70°41.420	136°25.750
2a	GAC-05	Coring	31/Aug/2014	12h32	-6	70°44.470	136°38.560
2a	PCBC-5	Coring	31/Aug/2014	15h33	-6	70°44.550	136°38.550
2a	UQAR-PCBC	Coring	01/Sept/2014	06h24	-6	70°33.040	137°31.940
2a	BR-1	Mooring	01/Sept/2014	15h26	-6	70°25.830	139°01.150
2a	482	Basic	01/Sept/2014	18h39	-6	70°31.460	139°22.870
2a	PCBC-6	Coring	02/Sept/2014	09h31	-6	70°35.090	136°00.750
2a	BC-10	Coring	02/Sept/2014	12h20	-6	70°35.950	136°04.180
2a	BC-11	Coring	02/Sept/2014	13h23	-6	70°37.820	136°11.340
2a	BC-14	Coring	02/Sept/2014	14h35	-6	70°31.600	136°20.340
2a	BC-15	Coring	02/Sept/2014	15h36	-6	70°34.350	136°30.990
2a	PCBC-7	Coring	02/Sept/2014	17h51	-6	70°41.430	136°43.050
2a	BC-16	Coring	02/Sept/2014	20h31	-6	70°38.770	136°48.690
2a	BR-2	Mooring	03/Sept/2014	10h18	-6	69°59.720	137°58.600
2a	Orion - A	Basic	04/Sept/2014	15h44	-6	69°21.950	138°14.020
2a	470	Nutrient	06/Sept/2014	06h50	-6	69°25.820	137°59.080
2a	472 B	Full	06/Sept/2014	08h18	-6	69°36.570	138°13.510
2a	474	Basic	06/Sept/2014	14h41	-6	69°47.860	138°26.140
2a	476	Nutrient	06/Sept/2014	17h00	-6	69°58.990	138°39.880
2a	478	Basic	06/Sept/2014	20h26	-6	70°10.060	138°54.600
2a	480	Nutrient	06/Sept/2014	22h49	-6	70°20.230	139°08.890
2a	PCBC-09	Coring	07/Sept/2014	06h20	-6	70°38.350	139°00.950
2b	1040	Basic	10/Sept/2014	07h03	-6	71°14.810	157°10.020

Leg	Station ID	Station Type	Local Date	Local Time	UTC to local	Latitude (N)	Longitude (W)
2b	1041	Nutrient	10/Sept/2014	10h49	-6	71°19.840	157°19.780
2b	1042	Basic	10/Sept/2014	14h10	-6	71°24.620	157°29.310
2b	1043	Nutrient	10/Sept/2014	22h27	-6	71°29.820	157°40.150
2b	1044	Basic	11/Sept/2014	01h12	-6	71°34.680	157°50.340
2b	BCC-13	Mooring	11/Sept/2014	13h50	-6	71°43.550	155°11.690
2b	BCE-13	Mooring	11/Sept/2014	15h10	-6	n-a	n-a
2b	BCW-13	Mooring	11/Sept/2014	17h02	-6	n-a	n-a
2b	1036	Nutrient	11/Sept/2014	18h20	-6	71°43.560	155°24.810
2b	1038	Basic	11/Sept/2014	23h08	-6	71°34.410	155°45.500
2b	1045	Basic	12/Sept/2014	08h00	-6	71°38.550	154°54.920
2b	BCE-14	Mooring	12/Sept/2014	10h13	-6	71°40.360	154°59.510
2b	1046	Basic	12/Sept/2014	12h06	-6	71°41.900	154°05.100
2b	BCC-13	Mooring	12/Sept/2014	13h35	-6	71°43.640	155°10.920
2b	1047	Basic	12/Sept/2014	18h46	-6	71°45.960	155°16.180
2b	BCW-14	Mooring	12/Sept/2014	20h03	-6	71°47.740	155°20.560
2b	1034	Full	12/Sept/2014	22h13	-6	71°54.440	154°58.180
2b	BCC-14	Mooring	13/Sept/2014	13h30	-6	71°44.610	155°07.410
2b	1032	Nutrient	13/Sept/2014	18h15	-6	72°03.300	154°37.260
2b	1030	Basic	13/Sept/2014	21h15	-6	72°12.370	153°56.500
2b	NORPAC 1	Net	14/Sept/2014	09h12	-6	72°28.790	157°01.350
2b	NORPAC 2	Net	14/Sept/2014	14h20	-6	73°03.630	159°21.180
2b	NORPAC 3	Net	14/Sept/2014	19h06	-6	73°45.190	161°14.470
2b	CAP 12 T	Mooring	15/Sept/2014	21h18	-6	75°12.340	172°33.940
2b	NORPAC 4	Net	16/Sept/2014	04h34	-6	75°12.420	169°49.460
2b	1085	Basic	16/Sept/2014	13h05	-6	75°03.690	167°08.400
2b	NORPAC 5	Net	17/Sept/2014	02h15	-6	75°04.270	164°21.910
2b	NAP-13	Mooring	17/Sept/2014	08h10	-6	74°36.120	161°56.290
2b	NAP-12	Mooring	17/Sept/2014	16h33	-6	75°00.260	162°00.670
2b	1100	Full	17/Sept/2014	21h09	-6	75°04.020	161°15.860
2b	n-a	CTD	18/Sept/2014	16h17	-6	74°15.170	158°16.050
2b	1105	Nutrient	18/Sept/2014	17h38	-6	74°47.230	157°34.120
2b	1107	Basic	19/Sept/2014	00h25	-6	74°36.590	155°49.720
2b	n-a	CTD	19/Sept/2014	15h37	-6	74°28.450	154°25.850
2b	1110	Nutrient	19/Sept/2014	23h38	-6	74°20.320	149°56.340
2b	1115	Basic	20/Sept/2014	12h15	-6	73°54.090	147°08.990
2b	1125	Nutrient	21/Sept/2014	06h02	-6	73°00.070	144°40.170
2b	1130	Basic	21/Sept/2014	20h46	-6	72°36.300	141°43.960
2b	435	Basic	23/Sept/2014	09h31	-6	71°04.700	133°38.120
3	PCBC-2	Coring	30/Sept/2014	15h35	-6	71°05.460	071°50.910
3	Gibbs-B	Full	01/Oct/2014	09h11	-6	70°46.030	072°15.620
3	176	Nutrient	02/Oct/2014	09h09	-6	69°35.530	065°26.060
3	179	Nutrient	03/Oct/2014	04h31	-6	67°20.390	062°37.030
3	180	Basic	03/Oct/2014	08h19	-6	67°28.380	061°42.330
3	181	Nutrient	03/Oct/2014	12h36	-6	67°33.210	061°22.610

Leg	Station ID	Station Type	Local Date	Local Time	UTC to local	Latitude (N)	Longitude (W)
3	Big Nose	Coring	04/Oct/2014	07h01	-6	66°57.040	062°16.770
3	Akpait-3	Coring	04/Oct/2014	10h11	-6	66°53.350	061°49.460
3	Akpait-1	Coring	04/Oct/2014	12h20	-6	66°52.960	061°44.640
3	Forbiche 1	Coring	06/Oct/2014	07h29	-6	63°38.410	068°37.230
3	640	Nutrient	07/Oct/2014	13h17	-6	58°55.500	062°09.280
3	645	Nutrient	08/Oct/2014	12h15	-6	56°42.200	059°42.210
3	650	Nutrient	08/Oct/2014	15h48	-6	53°48.290	055°26.060

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					
1a	n-a	Mapping	11/Jul/2014	05h10	-4	53°11.900	055°15.300	Mapping	187	000	230	13	11.8	8.03	1013.07	90	Bergy
1a	Home Bay	ROV	15/Jul/2014	04h16	-4	69°22.036	064°51.849	CTD-Rosette ↓	747	060	185	8	4.5	2.35	1007.79	80	Bergy
1a	Home Bay	ROV	15/Jul/2014	05h16	-4	69°22.027	064°51.946	CTD-Rosette ↑	734	054	170	3	5.2	2.68	1007.87	79	Bergy
1a	Home Bay	ROV	15/Jul/2014	05h58	-4	69°22.089	064°50.733	ROV 1 ↓	746	266	185	3	4.1	2.44	1007.7	83	Bergy
1a	Home Bay	ROV	15/Jul/2014	07h38	-4	69°22.068	064°50.781	Weather balloon	746	231	045	3	3.7	2.22	1007.79	84	Bergy
1a	Home Bay	ROV	15/Jul/2014	14h31	-4	69°21.363	064°51.114	ROV 1 ↑	691	041	060	6	4.2	2.85	1005.5	87	Bergy
1a	Scott Inlet	ROV	16/Jul/2014	06h19	-4	71°30.519	070°17.613	CTD-Rosette ↓	614	014	155	7	7.8	5.48	1002.68	85	Bergy
1a	Scott Inlet	ROV	16/Jul/2014	07h11	-4	71°30.516	070°17.580	CTD-Rosette ↑	610	058	140	8	6.5	5.65	1002.63	92	Bergy
1a	Scott Inlet	ROV	16/Jul/2014	07h30	-4	71°30.897	070°16.825	ROV 2 ↓ Moonpool	608	331	140	6	6.2	5.76	1002.65	92	Bergy
1a	Scott Inlet	ROV	16/Jul/2014	07h46	-4	71°30.891	070°16.818	ROV 2 ↓	608	030	145	8	7.3	5.17	1002.7	87	Bergy
1a	Scott Inlet	ROV	16/Jul/2014	15h17	-4	71°30.770	070°16.039	ROV 2 ↑	466.1	346	300	7	5.1	6.27	1003.62	98	Bergy
1a	Scott Inlet	ROV	16/Jul/2014	15h45	-4	71°30.775	070°15.985	ROV 2 ↑ Surface	466.1	348	300	8	5.5	6.32	1003.62	98	Bergy
1a	Scott Inlet	ROV	16/Jul/2014	20h00	-4	71°58.175	072°22.615	Weather balloon	758	306	310	8	4.1	6.08	1004.76	99	Bergy
1a	323	Basic+	17/Jul/2014	17h11	-4	74°09.437	080°28.384	Secchi ↓	859	272	080	12	5.5	6.23	1005.00	97	Bergy
1a	323	Basic+	17/Jul/2014	17h00	-4	74°09.437	080°28.384	PNF ↓	859	259	080	12	5.5	6.23	1005.00	97	Bergy
1a	323	Basic+	17/Jul/2014	17h10	-4	74°09.457	080°28.358	PNF ↑	859	277	080	12	5.5	6.23	1005.00	97	Bergy
1a	323	Basic+	17/Jul/2014	17h13	-4	74°09.448	080°28.379	Secchi ↑	859	264	080	12	5.5	6.23	1005.00	97	Bergy
1a	323	Basic+	17/Jul/2014	17h20	-4	74°09.472	080°28.499	CTD-Rosette ↓	859	306	050	15	7.4	6.08	1004.99	89	Bergy
1a	323	Basic+	17/Jul/2014	17h44	-4	74°09.370	080°29.275	CTD-Rosette ↑	859	262	060	20	8.8	6.18	1004.84	83	Bergy
1a	323	Basic+	17/Jul/2014	18h40	-4	74°09.382	080°28.892	Monster, LOKI ↓	794	249	060	22	8.6	5.66	1004.84	85	Bergy
1a	323	Basic+	17/Jul/2014	19h35	-4	74°09.373	080°29.517	Monster, LOKI↑	788	255	045	25	8.7	5.84	1004.85	85	Bergy

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					
1a	323	Basic+	17/Jul/2014	20h02	-4	74°09.388	080°29.385	CTD-Rosette ↓	794	256	040	19	5.5	6.08	1004.47	97	Bergy
1a	323	Basic+	17/Jul/2014	21h06	-4	74°09.273	080°31.210	CTD-Rosette ↑	773	185	045	27	5.9	6.05	1004.04	97	Bergy
1a	323	Basic+	17/Jul/2014	21h36	-4	74°09.063	080°30.273	Bioness ↓	782	209	045	29	5.6	6.06	1003.71	99	Bergy
1a	323	Basic+	17/Jul/2014	21h45	-4	74°08.822	080°31.388	Bioness ↑	777	297	050	26	5.1	6.08	1003.66	99	Bergy
1a	323	Basic+	17/Jul/2014	22h30	-4	74°09.440	080°28.712	Box Core #1 ↓	795	244	050	28	5.5	5.89	1033.21	99	Bergy
1a	323	Basic+	17/Jul/2014	23h06	-4	74°09.656	080°29.694	Box Core #1 ↑	788	261	045	29	6.8	5.88	1003.25	94	Bergy
1a	323	Basic+	17/Jul/2014	23h07	-4	74°09.656	080°29.694	Box Core #2 ↓	788	274	045	29	6.8	5.88	1003.25	94	Bergy
1a	323	Basic+	17/Jul/2014	23h49	-4	74°09.866	080°31.362	Box Core #2 ↑	778	271	045	26	5.6	6.05	1003.06	98	Bergy
1a	323	Basic+	18/Jul/2014	00h10	-4	74°09.927	080°32.159	Agassiz Trawl ↓	770	257	040	19	6.3	6.05	1003.11	96	Bergy
1a	323	Basic+	18/Jul/2014	00h55	-4	74°08.958	080°36.134	Agassiz Trawl ↑	781	273	050	20	5.2	5.80	1002.91	98	Bergy
1a	300	Nutrient	18/Jul/2014	02h10	-4	74°18.993	080°30.260	CTD-Rosette ↓	701	234	020	20	4.4	4.75	1003.69	99	Bergy
1a	300	Nutrient	18/Jul/2014	03h00	-4	74°18.931	080°31.042	CTD-Rosette ↑	704	270	030	15	5.3	4.46	1003.61	98	Bergy
1a	322	Nutrient	18/Jul/2014	04h13	-4	74°29.749	080°30.146	CTD-Rosette ↓	662	219	030	35	4.1	5.01	1001.54	99	Bergy
1a	322	Nutrient	18/Jul/2014	05h11	-4	74°29.427	080°36.404	CTD-Rosette ↑	662	204	040	28	5.3	4.18	1001.97	93	Bergy
1a	324	Nutrient	18/Jul/2014	19h23	-4	73°58.973	080°28.463	CTD-Rosette ↓	774	208	010	17	5.7	4.66	995.61	98	Bergy
1a	324	Nutrient	18/Jul/2014	20h25	-4	73°58.433	080°27.593	CTD-Rosette ↑	774	191	020	17	8.3	5.09	996.17	86	Bergy
1a	325	CTD+MVP	18/Jul/2014	21h35	-4	73°49.065	080°29.483	CTD-Rosette ↓	685	214	045	5	4.8	4.21	997.28	99	Bergy
1a	325	CTD+MVP	18/Jul/2014	22h20	-4	73°48.701	080°27.279	CTD-Rosette ↑	671	229	080	5	4.2	4.02	997.55	99	Bergy
1a	325	CTD+MVP	18/Jul/2014	22h46	-4	73°48.668	080°29.072	MVP ↓	656	003	090	5	4.4	3.45	997.85	99	Bergy
1a	325	CTD+MVP	19/Jul/2014	04h00	-4	74°28.871	080°36.147	MVP ↑	665	008	270	15	5.6	4.59	999.77	90	Bergy
1a	301	Full	19/Jul/2014	08h00	-4	74°06.158	083°22.936	PNF ↓	671	278	90	16	4.2	3.46	998.61	96	0/10
1a	301	Full	19/Jul/2014	08h05	-4	74°06.230	083°23.292	PNF ↑	671	250	100	22	4.5	3.43	998.53	95	0/10
1a	301	Full	19/Jul/2014	08h07	-4	74°06.251	083°23.386	Secchi ↓	670	262	100	22	4.5	3.43	998.53	95	0/10
1a	301	Full	19/Jul/2014	08h09	-4	74°06.280	083°23.491	Secchi ↑	670	274	90	20	4.5	3.43	998.53	95	0/10
1a	301	Full	19/Jul/2014	08h20	-4	74°06.379	083°24.434	CTD-Rosette ↓	671	290	90	21	4.1	3.52	998.67	97	0/10
1a	301	Full	19/Jul/2014	09h15	-4	74°06.530	083°26.559	CTD-Rosette ↑	670	289	90	23	8.0	3.58	999.17	84	0/10
1a	301	Full	19/Jul/2014	10h03	-4	74°06.243	083°22.791	Monster, LOKI ↓	670	270	90	23	6.1	3.44	999.00	91	0/10
1a	301	Full	19/Jul/2014	11h02	-4	74°06.886	083°23.230	Monster, LOKI↑	672	316	90	23	6.1	3.38	1000.33	90	0/10
1a	301	Full	19/Jul/2014	14h34	-4	74°05.982	083°23.153	CTD-Rosette ↓	667	260	70	20	4.8	3.48	998.12	95	0/10
1a	301	Full	19/Jul/2014	15h23	-4	74°05.935	083°24.581	CTD-Rosette ↑	667	277	60	15	8.0	3.38	998.09	82	0/10
1a	301	Full	19/Jul/2014	15h40	-4	74°06.181	083°22.866	Optic #1 ↓	671	256	70	23	5.4	3.41	997.41	92	0/10
1a	301	Full	19/Jul/2014	15h51	-4	74°06.213	083°23.355	Optic #1 ↑	671	250	060	25	6.1	3.45	997.86	89	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					
1a	301	Full	19/Jul/2014	15h54	-4	74°06.216	083°23.495	Optic #2 ↓	671	242	065	25	6.1	3.45	997.86	89	0/10
1a	301	Full	19/Jul/2014	16h05	-4	74°06.298	083°24.297	Optic #2 ↑	671	254	065	25	5.1	3.38	997.70	92	0/10
1a	301	Full	19/Jul/2014	16h18	-4	74°06.385	083°24.656	Tucker↓	671	260	065	29	5.2	3.38	997.76	92	0/10
1a	301	Full	19/Jul/2014	16h36	-4	74°06.243	083°25.727	Tucker ↑	668	355	070	24	4.6	3.44	997.38	93	0/10
1a	301	Full	19/Jul/2014	17h10	-4	74°06.150	083°22.712	Box Core ↓	671	264	080	23	7.1	3.46	997.37	84	0/10
1a	301	Full	19/Jul/2014	17h40	-4	74°06.272	083°23.589	Box Core (bottom)	672	257	090	27	6.1	3.34	997.05	87	0/10
1a	301	Full	19/Jul/2014	18h00	-4	74°06.418	083°24.400	Box Core ↑	672	258	090	27	6.0	3.23	997.05	88	0/10
1a	301	Full	19/Jul/2014	18h01	-4	74°06.431	083°24.473	Box Core ↓	672	258	090	27	6.0	3.23	997.05	88	0/10
1a	301	Full	19/Jul/2014	18h22	-4	74°06.612	083°25.520	Box Core (bottom)	672	255	090	26	5.5	3.20	997.12	90	0/10
1a	301	Full	19/Jul/2014	18h39	-4	74°06.769	083°25.954	Box Core ↑	672	283	090	30	5.6	3.17	997.63	90	0/10
1a	301	Full	19/Jul/2014	19h17	-4	74°06.399	083°24.953	Agassiz Trawl ↓	672	282	090	32	6.0	3.26	997.11	89	0/10
1a	301	Full	19/Jul/2014	19h21	-4	74°06.455	083°25.868	Agassiz Trawl ↑	671	308	090	33	6.0	3.26	997.11	89	0/10
1a	346	CTD	20/Jul/2014	11h00	-4	74°08.878	091°34.514	CTD-Rosette ↓	261	335	090	12	2.6	-0.43	997.01	99	9/10
1a	346	CTD	20/Jul/2014	11h29	-4	74°08.850	091°34.621	CTD-Rosette ↑	258	348	090	13	2.4	-0.54	997.50	99	9/10
1a	304	Full	20/Jul/2014	12h30	-4	74°14.438	091°32.238	PNF ↓	311	053	060	13	3.2	-0.51	998.72	97	9/10
1a	304	Full	20/Jul/2014	12h35	-4	74°14.438	091°32.238	PNF ↑	311	048	060	13	3.2	-0.51	998.72	97	9/10
1a	304	Full	20/Jul/2014	12h36	-4	74°14.410	091°32.228	Secchi ↓	314	045	060	13	3.2	-0.51	998.72	97	9/10
1a	304	Full	20/Jul/2014	12h38	-4	74°14.407	091°32.200	Secchi ↑	309	051	060	13	3.2	-0.51	998.72	97	9/10
1a	304	Full	20/Jul/2014	12h45	-4	74°14.385	091°32.187	CTD-Rosette ↓	309	053	070	13	3.4	-0.56	999.20	96	9/10
1a	304	Full	20/Jul/2014	13h10	-4	74°14.339	091°32.058	CTD-Rosette ↑	311	041	060	12	3.0	-0.54	999.07	97	9/10
1a	304	Full	20/Jul/2014	13h14	-4	74°14.346	091°31.884	Optic #1 ↓	311	055	060	11	2.8	-0.54	999.07	97	9/10
1a	304	Full	20/Jul/2014	13h34	-4	74°14.291	091°31.623	Optic #1 ↑	310	051	050	11	2.6	-0.52	999.78	98	9/10
1a	304	Full	20/Jul/2014	13h37	-4	74°14.291	091°31.623	Optic #2 ↓	311	050	055	11	2.6	-0.53	999.78	98	9/10
1a	304	Full	20/Jul/2014	13h40	-4	74°14.290	091°31.623	Optic #2 ↑	310	044	050	11	2.6	-0.53	999.78	98	9/10
1a	304	Full	20/Jul/2014	14h05	-4	74°14.222	091°31.629	Monster, LOKI ↓	312	039	040	11	2.7	-0.47	998.47	98	9/10
1a	304	Full	20/Jul/2014	14h37	-4	74°14.132	091°31.631	Monster, LOKI↑	309	004	030	12	2.6	-0.51	998.19	99	9/10
1a	304	Full	20/Jul/2014	14h52	-4	74°14.112	091°31.170	CTD-Rosette ↓	311	007	030	10	2.6	-0.55	999.02	99	9/10
1a	304	Full	20/Jul/2014	15h18	-4	74°14.040	091°29.688	CTD-Rosette ↑	312	013	040	11	2.7	-0.59	998.69	99	9/10
1a	304	Full	20/Jul/2014	15h38	-4	74°14.022	091°29.423	Hydrobios ↓	313	002	050	13	2.9	-0.55	999.63	99	9/10
1a	304	Full	20/Jul/2014	16h00	-4	74°14.012	091°29.017	Hydrobios ↑	314	353	045	11	2.6	-0.61	998.77	99	9/10
1a	304	Full	20/Jul/2014	16h27	-4	74°13.994	091°28.389	Box Core ↓	315	042	045	11	2.4	-0.63	998.81	99	9/10
1a	304	Full	20/Jul/2014	16h38	-4	74°13.964	091°28.108	Box Core (bottom)	314	039	045	11	2.4	-0.62	999.60	99	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					
1a	304	Full	20/Jul/2014	16h53	-4	74°13.895	091°27.821	Box Core ↑	313	047	030	10	2.7	-0.54	1000.21	99	9/10
1a	n-a	Ice	20/Jul/2014	21h40	-4	74°16.900	091°38.400	Ice Work ↓	459	317	270	7	1.7	-0.64	998.51	99	9/10
1a	n-a	Ice	20/Jul/2014	22h52	-4	74°16.708	091°37.799	Ice Work ↑	459	317	270	7	1.4	-0.64	998.77	99	9/10
1a	305	Full	22/Jul/2014	04h49	-4	74°19.067	094°54.464	Secchi, PNF ↓	186	192	220	12	1.3	-0.09	1006.13	99	2/10
1a	305	Full	22/Jul/2014	04h54	-4	74°19.065	094°54.407	Secchi, PNF ↑	187	186	210	12	1.3	-0.09	1006.13	99	2/10
1a	305	Full	22/Jul/2014	04h56	-4	74°19.060	094°54.397	Secchi ↓	187	208	210	12	1.3	-0.09	1006.13	99	2/10
1a	305	Full	22/Jul/2014	04h58	-4	74°19.066	094°54.394	Secchi ↑	187	214	210	11	1.3	-0.09	1006.13	99	2/10
1a	305	Full	22/Jul/2014	05h06	-4	74°19.094	094°54.346	CTD-Rosette ↓	186	092	220	14	1.3	-0.19	1006.34	99	2/10
1a	305	Full	22/Jul/2014	05h33	-4	74°19.203	094°54.116	CTD-Rosette ↑	187	062	215	15	3.3	-0.15	1007.56	98	2/10
1a	305	Full	22/Jul/2014	05h46	-4	74°19.262	094°53.912	Optic #1 ↓	184	004	210	15	2.6	-0.13	1007.52	98	3/10
1a	305	Full	22/Jul/2014	05h55	-4	74°19.273	094°53.758	Optic #1 ↑	184	303	210	16	2.0	-0.13	1007.54	99	3/10
1a	305	Full	22/Jul/2014	05h58	-4	74°19.284	094°53.725	Optic #2 ↓	184	325	210	15	1.7	-0.13	1007.54	99	3/10
1a	305	Full	22/Jul/2014	06h04	-4	74°19.323	094°53.691	Optic #2 ↑	187	341	220	14	1.2	-0.17	1007.28	99	3/10
1a	305	Full	22/Jul/2014	06h24	-4	74°19.383	094°53.463	Monster, LOKI ↓	187	009	220	16	1.3	-0.12	1007.07	99	3/10
1a	305	Full	22/Jul/2014	06h40	-4	74°19.390	094°53.191	Monster, LOKI↑	188	025	220	11	1.4	-0.09	1007.42	99	3/10
1a	305	Full	22/Jul/2014	07h17	-4	74°19.295	094°52.570	CTD-Rosette ↓	190	071	220	14	1.8	-0.09	1007.75	99	3/10
1a	305	Full	22/Jul/2014	07h44	-4	74°19.386	094°52.180	CTD-Rosette ↑	191	129	220	13	2.0	-0.09	1008.11	99	3/10
1a	305	Full	22/Jul/2014	08h52	-4	74°19.431	094°52.087	Hydrobios ↓	191	127	210	12	2.6	-0.06	1008.58	99	3/10
1a	305	Full	22/Jul/2014	09h06	-4	74°19.495	094°51.822	Hydrobios ↑	191	087	210	13	2.7	-0.18	1008.52	99	3/10
1a	305	Full	22/Jul/2014	09h26	-4	74°19.652	094°51.273	Box Core ↓	191	017	210	14	2.5	-0.11	1008.64	98	3/10
1a	305	Full	22/Jul/2014	09h31	-4	74°19.672	094°51.260	Box Core (bottom)	191	007	210	14	2.3	-0.11	1008.73	98	3/10
1a	305	Full	22/Jul/2014	09h37	-4	74°19.668	094°51.269	Box Core ↑	191	001	210	14	2.3	-0.11	1008.73	98	3/10
1a	305	Full	22/Jul/2014	10h03	-4	74°19.507	094°50.175	Bioness ↓	191	138	210	15	2.3	-0.10	1008.48	99	3/10
1a	305	Full	22/Jul/2014	10h35	-4	74°18.568	094°49.557	Bioness ↑	193	182	210	15	2.5	-0.13	1006.45	99	3/10
1a	305	Full	22/Jul/2014	11h00	-4	74°18.625	094°51.135	Agassiz Trawl ↓	190	330	210	15	2.5	-0.02	1006.38	99	3/10
1a	305	Full	22/Jul/2014	11h10	-4	74°18.761	094°48.945	Agassiz Trawl ↑	190	270	210	13	2.5	0.04	1006.37	99	3/10
1a	305	Full	22/Jul/2014	11h30	-4	74°18.881	094°48.452	Agassiz Trawl ↓	193	330	210	15	2.6	0.08	1006.40	99	3/10
1a	305	Full	22/Jul/2014	11h47	-4	74°19.057	094°48.652	Agassiz Trawl ↑	188	230	210	15	2.5	0.07	1006.36	99	3/10
1a	305A	Nutrient	22/Jul/2014	19h03	-4	74°12.974	094°12.918	CTD-Rosette ↓	171	096	240	16	1.4	0.28	1009.40	99	1/10
1a	305A	Nutrient	22/Jul/2014	19h30	-4	74°13.074	094°11.836	CTD-Rosette ↑	170	033	240	18	1.0	0.06	1009.70	99	1/10
1a	305A	Nutrient	22/Jul/2014	19h52	-4	74°13.146	094°10.873	Bioness ↓	169	045	250	15	2.1	0.05	1009.72	99	1/10
1a	305A	Nutrient	22/Jul/2014	20h06	-4	74°13.374	094°09.182	Bioness ↑	168	062	240	17	1.6	0.11	1009.63	99	1/10

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					
1a	305B	Nutrient	22/Jul/2014	23h10	-4	74°13.736	095°54.435	CTD-Rosette ↓	186	030	180	15	2.0	-0.67	1008.62	98	10/10
1a	305B	Nutrient	22/Jul/2014	23h41	-4	74°13.825	095°54.360	CTD-Rosette ↑	186	036	180	16	4.6	-0.70	1009.59	89	10/10
1a	305C	Nutrient	23/Jul/2014	00h45	-4	74°21.583	095°48.584	CTD-Rosette ↓	181	029	200	12	2.9	-0.84	1009.54	94	10/10
1a	305C	Nutrient	23/Jul/2014	01h07	-4	74°21.627	095°48.595	CTD-Rosette ↑	182	040	200	12	3.7	-0.85	1008.79	90	10/10
1a	305E	Nutrient	23/Jul/2014	03h54	-4	74°35.343	095°03.701	CTD-Rosette ↓	127	330	240	5	1.7	-0.59	1009.25	99	5/10
1a	305E	Nutrient	23/Jul/2014	04h13	-4	74°35.342	095°03.727	CTD-Rosette ↑	127	008	220	6	1.9	-0.71	1009.64	99	5/10
1a	305E	Nutrient	23/Jul/2014	04h31	-4	74°35.260	095°03.818	Box Core ↓	127	164	280	13	2.2	-0.72	1009.89	97	5/10
1a	305E	Nutrient	23/Jul/2014	04h36	-4	74°35.257	095°03.729	Box Core (bottom)	126	162	270	10	2.2	-0.72	1009.89	97	5/10
1a	305E	Nutrient	23/Jul/2014	04h40	-4	74°35.260	095°03.634	Box Core ↑	127	140	260	9	2.4	-0.75	1009.79	95	5/10
1a	n-a	Ice Island	25/Jul/2014	08h30	-4	73°59.600	075°49.900	Mapping (Start)	n-a	n-a	n-a	n-a	n-a	n-a	n-a	n-a	Bergy
1a	n-a	Ice Island	25/Jul/2014	11h05	-4	73°59.381	075°51.351	Mapping (End)	825	230	170	8	6.6	4.34	1014.20	95	Bergy
1b	200	Basic	27/Jul/2014	04h10	-4	73°25.636	064°03.068	Mapping (Start)	1424	137		0	4.5	4.02	1014.46	99	Bergy
1b	200	Basic	27/Jul/2014	06h35	-4	73°16.518	063°38.039	Mapping (End)	1477	000	255	8	4.5	2.93	1014.16	99	Bergy
1b	200	Basic	27/Jul/2014	06h38	-4	73°16.668	063°38.175	PNF ↓	1479	287	255	8	4.5	2.93	1014.16	99	Bergy
1b	200	Basic	27/Jul/2014	06h48	-4	73°16.694	063°38.184	Plankton net ↓	1464	323	255	10	4.3	3.05	1014.30	99	Bergy
1b	200	Basic	27/Jul/2014	06h42	-4	73°16.685	063°38.152	PNF ↑	1467	316	255	10	4.3	3.05	1014.30	99	Bergy
1b	200	Basic	27/Jul/2014	06h45	-4	73°16.685	063°38.162	Secchi ↓	1468	318	260	9	4.3	3.05	1014.30	99	Bergy
1b	200	Basic	27/Jul/2014	06h47	-4	73°16.694	063°38.174	Secchi ↑	1469	321	255	9	4.3	3.05	1014.30	99	Bergy
1b	200	Basic	27/Jul/2014	06h51	-4	73°16.703	063°38.185	Plankton net ↑	1461	349	250	8	4.2	3.09	1014.32	99	Bergy
1b	200	Basic	27/Jul/2014	07h03	-4	73°16.739	063°38.206	CTD-Rosette ↓	1461	085	270	6	4.1	3.10	1014.29	99	Bergy
1b	200	Basic	27/Jul/2014	07h39	-4	73°16.912	063°37.913	CTD-Rosette ↑	1441	075	280	8	3.9	3.10	1014.37	99	Bergy
1b	200	Basic	27/Jul/2014	07h58	-4	73°16.791	063°38.191	Hydrobios ↓	1460	193	300	6	3.9	3.20	1014.51	99	Bergy
1b	200	Basic	27/Jul/2014	09h25	-4	73°17.311	063°38.638	Hydrobios ↑	1431	166	300	10	7.1	3.12	1014.39	89	Bergy
1b	200	Basic	27/Jul/2014	09h54	-4	73°16.647	063°37.934	CTD-Rosette ↓	1470	138	285	8	4.3	3.15	1014.05	98	Bergy
1b	200	Basic	27/Jul/2014	11h38	-4	73°17.414	063°36.515	CTD-Rosette ↑	1364	148	290	13	5.9	3.07	1013.85	94	Bergy
1b	200	Basic	27/Jul/2014	13h05	-4	73°16.734	063°38.084	Tucker↓	1458	186	300	12	4.0	3.21	1013.85	99	Bergy
1b	200	Basic	27/Jul/2014	13h21	-4	73°16.816	063°36.530	Tucker ↑	1430	330	300	10	4.0	3.30	1013.98	99	Bergy
1b	200	Basic	27/Jul/2014	14h04	-4	73°16.742	063°37.755	CTD-Rosette ↓	1455	108	310	10	4.3	3.27	1014.16	99	Bergy
1b	200	Basic	27/Jul/2014	15h10	-4	73°16.722	063°37.488	CTD-Rosette ↑	1462	108	320	12	3.4	3.08	1014.31	99	Bergy
1b	200	Basic	27/Jul/2014	15h36	-4	73°16.893	063°38.108	Box Core ↓	1451	163	320	9	4.7	3.11	1014.71	99	Bergy
1b	200	Basic	27/Jul/2014	16h02	-4	73°16.897	063°37.939	Box Core (bottom)	1450	160	345	12	4.4	2.97	1015.07	98	Bergy
1b	200	Basic	27/Jul/2014	16h33	-4	73°16.895	063°37.868	Box Core ↑	1442	136	350	15	6.3	3.12	1015.34	92	Bergy

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					
1b	200	Basic	27/Jul/2014	16h49	-4	73°16.796	063°37.807	Agassiz Trawl ↓	1449	126	330	11	3.7	3.08	1015.37	99	Bergy
1b	200	Basic	27/Jul/2014	17h59	-4	73°16.209	063°35.526	Agassiz Trawl ↑	1457	082	320	13	3.7	3.38	1015.37	99	Bergy
1b	200	Basic	27/Jul/2014	18h20	-4	73°16.893	063°38.063	Box Core ↓	1448	120	310	9	3.0	3.35	1015.34	99	Bergy
1b	200	Basic	27/Jul/2014	18h42	-4	73°16.907	063°38.007	Box Core (bottom)	1445	163	310	16	3.6	3.08	1015.53	99	Bergy
1b	200	Basic	27/Jul/2014	19h05	-4	73°16.878	063°37.820	Box Core ↑	1444	181	315	17	3.3	3.24	1015.68	99	Bergy
1b	n-a	Basic	27/Jul/2014	n-a	-a	n-a	n-a	MVP ↓	n-a	n-a	n-a	n-a	n-a	n-a	n-a	n-a	n-a
1b	204	Basic	28/Jul/2014	06h50	-4	73°16.076	058°14.246	MVP ↑	856	086	330	10	2.7	5.89	1016.93	99	Bergy
1b	204	Basic	28/Jul/2014	08h45	-4	73°15.679	057°53.268	Secchi, PNF ↓	986	178	315	8	3.2	5.45	1017.82	99	Bergy
1b	204	Basic	28/Jul/2014	08h52	-4	73°15.727	057°53.497	Secchi, PNF ↑	986	100	315	6	3.3	5.55	1017.92	99	Bergy
1b	204	Basic	28/Jul/2014	08h57	-4	73°15.722	057°53.595	Secchi, PNF ↓	986	122	330	8	3.3	5.55	1017.92	99	Bergy
1b	204	Basic	28/Jul/2014	09h02	-4	73°15.738	057°53.748	Secchi, PNF ↑	986	121	330	8	2.9	5.41	1018.08	99	Bergy
1b	204	Basic	28/Jul/2014	09h25	-4	73°15.724	057°52.919	CTD-Rosette ↓	998	175	300	9	3.3	5.46	1018.00	99	Bergy
1b	204	Basic	28/Jul/2014	10h08	-4	73°15.867	057°52.692	CTD-Rosette ↑	987	140	300	7	4.1	5.58	1016.76	99	Bergy
1b	204	Basic	28/Jul/2014	10h33	-4	73°15.570	057°53.309	Monster, LOKI ↓	987	133	290	5	3.5	5.50	1018.03	99	Bergy
1b	204	Basic	28/Jul/2014	11h42	-4	73°15.370	057°53.390	Monster, LOKI↑	991	075	300	6	3.1	5.67	1017.09	99	Bergy
1b	204	Basic	28/Jul/2014	12h30	-4	73°15.694	057°53.276	CTD-Rosette ↓	987	042	260	4	3.4	5.63	1017.21	99	Bergy
1b	204	Basic	28/Jul/2014	13h42	-4	73°15.657	057°53.094	CTD-Rosette ↑	922	067	260	4	3.9	5.73	1017.55	99	Bergy
1b	204	Basic	28/Jul/2014	13h53	-4	73°15.667	057°53.074	Optic ↓	989	070	260	4	4.4	5.73	1017.50	99	Bergy
1b	204	Basic	28/Jul/2014	14h18	-4	73°15.684	057°52.940	Optic ↑	988	113	250	5	4.6	5.73	1017.68	99	Bergy
1b	204	Basic	28/Jul/2014	14h25	-4	73°15.686	057°52.818	Tucker↓	986	140	250	5	5.4	5.73	1017.47	99	Bergy
1b	204	Basic	28/Jul/2014	14h38	-4	73°16.193	057°52.727	Tucker ↑	986	287	260	5	4.3	5.77	1018.01	99	Bergy
1b	204	Basic	28/Jul/2014	15h00	-4	73°15.655	057°53.329	Box Core ↓	991	141	250	0	4.3	5.80	1017.98	99	Bergy
1b	204	Basic	28/Jul/2014	15h21	-4	73°15.675	057°53.219	Box Core (bottom)	987	134	260	3	5.5	5.46	1018.27	99	Bergy
1b	204	Basic	28/Jul/2014	15h40	-4	73°15.687	057°52.958	Box Core ↑	989	159	270	1	5.4	5.32	1018.27	97	Bergy
1b	204	Basic	28/Jul/2014	15h50	-4	73°15.667	057°52.749	Agassiz Trawl ↓	988	159	280	5	5.2	5.43	1018.29	98	Bergy
1b	204	Basic	28/Jul/2014	16h37	-4	73°15.561	057°50.184	Agassiz Trawl ↑	981	011	290	2	3.9	5.69	1018.54	99	Bergy
1b	204	Basic	28/Jul/2014	16h56	-4	73°15.644	057°53.213	Box Core ↓	986	094	280	5	3.6	5.69	1018.76	99	Bergy
1b	204	Basic	28/Jul/2014	17h14	-4	73°15.666	057°53.264	Box Core (bottom)	995	112	270	4	4.5	5.26	1019.02	96	Bergy
1b	204	Basic	28/Jul/2014	17h31	-4	73°15.670	057°53.236	Box Core ↑	988	089	290	3	4.8	5.10	1019.05	96	Bergy
1b	204	Basic	28/Jul/2014	18h50	-4	73°15.682	057°53.138	CASQ Core ↓	986	278	250	3	3.7	5.36	1019.45	99	Bergy
1b	204	Basic	28/Jul/2014	19h10	-4	73°15.663	057°53.165	CASQ Core (bottom)	987	254	230	3	3.8	5.42	1019.50	99	Bergy
1b	204	Basic	28/Jul/2014	19h38	-4	73°15.694	057°53.271	CASQ Core ↑	986	284	230	4	3.7	5.40	1019.56	99	Bergy

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					
1b	206	Nutrient	29/Jul/2014	01h10	-4	74°04.363	059°02.663	CTD-Rosette ↓	184	028	180	4	4.2	5.07	1020.08	99	Bergy
1b	206	Nutrient	29/Jul/2014	01h38	-4	74°04.474	059°02.565	CTD-Rosette ↑	184	033	210	6	4.7	5.02	1020.14	97	Bergy
1b	208	CTD	29/Jul/2014	05h12	-4	74°44.454	059°59.351	CTD ↓	857	023	185	10	3.4	5.58	1020.94	99	Bergy
1b	208	CTD	29/Jul/2014	05h47	-4	74°44.577	060°00.086	CTD ↑	844	064	190	10	4.7	5.55	1021.12	97	Bergy
1b	210	Basic	29/Jul/2014	10h35	-4	75°25.567	061°57.699	Mapping (Start)	1043	082	135	5	4.1	5.08	1022.55	99	Bergy
1b	210	Basic	29/Jul/2014	12h50	-4	75°24.378	061°38.912	Mapping (End)	1145	293	120	8	4.2	5.23	1022.80	98	Bergy
1b	210	Basic	29/Jul/2014	12h55	-4	75°24.395	061°38.888	PNF ↓	1142	317	120	8	4.2	5.23	1022.80	98	Bergy
1b	210	Basic	29/Jul/2014	12h58	-4	75°24.406	061°38.926	PNF ↑	1140	309	120	8	4.2	5.23	1022.80	98	Bergy
1b	210	Basic	29/Jul/2014	12h58	-4	75°24.416	061°38.964	Secchi ↓	1145	300	120	8	4.2	5.23	1022.80	98	Bergy
1b	210	Basic	29/Jul/2014	13h00	-4	75°24.408	061°38.939	Secchi ↑	1145	318	120	8	4.2	5.23	1022.70	98	Bergy
1b	210	Basic	29/Jul/2014	13h17	-4	75°24.453	061°38.965	CTD-Rosette ↓	1133	327	110	3	4.7	5.18	1023.12	98	Bergy
1b	210	Basic	29/Jul/2014	13h52	-4	75°24.481	061°39.257	CTD-Rosette ↑	1142	353	110	3	5.8	5.07	1023.12	94	Bergy
1b	210	Basic	29/Jul/2014	14h33	-4	75°24.413	061°39.431	Monster, LOKI ↓	1155	345	120	2	5.4	5.13	1023.44	99	Bergy
1b	210	Basic	29/Jul/2014	16h03	-4	75°24.613	061°39.569	Monster, LOKI↑	1147	322	140	5	4.4	5.10	1023.98	99	Bergy
1b	210	Basic	29/Jul/2014	16h27	-4	75°24.185	061°37.722	Tucker↓	1126	148	130	8	5.3	5.19	1024.06	96	Bergy
1b	210	Basic	29/Jul/2014	16h52	-4	75°24.299	061°34.638	Tucker ↑	1154	018	120	3	4.7	5.30	1024.23	99	Bergy
1b	210	Basic	29/Jul/2014	17h13	-4	75°24.024	061°39.021	CTD-Rosette ↓	1157	320	120	5	4.8	5.35	1024.30	99	Bergy
1b	210	Basic	29/Jul/2014	17h26	-4	75°24.0115	061°39.870	CTD-Rosette ↑	1168	315	130	5	5.4	5.40	1024.50	95	Bergy
1b	210	Basic	29/Jul/2014	18h52	-4	75°24.317	061°39.357	CASQ Core ↓	1155	276	130	11	4.9	5.10	1024.44	99	Bergy
1b	210	Basic	29/Jul/2014	19h10	-4	75°24.323	061°39.316	CASQ Core (bottom)	1154	332	130	7	5.0	4.92	1024.52	98	Bergy
1b	210	Basic	29/Jul/2014	19h39	-4	75°24.423	061°40.114	CASQ Core ↑	1156	027	125	3	5.4	5.25	1024.76	97	Bergy
1b	210	Basic	29/Jul/2014	20h32	-4	75°24.250	061°39.167	Box Core ↓	1157	266	135	6	4.4	5.36	1024.77	99	Bergy
1b	210	Basic	29/Jul/2014	20h55	-4	75°24.372	061°39.750	Box Core (bottom)	1149	245	135	8	4.1	5.33	1024.85	99	Bergy
1b	210	Basic	29/Jul/2014	21h12	-4	75°24.490	061°39.990	Box Core ↑	1137	265	135	7	4.1	5.37	1024.76	99	Bergy
1b	210	Basic	29/Jul/2014	21h29	-4	75°24.484	061°40.710	Agassiz Trawl ↓	1163	170	135	9	4.0	5.36	1024.75	99	Bergy
1b	210	Basic	29/Jul/2014	22h15	-4	75°24.792	061°40.809	Agassiz Trawl ↑	1119	196	135	6	4.0	5.41	1024.91	99	Bergy
1b	210	Basic	29/Jul/2014	22h35	-4	75°24.464	061°39.374	Box Core ↓	1162	275	120	7	3.8	5.41	1024.74	99	Bergy
1b	210	Basic	29/Jul/2014	22h53	-4	75°24.574	061°39.695	Box Core (bottom)	1152	258	140	7	3.4	5.29	1024.65	99	Bergy
1b	210	Basic	29/Jul/2014	23h14	-4	75°24.717	061°39.989	Box Core ↑	1148	252	135	7	3.3	5.38	1024.50	99	Bergy
1b	212	CTD	30/Jul/2014	03h15	-4	75°37.986	064°36.115	CTD-Rosette ↓	499	305	90	5	3.6	4.02	1024.10	99	Bergy
1b	212	CTD	30/Jul/2014	03h35	-4	75°37.876	064°35.928	CTD-Rosette ↑	499	267	100	5	3.7	3.71	1024.17	99	Bergy
1b	214	Nutrient	30/Jul/2014	08h16	-4	75°47.642	067°56.959	CTD-Rosette ↓	284	298	90	14	3.2	3.43	1024.43	99	Bergy

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					
1b	214	Nutrient	30/Jul/2014	08h52	-4	75°47.898	067°58.675	CTD-Rosette ↑	286	323	90	15	4.1	3.53	1024.67	99	Bergy
1b	115	Full	30/Jul/2014	13h45	-4	76°19.994	071°12.987	Secchi, PNF ↓	675	095	90	7	3.3	3.14	1023.04	99	Bergy
1b	115	Full	30/Jul/2014	13h50	-4	76°20.043	071°12.982	Secchi, PNF ↑	675	121	90	8	3.0	3.08	1022.53	99	Bergy
1b	115	Full	30/Jul/2014	13h52	-4	76°20.048	071°12.962	Plankton net ↓	675	123	90	8	3.0	3.08	1022.53	99	Bergy
1b	115	Full	30/Jul/2014	13h56	-4	76°20.058	071°12.945	Plankton net ↑	677	126	100	8	3.0	3.08	1022.53	99	Bergy
1b	115	Full	30/Jul/2014	14h06	-4	76°20.074	071°12.848	CTD-Rosette ↓	676	119	90	8	2.6	3.02	1022.26	99	Bergy
1b	115	Full	30/Jul/2014	14h43	-4	76°20.086	071°12.817	CTD-Rosette ↑	677	139	90	9	2.7	3.06	1022.21	99	Bergy
1b	115	Full	30/Jul/2014	15h40	-4	76°19.952	071°12.291	Hydrobios ↓	676	104	90	6	3.1	3.08	1022.26	99	Bergy
1b	115	Full	30/Jul/2014	16h21	-4	76°19.890	071°12.282	Hydrobios ↑	671	088	120	4	3.0	3.03	1022.05	99	Bergy
1b	115	Full	30/Jul/2014	16h44	-4	76°19.623	071°09.876	CTD-Rosette ↓	674	095	95	3	3.0	3.04	1022.53	99	Bergy
1b	115	Full	30/Jul/2014	17h42	-4	76°19.257	071°09.968	CTD-Rosette ↑	657	070	100	5	3.1	3.18	1022.13	99	Bergy
1b	115	Full	30/Jul/2014	18h22	-4	76°20.104	071°13.052	Monster, LOKI ↓	674	243	120	3	3.1	3.05	1021.53	99	Bergy
1b	115	Full	30/Jul/2014	19h10	-4	76°19.968	071°13.559	Monster, LOKI↑	659	287	n-a	0	3.5	3.20	1023.61	98	Bergy
1b	115	Full	30/Jul/2014	19h38	-4	76°19.883	071°13.890	CTD-Rosette ↓	665	341	n-a	0	3.6	3.31	1023.88	97	Bergy
1b	115	Full	30/Jul/2014	20h04	-4	76°19.864	071°14.321	CTD-Rosette ↑	670	031	n-a	0	3.5	3.20	1023.98	98	Bergy
1b	115	Full	30/Jul/2014	20h27	-4	76°19.947	071°11.426	Bioness ↓	676	103	n-a	0	3.2	3.12	1023.19	99	Bergy
1b	115	Full	30/Jul/2014	20h36	-4	76°19.694	071°11.279	Bioness ↑	641	226	n-a	0	3.2	3.16	1023.10	99	Bergy
1b	115	Full	30/Jul/2014	20h59	-4	76°19.967	071°11.541	Tucker ↓	674	071	n-a	0	3.0	3.27	1021.38	99	Bergy
1b	115	Full	30/Jul/2014	21h15	-4	76°20.409	071°12.681	Tucker ↑	656	259	n-a	0	2.9	3.23	1020.85	99	Bergy
1b	115	Full	30/Jul/2014	22h10	-4	76°18.836	071°06.788	Box Core ↓	656	218	n-a	0	3.1	3.24	1020.59	99	Bergy
1b	115	Full	30/Jul/2014	22h25	-4	76°18.998	071°07.196	Box Core (bottom)	656	228	n-a	0	3.3	2.68	1020.68	99	Bergy
1b	115	Full	30/Jul/2014	22h37	-4	76°19.096	071°07.577	Box Core ↑	656	202	n-a	0	3.2	2.59	1020.42	99	Bergy
1b	115	Full	30/Jul/2014	22h51	-4	76°18.710	071°06.261	Agassiz Trawl ↓	656	123	n-a	0	3.1	2.60	1020.48	99	Bergy
1b	115	Full	30/Jul/2014	23h32	-4	76°18.870	071°06.380	Agassiz Trawl ↑	662	038	n-a	0	2.8	3.19	1020.77	99	Bergy
1b	115	Full	31/Jul/2014	00h14	-4	76°18.863	071°06.748	Box Core ↓	655	119	n-a	0	2.8	3.49	1020.47	99	Bergy
1b	115	Full	31/Jul/2014	00h24	-4	76°18.897	071°06.687	Box Core (bottom)	657	167	n-a	0	2.8	3.44	1020.28	99	Bergy
1b	115	Full	31/Jul/2014	00h33	-4	76°18.888	071°06.773	Box Core ↑	658	174	n-a	0	2.8	3.46	1020.32	98	Bergy
1b	114	CTD	31/Jul/2014	01h48	-4	76°19.498	071°47.109	CTD-Rosette ↓	616	286	n-a	0	2.9	3.31	1021.3	99	Bergy
1b	114	CTD	31/Jul/2014	02h13	-4	76°19.564	071°46.838	CTD-Rosette ↑	621	314	n-a	0	3.1	3.71	1021.4	99	Bergy
1b	113	Nutrient	31/Jul/2014	03h00	-4	76°19.172	072°12.518	CTD-Rosette ↓	552	271	n-a	0	3.4	3.97	1020.82	99	Bergy
1b	113	Nutrient	31/Jul/2014	04h05	-4	76°19.014	072°12.330	CTD-Rosette ↑	547	321	270	3	3.3	4.02	1021.26	99	Bergy
1b	112	CTD	31/Jul/2014	04h58	-4	76°19.095	072°42.317	CTD ↓	574	314	290	7	3.4	4.10	1021.28	99	Bergy

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					
1b	112	CTD	31/Jul/2014	05h23	-4	76°18.980	072°42.416	CTD ↑	571	356	295	7	3.3	3.89	1021.45	99	Bergy
1b	112	CTD	31/Jul/2014	05h43	-4	76°18.917	072°42.132	IKMT test ↓	562	072	305	5	3.2	3.87	1021.42	99	Bergy
1b	112	CTD	31/Jul/2014	06h22	-4	76°18.877	072°44.241	IKMT test ↑	566	162	285	8	3.5	3.93	1021.17	99	Bergy
1b	111	Basic	31/Jul/2014	07h07	-4	76°18.387	073°13.300	CTD-Rosette ↓	592	198	315	6	3.7	4.02	1020.40	99	Bergy
1b	111	Basic	31/Jul/2014	07h33	-4	76°18.304	073°13.738	CTD-Rosette ↑	596	236	335	6	4.0	4.07	1021.19	99	Bergy
1b	111	Basic	31/Jul/2014	07h51	-4	76°18.300	073°13.673	Monster, LOKI ↓	598	015	315	8	3.8	4.14	1021.33	99	Bergy
1b	111	Basic	31/Jul/2014	08h30	-4	76°18.000	073°13.000	Monster, LOKI↑	596	030	300	6	3.5	4.35	1022.30	99	Bergy
1b	111	Basic	31/Jul/2014	08h51	-4	76°18.397	073°12.961	CTD-Rosette ↓	595	171	315	7	3.4	4.39	1022.45	99	Bergy
1b	111	Basic	31/Jul/2014	09h41	-4	76°18.335	073°13.622	CTD-Rosette ↑	599	223	330	8	4.2	4.22	1020.25	99	Bergy
1b	111	Basic	31/Jul/2014	10h15	-4	76°18.400	073°14.189	Tucker ↓	600	074	330	8	4.4	4.39	1020.22	99	Bergy
1b	111	Basic	31/Jul/2014	10h35	-4	76°18.595	073°13.892	Tucker ↑	397	011	325	10	3.9	4.40	1020.07	99	Bergy
1b	111	Basic	31/Jul/2014	10h57	-4	76°18.354	073°13.180	Box Core ↓	594	109	300	6	4.0	4.39	1019.91	99	Bergy
1b	111	Basic	31/Jul/2014	11h10	-4	76°18.376	073°13.156	Box Core (bottom)	594	055	310	6	3.6	4.47	1019.65	99	Bergy
1b	111	Basic	31/Jul/2014	11h23	-4	76°18.406	073°13.117	Box Core ↑	595	056	310	6	3.6	4.48	1019.58	99	Bergy
1b	111	Basic	31/Jul/2014	12h16	-4	76°18.313	073°14.444	Agassiz Trawl ↓	596	006	310	6	3.9	4.43	1019.42	99	Bergy
1b	111	Basic	31/Jul/2014	13h10	-4	76°18.987	073°15.184	Agassiz Trawl ↑	606	269	300	6	3.8	4.49	1019.35	99	Bergy
1b	110	Nutrient	31/Jul/2014	13h56	-4	76°17.919	073°37.676	CTD-Rosette ↓	532	267	330	5	3.8	4.54	1019.16	99	Bergy
1b	110	Nutrient	31/Jul/2014	14h48	-4	76°17.798	073°37.561	CTD-Rosette ↑	529	290	300	7	3.8	4.38	1019.05	99	Bergy
1b	109	CTD	31/Jul/2014	15h44	-4	76°17.335	074°06.571	CTD-Rosette ↓	452	314	300	7	3.5	4.73	1016.67	99	Bergy
1b	109	CTD	31/Jul/2014	16h05	-4	76°17.273	074°06.258	CTD-Rosette ↑	452	015	315	9	3.4	4.41	1018.91	99	Bergy
1b	108	Full	31/Jul/2014	17h03	-4	76°16.281	074°35.702	Plankton net ↓	444	356	315	6	2.6	4.57	1018.62	99	Bergy
1b	108	Full	31/Jul/2014	17h06	-4	76°16.229	074°35.650	Plankton net ↑	444	358	320	8	2.7	4.53	1018.65	99	Bergy
1b	108	Full	31/Jul/2014	17h10	-4	76°16.224	074°35.642	PNF ↓	444	357	315	7	2.7	4.53	1018.65	99	Bergy
1b	108	Full	31/Jul/2014	17h13	-4	76°16.216	074°35.631	PNF ↑	444	357	310	6	2.7	4.53	1018.65	99	Bergy
1b	108	Full	31/Jul/2014	17h15	-4	76°16.209	074°35.617	Secchi ↓	444	358	320	6	2.7	4.53	1018.65	99	Bergy
1b	108	Full	31/Jul/2014	17h17	-4	76°16.211	074°35.619	Secchi ↑	444	337	315	5	2.7	4.53	1018.65	99	Bergy
1b	108	Full	31/Jul/2014	17h54	-4	76°16.174	074°36.155	CTD-Rosette ↓	447	330	295	5	2.3	4.34	1018.32	99	Bergy
1b	108	Full	31/Jul/2014	18h47	-4	76°16.052	074°35.952	CTD-Rosette ↑	448	004	270	4	2.6	4.56	1018.53	99	Bergy
1b	108	Full	31/Jul/2014	19h10	-4	76°16.122	074°36.279	Hydrobios ↓	447	255	310	4	2.9	4.63	1018.37	99	Bergy
1b	108	Full	31/Jul/2014	19h36	-4	76°16.020	074°36.737	Hydrobios ↑	448	026	320	5	2.7	4.37	1018.15	99	Bergy
1b	108	Full	31/Jul/2014	20h10	-4	76°16.250	074°36.192	Monster, LOKI ↓	446	047	315	4	2.6	4.59	1018.19	99	Bergy
1b	108	Full	31/Jul/2014	20h42	-4	76°16.176	074°36.681	Monster, LOKI↑	449	056	330	4	2.4	4.38	1018.16	99	Bergy

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					
1b	108	Full	31/Jul/2014	21h10	-4	76°16.381	074°35.730	Optic ↓	446	048	330	3	2.3	4.35	1018.29	99	Bergy
1b	108	Full	31/Jul/2014	21h34	-4	76°16.390	074°36.100	Optic ↑	446	077	000	3	2.4	4.32	1017.91	99	Bergy
1b	108	Full	31/Jul/2014	21h45	-4	76°16.184	074°36.660	Bioness ↓	448	290	015	4	2.4	4.33	1017.88	99	Bergy
1b	108	Full	31/Jul/2014	22h01	-4	76°16.362	074°36.947	Bioness ↑	448	142	000	5	2.5	4.32	1017.96	99	Bergy
1b	108	Full	31/Jul/2014	22h14	-4	76°16.182	074°36.242	Tucker ↓	447	101	030	5	2.4	4.28	1018.02	99	Bergy
1b	108	Full	31/Jul/2014	22h32	-4	76°16.723	074°35.922	Tucker ↑	444	302	000	2	2.6	4.26	1017.87	99	Bergy
1b	108	Full	31/Jul/2014	22h48	-4	76°16.210	074°35.823	Bioness ↓	445	250	030	2	2.5	4.27	1017.89	99	Bergy
1b	108	Full	31/Jul/2014	22h56	-4	76°16.287	074°36.963	Bioness ↑	448	318	090	3	2.5	4.32	1017.80	99	Bergy
1b	108	Full	31/Jul/2014	23h56	-4	76°16.356	074°36.428	Agassiz Trawl ↓	448	226	140	2	3.0	4.25	1017.22	99	Bergy
1b	108	Full	01/Aug/2014	00h35	-4	76°16.258	074°36.418	Agassiz Trawl ↑	449	206	110	5	3.1	4.29	1017.30	99	Bergy
1b	108	Full	01/Aug/2014	00h46	-4	76°16.251	074°36.362	Box Core ↓	448	136	140	6	3.0	4.29	1017.31	99	Bergy
1b	108	Full	01/Aug/2014	00h56	-4	76°16.274	074°36.417	Box Core (bottom)	447	122	150	6	3.1	4.31	1017.33	99	Bergy
1b	108	Full	01/Aug/2014	01h08	-4	76°16.283	074°36.298	Box Core ↑	448	116	150	6	3.1	4.31	1017.30	99	Bergy
1b	108	Full	01/Aug/2014	01h50	-4	76°16.286	074°35.925	CTD-Rosette ↓	447	152	130	11	3.5	4.26	1016.59	99	Bergy
1b	108	Full	01/Aug/2014	02h13	-4	76°16.351	074°36.288	CTD-Rosette ↑	449	263	130	9	4.5	4.25	1017.01	99	Bergy
1b	107	Nutrient	01/Aug/2014	03h14	-4	76°16.933	074°58.795	CTD-Rosette ↓	441	352	120	12	3.9	4.55	1016.58	99	Bergy
1b	107	Nutrient	01/Aug/2014	03h54	-4	76°16.935	074°58.995	CTD-Rosette ↑	439	307	115	14	4.5	4.33	1016.68	99	Bergy
1b	106	CTD	01/Aug/2014	04h51	-4	76°18.505	075°21.692	CTD-Rosette ↓	379	294	120	15	4.4	4.68	1015.86	99	Bergy
1b	106	CTD	01/Aug/2014	05h11	-4	76°18.478	075°22.190	CTD-Rosette ↑	379	315	125	17	4.5	4.56	1015.93	99	Bergy
1b	105	Basic	01/Aug/2014	06h01	-4	76°19.085	075°46.495	CTD-Rosette ↓	333	307	125	13	5.2	4.74	1017.23	98	Bergy
1b	105	Basic	01/Aug/2014	06h50	-4	76°18.825	075°47.625	CTD-Rosette ↑	334	307	115	14	4.7	4.66	1017.20	99	Bergy
1b	105	Basic	01/Aug/2014	07h27	-4	76°18.962	075°46.786	Monster, LOKI ↓	334	304	115	16	7.5	4.61	1017.46	94	Bergy
1b	105	Basic	01/Aug/2014	08h00	-4	76°19.024	075°47.431	Monster, LOKI↑	337	327	125	19	4.7	4.60	1017.17	99	Bergy
1b	105	Basic	01/Aug/2014	08h25	-4	76°19.272	075°49.563	Tucker ↓	335	347	120	21	6.5	4.56	1017.28	96	Bergy
1b	105	Basic	01/Aug/2014	08h53	-4	76°19.390	075°54.585	Tucker ↑	323	272	120	19	4.6	4.61	1016.81	99	Bergy
1b	105	Basic	01/Aug/2014	09h30	-4	76°19.384	075°46.710	CTD-Rosette ↓	334	305	120	16	4.9	4.68	1015.51	99	Bergy
1b	105	Basic	01/Aug/2014	09h55	-4	76°19.581	075°48.495	CTD-Rosette ↑	343	266	110	13	7.0	4.55	1016.47	95	Bergy
1b	105	Basic	01/Aug/2014	10h10	-4	76°19.590	075°50.257	Optic #1 ↓	328	320	110	18	5.6	4.52	1016.40	97	Bergy
1b	105	Basic	01/Aug/2014	10h26	-4	76°19.822	075°51.259	Optic #1 ↑	327	268	130	20	5.7	4.58	1016.52	96	Bergy
1b	105	Basic	01/Aug/2014	10h28	-4	76°19.822	075°51.259	Optic #2 ↓	327	268	130	20	5.7	4.58	1016.52	96	Bergy
1b	105	Basic	01/Aug/2014	10h42	-4	76°20.118	075°52.226	Optic #2 ↑	325	280	135	21	4.9	4.60	1016.35	98	Bergy
1b	105	Basic	01/Aug/2014	11h06	-4	76°19.426	075°47.796	Box Core ↓	342	321	120	23	4.6	4.56	1015.75	99	Bergy

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					
1b	105	Basic	01/Aug/2014	11h15	-4	76°19.558	075°48.123	Box Core (bottom)	343	302	120	22	6.6	4.59	1016.22	93	Bergy
1b	105	Basic	01/Aug/2014	11h24	-4	76°19.681	075°48.555	Box Core ↑	345	297	120	19	5.9	4.62	1016.18	96	Bergy
1b	105	Basic	01/Aug/2014	11h43	-4	76°19.780	075°48.471	Agassiz Trawl ↓	345	318	120	22	5.2	4.60	1015.66	99	Bergy
1b	105	Basic	01/Aug/2014	12h15	-4	76°20.298	075°52.567	Agassiz Trawl ↑	331	209	110	15	4.9	4.57	1016.40	99	Bergy
1b	104	CTD	01/Aug/2014	13h08	-4	76°20.475	076°10.337	CTD-Rosette ↓	193	313	110	12	5.5	4.64	1016.79	98	Bergy
1b	104	CTD	01/Aug/2014	13h22	-4	76°20.473	076°10.322	CTD-Rosette ↑	192	306	100	12	5.3	4.62	1017.79	98	Bergy
1b	103	Nutrient	01/Aug/2014	13h53	-4	76°21.217	076°34.411	CTD-Rosette ↓	149	282	110	12	4.5	4.60	1016.93	99	Bergy
1b	103	Nutrient	01/Aug/2014	14h21	-4	76°21.366	076°34.966	CTD-Rosette ↑	149	277	110	11	5.3	4.46	1017.46	99	Bergy
1b	102	CTD	01/Aug/2014	15h05	-4	76°22.409	076°58.369	CTD-Rosette ↓	241	279	100	9	5.7	4.56	1015.67	96	Bergy
1b	102	CTD	01/Aug/2014	15h20	-4	76°22.377	076°58.671	CTD-Rosette ↑	246	294	100	9	6.4	4.43	1015.63	95	Bergy
1b	101	Full	01/Aug/2014	15h59	-4	76°22.900	077°23.568	Optic #1 ↓	353	270	085	11	4.6	3.62	1015.89	99	Bergy
1b	101	Full	01/Aug/2014	16h12	-4	76°22.851	077°23.558	Optic #1 ↑	355	265	090	12	5.1	3.18	1015.79	99	Bergy
1b	101	Full	01/Aug/2014	16h14	-4	76°22.840	077°23.568	Optic #2 ↓	355	266	090	11	5.1	3.18	1015.79	99	Bergy
1b	101	Full	01/Aug/2014	16h27	-4	76°22.789	077°23.673	Optic #2 ↑	356	261	080	7	5.6	3.10	1015.65	99	Bergy
1b	101	Full	01/Aug/2014	16h41	-4	76°22.717	077°23.671	Secchi, PNF, plankton ↓	357	267	085	11	6.3	2.80	1015.74	95	Bergy
1b	101	Full	01/Aug/2014	16h52	-4	76°22.641	077°23.706	Secchi, PNF, plankton ↑	361	261	090	10	5.1	2.80	1015.79	99	Bergy
1b	101	Full	01/Aug/2014	16h50	-4	76°22.810	077°23.762	CTD-Rosette ↓	360	254	070	8	5.1	2.80	1015.79	99	Bergy
1b	101	Full	01/Aug/2014	17h51	-4	76°22.246	077°24.660	CTD-Rosette ↑	383	220	010	12	4.2	2.84	1015.75	98	Bergy
1b	101	Full	01/Aug/2014	18h03	-4	76°22.184	077°24.953	Tucker ↓	390	235	040	8	4.7	2.84	1015.61	97	Bergy
1b	101	Full	01/Aug/2014	18h25	-4	76°21.126	077°25.835	Tucker ↑	392	156	050	10	3.4	2.93	1015.44	99	Bergy
1b	101	Full	01/Aug/2014	19h22	-4	76°23.144	077°24.059	Hydrobios ↓	347	231	030	12	6.6	3.31	1015.43	94	Bergy
1b	101	Full	01/Aug/2014	19h45	-4	76°23.012	077°24.139	Hydrobios ↑	356	255	030	10	4.0	3.13	1015.44	99	Bergy
1b	101	Full	01/Aug/2014	20h35	-4	76°23.030	077°25.919	Monster, LOKI ↓	392	220	000	17	3.6	2.88	1015.70	99	Bergy
1b	101	Full	01/Aug/2014	21h08	-4	76°22.991	077°26.969	Monster, LOKI ↑	399	216	030	13	3.3	2.33	1015.59	99	Bergy
1b	101	Full	01/Aug/2014	21h55	-4	76°23.047	077°24.827	Bioness ↓	369	232	030	11	4.3	2.85	1015.58	98	Bergy
1b	101	Full	01/Aug/2014	22h05	-4	76°22.984	077°26.415	Bioness ↑	397	315	030	15	3.2	2.94	1015.57	99	Bergy
1b	101	Full	01/Aug/2014	23h09	-4	76°21.385	077°32.489	Box Core ↓	365	217	015	17	5.1	2.85	1015.29	98	Bergy
1b	101	Full	01/Aug/2014	23h21	-4	76°21.293	077°33.200	Box Core (bottom)	360	125	015	16	3.7	2.36	1015.12	97	Bergy
1b	101	Full	01/Aug/2014	23h31	-4	76°21.263	077°33.917	Box Core ↑	349	194	015	13	2.3	2.60	1015.21	99	Bergy
1b	101	Full	01/Aug/2014	23h43	-4	76°21.202	077°34.905	Agassiz Trawl ↓	340	190	015	14	3.3	2.86	1015.23	99	Bergy
1b	101	Full	02/Aug/2014	00h13	-4	76°21.159	077°32.081	Agassiz Trawl ↑	377	358	010	16	2.4	2.88	1014.90	99	Bergy
1b	101	Full	02/Aug/2014	00h28	-4	76°21.284	077°32.574	Box Core ↓	365	228	020	16	2.6	2.76	1015.90	99	Bergy

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					
1b	101	Full	02/Aug/2014	00h34	-4	76°21.307	077°32.673	Box Core (bottom)	365	208	010	10	3.0	2.36	1015.01	99	Bergy
1b	101	Full	02/Aug/2014	00h40	-4	76°21.336	077°32.809	Box Core ↑	365	221	020	15	4.5	1.75	1015.00	98	Bergy
1b	101	Full	02/Aug/2014	01h35	-4	76°23.056	077°23.761	CTD-Rosette ↓	350	276	010	14	2.5	2.79	1014.67	99	Bergy
1b	101	Full	02/Aug/2014	02h10	-4	76°23.033	077°23.937	CTD-Rosette ↑	354	252	010	9	4.6	2.14	1014.69	95	Bergy
1b	KEN1	Full	03/Aug/2014	08h08	-4	81°21.959	064°11.710	Secchi, PNF, plankton ↓	496	350	240	10	2.8	-0.60	1009.53	90	Bergy
1b	KEN1	Full	03/Aug/2014	08h29	-4	81°22.010	064°10.628	Secchi, PNF, plankton ↑	498	079	225	9	1.7	-0.61	1010.14	92	Bergy
1b	KEN1	Full	03/Aug/2014	08h53	-4	81°22.023	064°10.735	CTD-Rosette ↓	497	058	255	17	3.3	-0.62	1009.89	86	Bergy
1b	KEN1	Full	03/Aug/2014	09h29	-4	81°22.266	064°09.001	CTD-Rosette ↑	533	089	210	18	3.6	-0.59	1009.72	86	Bergy
1b	KEN1	Full	03/Aug/2014	09h45	-4	81°22.596	064°06.977	Tucker ↓	547	033	225	22	2.8	-0.56	1009.20	89	Bergy
1b	KEN1	Full	03/Aug/2014	10h14	-4	81°22.725	064°08.233	Tucker ↑	532	040	210	25	2.6	-0.62	1009.25	89	Bergy
1b	KEN1	Full	03/Aug/2014	10h40	-4	81°23.076	064°05.850	Bioness ↓	530	012	170	22	2.4	-0.63	1009.50	90	Bergy
1b	KEN1	Full	03/Aug/2014	11h00	-4	81°23.170	064°02.300	Bioness ↑	521	080	160	15	2.9	-0.64	1009.00	89	Bergy
1b	KEN1	Full	03/Aug/2014	11h53	-4	81°22.990	063°58.530	Monster, LOKI ↓	535	041	210	21	3.3	-0.62	1009.88	88	Bergy
1b	KEN1	Full	03/Aug/2014	12h42	-4	81°22.460	063°57.974	Monster, LOKI ↑	524	056	210	22	5.5	-0.59	1010.21	84	Bergy
1b	KEN1	Full	03/Aug/2014	14h00	-4	81°22.167	063°56.521	CTD-Rosette ↓	548	066	230	6	3.2	-0.58	1010.96	92	Bergy
1b	KEN1	Full	03/Aug/2014	14h50	-4	81°21.604	063°57.361	CTD-Rosette ↑	530	037	160	4	1.9	-0.56	1010.96	97	Bergy
1b	KEN1	Full	03/Aug/2014	15h05	-4	81°21.580	063°57.295	Hydrobios ↓	531	052	170	3	1.6	-0.55	1010.97	96	Bergy
1b	KEN1	Full	03/Aug/2014	15h37	-4	81°21.322	063°57.565	Hydrobios ↑	541	038	190	12	4.5	-0.56	1010.94	88	Bergy
1b	KEN1	Full	03/Aug/2014	18h29	-4	81°22.294	063°57.332	Box Core ↓	560	315	215	20	1.5	-0.35	1011.44	93	Bergy
1b	KEN1	Full	03/Aug/2014	18h40	-4	81°22.313	063°56.708	Box Core (bottom)	560	021	200	20	1.6	-0.33	1011.43	93	Bergy
1b	KEN1	Full	03/Aug/2014	18h53	-4	81°22.342	063°56.248	Box Core ↑	551	010	200	18	2.5	-0.31	1011.60	90	Bergy
1b	KEN1	Full	03/Aug/2014	19h00	-4	81°22.363	063°55.928	Agassiz Trawl ↓	549	007	195	18	2.8	-0.31	1011.63	89	Bergy
1b	KEN1	Full	03/Aug/2014	19h58	-4	81°24.179	064°00.159	Agassiz Trawl ↑	549	020	210	27	3.0	-0.31	1011.16	88	Bergy
1b	KEN2	Nutrient	03/Aug/2014	22h47	-4	81°04.731	065°50.169	CTD-Rosette ↓	387	019	225	26	2.7	-0.59	1012.58	94	Bergy
1b	KEN2	Nutrient	03/Aug/2014	23h26	-4	81°04.788	065°49.250	CTD-Rosette ↑	388	053	210	23	4.1	-0.61	1012.99	88	Bergy
1b	KEN3	Basic	04/Aug/2014	01h22	-4	80°47.864	067°19.100	Plankton net ↓	404	039	230	17	2.0	-0.30	1013.75	96	Bergy
1b	KEN3	Basic	04/Aug/2014	01h26	-4	80°47.777	067°19.056	Plankton net ↑	402	042	230	17	2.0	-0.30	1013.75	96	Bergy
1b	KEN3	Basic	04/Aug/2014	01h50	-4	80°47.565	067°18.065	CTD-Rosette ↓	402	308	250	14	2.3	-0.15	1014.49	97	Bergy
1b	KEN3	Basic	04/Aug/2014	02h11	-4	80°47.273	067°17.404	CTD-Rosette ↑	403	016	250	14	1.3	-0.11	1014.59	98	Bergy
1b	KEN3	Basic	04/Aug/2014	02h37	-4	80°47.962	067°17.875	Monster, LOKI ↓	406	256	220	8	2.0	-0.10	1014.86	97	Bergy
1b	KEN3	Basic	04/Aug/2014	03h15	-4	80°47.646	067°18.742	Monster, LOKI ↑	402	319	210	10	1.7	-0.11	1015.13	98	Bergy
1b	KEN3	Basic	04/Aug/2014	03h35	-4	80°48.013	067°17.766	CTD-Rosette ↓	407	114	230	11	1.6	-0.14	1015.20	99	Bergy

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					
1b	KEN3	Basic	04/Aug/2014	04h15	-4	80°47.729	067°18.067	CTD-Rosette ↑	406	082	210	17	2.5	-0.11	1015.20	96	Bergy
1b	KEN3	Basic	04/Aug/2014	04h23	-4	80°47.843	067°17.665	Tucker ↓	406	032	200	15	2.5	-0.11	1015.26	97	Bergy
1b	KEN3	Basic	04/Aug/2014	04h47	-4	80°48.283	067°14.825	Tucker ↑	409	323	215	17	2.5	-0.28	1015.34	96	Bergy
1b	KEN3	Basic	04/Aug/2014	05h00	-4	80°47.904	067°16.001	Agassiz Trawl ↓	409	041	220	12	2.3	-0.29	1015.31	98	Bergy
1b	KEN3	Basic	04/Aug/2014	05h50	-4	80°47.918	067°13.929	Agassiz Trawl ↑	408	069	215	14	2.4	-0.29	1015.51	97	Bergy
1b	KEN4	Nutrient	04/Aug/2014	08h38	-4	80°24.000	068°48.200	CTD-Rosette ↓	370	059	240	9	1.1	-0.01	1016.11	98	Bergy
1b	KEN4	Nutrient	04/Aug/2014	09h26	-4	80°23.921	068°48.581	CTD-Rosette ↑	368	024	150	5	2.2	-0.01	1016.29	96	Bergy
1b	KANE1	Basic	04/Aug/2014	12h13	-4	79°59.411	069°45.664	PNF ↓	244	315	210	13	3.8	0.46	1016.81	91	Bergy
1b	KANE1	Basic	04/Aug/2014	12h16	-4	79°59.382	069°45.794	PNF ↑	246	319	210	13	3.8	0.46	1016.73	92	Bergy
1b	KANE1	Basic	04/Aug/2014	12h16	-4	79°59.382	069°45.784	Secchi ↓	246	319	210	13	3.8	0.46	1016.73	92	Bergy
1b	KANE1	Basic	04/Aug/2014	12h18	-4	79°59.361	069°45.848	Secchi ↑	245	324	210	13	3.8	0.46	1016.73	92	Bergy
1b	KANE1	Basic	04/Aug/2014	12h19	-4	79°59.343	069°45.895	Plankton net ↓	245	326	210	14	3.5	0.53	1016.73	92	Bergy
1b	KANE1	Basic	04/Aug/2014	12h23	-4	79°59.284	069°45.990	Plankton net ↑	247	308	205	12	3.5	0.53	1016.73	92	Bergy
1b	KANE1	Basic	04/Aug/2014	12h34	-4	79°59.137	069°46.705	CTD-Rosette ↓	245	83	210	13	3.2	0.50	1016.71	94	Bergy
1b	KANE1	Basic	04/Aug/2014	13h10	-4	79°58.614	069°48.006	CTD-Rosette ↑	245	123	235	9	3.9	0.45	1016.68	90	Bergy
1b	KANE1	Basic	04/Aug/2014	13h21	-4	79°58.400	069°47.948	Tucker ↓	246	097	235	10	3.9	0.45	1016.98	90	Bergy
1b	KANE1	Basic	04/Aug/2014	13h51	-4	79°58.856	069°49.469	Tucker ↑	244	210	225	11	3.5	0.52	1016.89	91	Bergy
1b	KANE1	Basic	04/Aug/2014	14h30	-4	79°59.983	069°45.314	CTD-Rosette ↓	245	339	230	17	5.2	0.54	1016.70	86	Bergy
1b	KANE1	Basic	04/Aug/2014	15h09	-4	79°59.584	069°46.636	CTD-Rosette ↑	239	296	180	10	4.9	0.47	1016.80	84	Bergy
1b	KANE1	Basic	04/Aug/2014	15h50	-4	79°59.696	069°44.634	Monster, LOKI ↓	244	303	205	13	2.6	0.83	1016.74	94	Bergy
1b	KANE1	Basic	04/Aug/2014	16h14	-4	79°59.473	069°45.314	Monster, LOKI ↑	246	352	205	13	2.6	0.98	1016.71	94	Bergy
1b	KANE1	Basic	04/Aug/2014	16h33	-4	79°59.493	069°45.466	Agassiz Trawl ↓	246	021	210	11	3.0	1.22	1016.83	93	Bergy
1b	KANE1	Basic	04/Aug/2014	17h05	-4	80°00.387	069°46.607	Agassiz Trawl ↑	246	289	190	9	3.0	1.83	1016.71	93	Bergy
1b	KANE2B	CASQ+Box	04/Aug/2014	20h29	-4	79°30.908	070°49.742	CASQ Core ↓	218	070	315	10	3.7	1.45	1016.84	99	Bergy
1b	KANE2B	CASQ+Box	04/Aug/2014	20h35	-4	79°30.903	070°49.810	CASQ Core (bottom)	220	072	315	9	4.0	1.44	1016.77	99	Bergy
1b	KANE2B	CASQ+Box	04/Aug/2014	20h41	-4	79°30.894	070°49.959	CASQ Core ↑	218	080	315	9	4.7	1.50	1016.73	99	Bergy
1b	KANE2B	CASQ+Box	04/Aug/2014	21h27	-4	79°30.909	070°50.819	Box Core ↓	219	069	330	2	6.2	1.64	1016.81	92	Bergy
1b	KANE2B	CASQ+Box	04/Aug/2014	21h33	-4	79°30.922	070°50.982	Box Core (bottom)	218	059	000	2	6.4	1.66	1016.82	90	Bergy
1b	KANE2B	CASQ+Box	04/Aug/2014	21h39	-4	79°30.934	070°51.132	Box Core ↑	219	057	330	2	6.4	1.67	1016.82	90	Bergy
1b	KANE2B	CASQ+Box	04/Aug/2014	22h41	-4	79°31.088	070°52.590	Box Core ↓	219	033	285	2	6.4	1.72	1016.67	89	Bergy
1b	KANE2B	CASQ+Box	04/Aug/2014	22h48	-4	79°31.101	070°52.715	Box Core (bottom)	223	033	n-a	0	6.5	1.74	1016.42	87	Bergy
1b	KANE2B	CASQ+Box	04/Aug/2014	22h55	-4	79°31.113	070°52.834	Box Core ↑	228	032	n-a	0	6.5	1.71	1016.38	87	Bergy

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					
1b	KANE2B	CASQ+Box	04/Aug/2014	23h13	-4	79°31.140	070°53.163	Box Core ↓	218	011	n-a	0	6.3	1.66	1016.29	87	Bergy
1b	KANE2B	CASQ+Box	04/Aug/2014	23h19	-4	79°31.137	070°53.287	Box Core (bottom)	217	013	n-a	0	6.3	1.66	1016.29	87	Bergy
1b	KANE2B	CASQ+Box	04/Aug/2014	23h25	-4	79°31.115	070°53.404	Box Core ↑	218	030	n-a	0	6.2	1.68	1016.27	88	Bergy
1b	KANE2	Nutrient	05/Aug/2014	00h40	-4	79°40.270	070°44.623	CTD-Rosette ↓	236	028	260	11	4.5	1.07	1015.80	95	Bergy
1b	KANE2	Nutrient	05/Aug/2014	01h10	-4	79°40.162	070°45.214	CTD-Rosette ↑	236	006	220	8	3.9	1.00	1015.64	96	Bergy
1b	KANE3	Basic	05/Aug/2014	03h02	-4	79°21.759	071°51.701	Secchi ↓	222	318	190	2	2.9	1.61	1015.63	97	Bergy
1b	KANE3	Basic	05/Aug/2014	03h04	-4	79°21.753	071°51.712	Secchi ↑	222	316	190	2	2.9	1.61	1015.63	97	Bergy
1b	KANE3	Basic	05/Aug/2014	03h00	-4	79°21.770	071°51.671	PNF ↓	223	298	190	2	2.9	1.61	1015.41	97	Bergy
1b	KANE3	Basic	05/Aug/2014	03h02	-4	79°21.763	071°51.695	PNF ↑	223	316	190	2	2.9	1.61	1015.41	97	Bergy
1b	KANE3	Basic	05/Aug/2014	03h05	-4	79°21.750	071°51.716	Plankton net ↓	224	317	190	2	2.9	1.61	1015.41	97	Bergy
1b	KANE3	Basic	05/Aug/2014	03h08	-4	79°21.739	071°51.728	Plankton net ↑	221	328	190	2	2.9	1.61	1015.41	97	Bergy
1b	KANE3	Basic	05/Aug/2014	03h18	-4	79°21.665	071°51.701	CTD-Rosette ↓	221	314	270	2	3.2	2.29	1015.62	97	Bergy
1b	KANE3	Basic	05/Aug/2014	03h48	-4	79°21.486	071°51.594	CTD-Rosette ↑	216	298	270	2	3.4	2.28	1015.49	97	Bergy
1b	KANE3	Basic	05/Aug/2014	04h02	-4	79°21.407	071°51.280	Tucker ↓	216	193	300	6	3.9	2.28	1015.37	96	Bergy
1b	KANE3	Basic	05/Aug/2014	04h17	-4	79°21.412	071°48.675	Tucker ↑	219	350	320	10	3.9	2.31	1015.28	94	Bergy
1b	KANE3	Basic	05/Aug/2014	04h48	-4	79°21.063	071°51.884	CTD-Rosette ↓	213	114	330	9	3.4	2.70	1015.14	96	Bergy
1b	KANE3	Basic	05/Aug/2014	05h25	-4	79°20.767	071°51.469	CTD-Rosette ↑	215	072	330	9	3.3	2.43	1014.89	96	Bergy
1b	KANE3	Basic	05/Aug/2014	05h49	-4	79°20.808	071°51.509	Monster, LOKI ↓	216	071	340	8	4.1	2.49	1014.88	94	Bergy
1b	KANE3	Basic	05/Aug/2014	06h04	-4	79°20.669	071°51.331	Monster, LOKI ↑	218	086	345	10	2.9	2.44	1014.73	97	Bergy
1b	KANE3	Basic	05/Aug/2014	06h27	-4	79°20.627	071°51.310	Agassiz Trawl ↓	213	208	330	10	3.2	2.52	1014.65	98	Bergy
1b	KANE3	Basic	05/Aug/2014	06h45	-4	79°20.345	071°49.042	Agassiz Trawl ↑	214	052	340	9	3.1	2.51	1014.71	97	Bergy
1b	KANE4	Nutrient	05/Aug/2014	09h12	-4	79°00.356	070°29.245	CTD-Rosette ↓	356	218	050	11	4.3	2.47	1014.29	94	Bergy
1b	KANE4	Nutrient	05/Aug/2014	10h01	-4	79°00.292	070°30.648	CTD-Rosette ↑	348	030	030	12	6.2	2.15	1014.18	86	Bergy
1b	134	CTD	05/Aug/2014	11h05	-4	78°59.986	071°17.973	CTD-Rosette ↓	211	222	045	12	4.3	2.90	1014.31	94	Bergy
1b	134	CTD	05/Aug/2014	11h18	-4	79°00.010	071°18.219	CTD-Rosette ↑	205	267	030	11	5.7	2.75	1014.25	87	Bergy
1b	134	CTD	05/Aug/2014	15h07	-4	79°03.736	071°40.485	CTD-Rosette ii2 ↓	208	215	020	4	4.8	2.25	1014.62	90	Bergy
1b	134	CTD	05/Aug/2014	15h21	-4	79°03.735	071°40.720	CTD-Rosette ii2 ↑	208	227	040	4	6.3	2.39	1014.62	84	Bergy
1b	134	CTD	05/Aug/2014	15h41	-4	79°03.226	071°42.146	CTD-Rosette ii1 ↓	209	217	060	3	6.1	2.49	1014.57	85	Bergy
1b	134	CTD	05/Aug/2014	15h55	-4	79°03.257	071°42.148	CTD-Rosette ii1 ↑	209	197	060	4	5.8	2.54	1014.64	86	Bergy
1b	134	CTD	05/Aug/2014	16h41	-4	79°03.707	071°39.059	CTD-Rosette ii3 ↓	209	157	n-a	0	4.3	2.52	1014.83	94	Bergy
1b	134	CTD	05/Aug/2014	16h55	-4	79°03.697	071°38.971	CTD-Rosette ii3 ↑	210	132	n-a	0	4.5	2.46	1014.76	94	Bergy
1b	134	CTD	05/Aug/2014	17h17	-4	79°04.676	071°37.257	CTD-Rosette ii4 ↓	203	301	n-a	0	4.5	2.44	1014.73	93	Bergy

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					
1b	134	CTD	05/Aug/2014	17h30	-4	79°04.663	07137.204	CTD-Rosette ii4 ↑	202	335	n-a	0	4.2	2.28	1014.85	93	Bergy
1b	134	CTD	05/Aug/2014	17h59	-4	79°04.450	071°40.850	CTD-Rosette ii5 ↓	197	266	n-a	0	3.7	2.35	1014.99	95	Bergy
1b	134	CTD	05/Aug/2014	18h12	-4	79°04.464	071°40.795	CTD-Rosette ii5 ↑	198	240	n-a	0	5.1	2.55	1014.98	88	Bergy
1b	132B	CTD	05/Aug/2014	20h38	-4	78°59.983	072°17.058	CTD-Rosette ↓	254	237	180	5	4.9	2.21	1015.31	90	Bergy
1b	132B	CTD	05/Aug/2014	20h48	-4	78°59.934	072°16.754	CTD-Rosette ↑	247	232	180	5	4.3	2.07	1015.32	94	Bergy
1b	KANE5	Basic	05/Aug/2014	22h05	-4	79°00.369	073°12.356	Secchi, PNF, plankton ↓	244	033	180	5	3.5	2.17	1015.31	94	Bergy
1b	KANE5	Basic	05/Aug/2014	22h15	-4	79°00.378	073°12.360	Secchi, PNF, plankton ↑	244	004	120	6	3.5	2.38	1015.43	93	Bergy
1b	KANE5	Basic	05/Aug/2014	22h23	-4	79°00.406	073°12.385	CTD-Rosette ↓	244	358	135	6	4.4	2.08	1015.49	89	Bergy
1b	KANE5	Basic	05/Aug/2014	22h49	-4	79°00.365	073°12.455	CTD-Rosette ↑	245	338	180	5	4.3	2.09	1015.49	90	Bergy
1b	KANE5	Basic	05/Aug/2014	23h00	-4	79°00.618	073°12.525	Tucker ↓	244	049	210	2	4.2	2.09	1015.44	90	Bergy
1b	KANE5	Basic	05/Aug/2014	23h17	-4	79°01.196	073°12.940	Tucker ↑	235	283	225	2	3.4	2.49	1015.45	94	Bergy
1b	KANE5	Basic	05/Aug/2014	23h56	-4	79°00.059	073°12.160	CTD-Rosette ↓	250	343	020	2	3.2	2.65	1015.30	95	Bergy
1b	KANE5	Basic	06/Aug/2014	00h35	-4	79°00.092	073°12.274	CTD-Rosette ↑	250	005	150	4	4.3	2.07	1015.56	89	Bergy
1b	KANE5	Basic	06/Aug/2014	00h53	-4	79°00.104	073°12.337	Monster, LOKI ↓	250	043	120	2	4.1	2.02	1015.54	90	Bergy
1b	KANE5	Basic	06/Aug/2014	01h10	-4	79°00.149	073°12.649	Monster, LOKI↑	250	085	110	2	3.9	1.87	1015.48	92	Bergy
1b	KANE5	Basic	06/Aug/2014	01h30	-4	79°00.204	073°12.659	Agassiz Trawl ↓	249	233	100	2	3.5	1.99	1015.58	92	Bergy
1b	KANE5	Basic	06/Aug/2014	01h57	-4	79°00.340	073°11.692	Agassiz Trawl ↑	246	352	110	3	3.6	2.14	1015.60	93	Bergy
1b	127	Nutrient	06/Aug/2014	05h42	-4	78°18.035	074°28.934	CTD-Rosette ↓	526	234	000	7	3.7	1.46	1015.59	89	Bergy
1b	127	Nutrient	06/Aug/2014	06h40	-4	78°17.803	074°29.290	CTD-Rosette ↑	543	159	000	7	4.7	1.31	1015.73	84	Bergy
1b	120	Basic	06/Aug/2014	12h00	-4	78719.375	075°41.703	PNF ↓	560	215	020	7	3.4	3.28	1015.90	99	Bergy
1b	120	Basic	06/Aug/2014	12h04	-4	77°19.395	075°41.613	PNF ↑	560	215	020	7	3.4	3.28	1015.90	99	Bergy
1b	120	Basic	06/Aug/2014	12h07	-4	77°19.405	075°41.543	Secchi ↓	563	234	020	7	3.4	3.28	1015.90	99	Bergy
1b	120	Basic	06/Aug/2014	12h09	-4	77°19.405	075°41.543	Secchi ↑	561	234	020	7	3.4	3.28	1015.90	99	Bergy
1b	120	Basic	06/Aug/2014	12h11	-4	77°19.416	075°41.567	Plankton net ↓	561	225	030	8	6.6	3.00	1015.90	87	Bergy
1b	120	Basic	06/Aug/2014	12h13	-4	77°19.415	075°41.565	Plankton net ↑	561	225	030	8	6.6	3.00	1015.90	87	Bergy
1b	120	Basic	06/Aug/2014	12h23	-4	77°19.434	075°41.641	CTD-Rosette ↓	559	236	040	10	5.9	2.94	1015.95	92	Bergy
1b	120	Basic	06/Aug/2014	13h00	-4	77°19.511	075°41.586	CTD-Rosette ↑	559	261	050	7	7.0	3.05	1016.30	86	Bergy
1b	120	Basic	06/Aug/2014	13h25	-4	77°19.295	075°42.495	Optic ↓	566	231	060	9	6.0	2.95	1016.45	91	Bergy
1b	120	Basic	06/Aug/2014	13h48	-4	77°19.372	075°42.638	Optic ↑	564	233	050	9	4.7	3.09	1016.56	97	Bergy
1b	120	Basic	06/Aug/2014	13h57	-4	77°19.240	075°42.820	Tucker ↓	567	168	050	9	4.1	3.14	1016.56	97	Bergy
1b	120	Basic	06/Aug/2014	14h15	-4	77°19.143	075°41.344	Tucker ↑	561	335	060	8	3.7	2.91	1016.60	99	Bergy
1b	120	Basic	06/Aug/2014	14h33	-4	77°19.313	075°42.108	CTD-Rosette ↓	561	248	050	8	4.5	2.73	1016.79	98	Bergy

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					
1b	120	Basic	06/Aug/2014	15h26	-4	77°19.553	075°42.248	CTD-Rosette ↑	558	249	030	4	4.6	3.05	1016.98	95	Bergy
1b	120	Basic	06/Aug/2014	15h55	-4	77°19.347	075°42.423	Monster, LOKI ↓	563	249	010	6	4.6	2.84	1016.98	95	Bergy
1b	120	Basic	06/Aug/2014	16h33	-4	77°19.537	075°42.748	Monster, LOKI↑	559	203	035	9	4.6	2.87	1016.89	93	Bergy
1b	120	Basic	06/Aug/2014	16h50	-4	77°19.418	075°43.332	Agassiz Trawl ↓	563	169	020	11	4.0	2.81	1016.83	96	Bergy
1b	120	Basic	06/Aug/2014	17h28	-4	77°19.206	075°42.655	Agassiz Trawl ↑	565	157	050	10	4.0	2.80	1017.00	97	Bergy
1b	120	Basic	06/Aug/2014	18h04	-4	77°19.454	075°44.460	IKMT ↓	559	199	055	10	4.4	2.97	1016.96	96	Bergy
1b	120	Basic	06/Aug/2014	18h53	-4	77°19.407	075°44.722	IKMT ↑	558	158	050	14	4.1	2.98	1017.08	96	Bergy
1b	335	Basic	08/Aug/2014	20h20	-4	74°25.689	098°50.189	Secchi, PNF ↓	129	181	315	16	2.4	-0.56	1011.58	92	9/10
1b	335	Basic	08/Aug/2014	20h27	-4	74°25.669	098°49.916	Secchi, PNF ↑	128	190	315	17	2.3	-0.52	1011.51	93	9/10
1b	335	Basic	08/Aug/2014	20h46	-4	74°25.667	098°49.600	CTD-Rosette ↓	129	187	315	18	2.3	-0.52	1011.51	93	9/10
1b	335	Basic	08/Aug/2014	21h12	-4	74°25.609	098°48.836	CTD-Rosette ↑	129	213	330	15	2.1	-0.55	1011.30	93	9/10
1b	335	Basic	08/Aug/2014	21h18	-4	74°25.594	098°48.649	Plankton net ↓	126	219	330	14	2.1	-0.55	1011.30	93	9/10
1b	335	Basic	08/Aug/2014	21h23	-4	74°25.589	098°48.564	Plankton net ↑	127	221	330	14	2.2	-0.56	1011.40	93	9/10
1b	335	Basic	08/Aug/2014	21h26	-4	74°25.577	098°48.473	Optic ↓	128	221	330	14	2.2	-0.56	1011.40	93	9/10
1b	335	Basic	08/Aug/2014	21h52	-4	74°25.543	098°48.219	Optic ↑	125	221	330	16	2.4	-0.58	1011.31	92	9/10
1b	335	Basic	08/Aug/2014	22h06	-4	74°25.486	098°47.926	Hydrobios ↓	124	203	330	17	2.8	-0.59	1011.10	93	9/10
1b	335	Basic	08/Aug/2014	22h18	-4	74°25.473	098°47.848	Hydrobios ↑	123	217	330	17	2.8	-0.58	1011.04	92	9/10
1b	335	Basic	08/Aug/2014	22h50	-4	74°25.331	098°47.669	CTD-Rosette ↓	122	176	330	18	2.5	-0.55	1010.76	93	9/10
1b	335	Basic	08/Aug/2014	23h18	-4	74°25.271	098°47.260	CTD-Rosette ↑	118	218	330	17	3.5	-0.55	1010.64	90	9/10
1b	335	Basic	08/Aug/2014	23h36	-4	74°25.240	098°47.213	Monster, LOKI ↓	116	251	330	14	2.3	-0.52	1010.68	93	9/10
1b	335	Basic	08/Aug/2014	23h45	-4	74°25.212	098°47.286	Monster, LOKI↑	116	268	330	14	1.9	-0.52	1010.57	94	9/10
1b	309	Basic	10/Aug/2014	05h06	-4	72°57.243	096°09.664	Secchi, PNF, plankton ↓	339	008	240	20	0.6	-0.66	1005.61	98	9/10
1b	309	Basic	10/Aug/2014	05h20	-4	72°57.166	096°09.423	Secchi, PNF, plankton ↑	339	062	250	14	2.0	-0.39	1005.63	93	9/10
1b	309	Basic	10/Aug/2014	05h28	-4	72°57.128	096°09.375	CTD-Rosette ↓	338	075	245	18	2.0	-0.39	1005.63	93	9/10
1b	309	Basic	10/Aug/2014	05h56	-4	72°57.078	096°09.180	CTD-Rosette ↑	335	068	260	19	2.5	-0.38	1005.74	90	9/10
1b	309	Basic	10/Aug/2014	06h08	-4	72°57.209	096°07.512	Tucker ↓	324	045	250	16	1.1	-0.38	1005.67	95	9/10
1b	309	Basic	10/Aug/2014	06h25	-4	72°57.723	096°06.745	Tucker ↑	321	028	245	17	-0.1	-0.35	1005.64	99	9/10
1b	309	Basic	10/Aug/2014	06h36	-4	72°57.707	096°06.653	Optic ↓	320	070	255	17	0.2	-0.36	1005.80	99	9/10
1b	309	Basic	10/Aug/2014	07h05	-4	72°57.750	096°06.266	Optic ↑	318	094	245	18	2.9	-0.37	1005.98	88	9/10
1b	309	Basic	10/Aug/2014	07h17	-4	72°57.778	096°06.166	Monster, LOKI ↓	318	085	260	18	3.0	-0.35	1005.89	88	9/10
1b	309	Basic	10/Aug/2014	07h41	-4	72°57.750	096°06.006	Monster, LOKI↑	316	089	240	19	0.8	-0.30	1005.73	96	9/10
1b	309	Basic	10/Aug/2014	09h21	-4	72°57.848	096°03.880	CTD-Rosette ↓	325	126	240	16	0.6	-0.26	1006.06	99	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					
1b	309	Basic	10/Aug/2014	10h04	-4	72°58.195	096°03.180	CTD-Rosette ↑	333	122	230	17	0.8	-0.17	1005.98	99	9/10
1b	309	Basic	10/Aug/2014	10h13	-4	72°58.296	096°02.739	Agassiz Trawl ↓	335	053	250	12	1.1	-0.20	1005.95	99	9/10
1b	309	Basic	10/Aug/2014	10h40	-4	72°58.688	096°03.386	Agassiz Trawl ↑	329	216	270	16	0.6	-0.21	1005.97	97	9/10
1b	309	Basic	10/Aug/2014	11h30	-4	72°58.399	096°02.695	Box Core ↓	336	356	270	10	1.3	-0.17	1005.93	94	9/10
1b	309	Basic	10/Aug/2014	11h35	-4	72°58.494	096°02.536	Box Core (bottom)	335	336	255	8	0.8	-0.15	1005.83	96	9/10
1b	309	Basic	10/Aug/2014	11h43	-4	72°58.568	096°02.313	Box Core ↑	336	359	270	10	0.5	-0.15	1005.88	97	9/10
1b	310	Basic	10/Aug/2014	21h32	-4	71°17.723	097°41.465	Secchi, PNF, plankton ↓	136	354	270	14	0.2	-0.24	1009.66	99	Bergy
1b	310	Basic	10/Aug/2014	21h43	-4	71°17.783	097°41.264	Secchi, PNF, plankton ↑	139	005	270	14	0.2	-0.26	1009.68	99	Bergy
1b	310	Basic	10/Aug/2014	21h55	-4	71°17.835	097°41.330	CTD-Rosette ↓	137	143	270	14	0.4	-0.22	1009.64	99	Bergy
1b	310	Basic	10/Aug/2014	22h30	-4	71°18.120	097°40.597	CTD-Rosette ↑	135	090	315	14	1.2	-0.22	1009.81	99	Bergy
1b	310	Basic	10/Aug/2014	22h48	-4	71°17.360	097°40.500	Tucker ↓	138	048	300	10	0.5	-0.25	1009.76	99	Bergy
1b	310	Basic	10/Aug/2014	23h06	-4	71°17.870	097°40.649	Tucker ↑	138	257	315	8	0.4	-0.31	1009.81	99	Bergy
1b	310	Basic	10/Aug/2014	23h22	-4	71°17.646	097°42.538	Optic ↓	128	007	315	10	0.5	-0.28	1009.72	99	Bergy
1b	310	Basic	10/Aug/2014	23h55	-4	71°17.710	097°42.182	Optic ↑	131	049	315	8	0.3	-0.21	1009.85	99	Bergy
1b	310	Basic	11/Aug/2014	00h07	-4	71°17.705	097°42.059	CTD-Rosette ↓	132	050	300	8	0.3	-0.19	1009.73	99	Bergy
1b	310	Basic	11/Aug/2014	00h32	-4	71°17.706	097°41.871	CTD-Rosette ↑	131	060	300	6	-0.1	-0.17	1009.88	99	Bergy
1b	310	Basic	11/Aug/2014	00h57	-4	71°17.668	097°41.672	Monster, LOKI ↓	134	089	310	11	0.3	-0.13	1009.86	98	Bergy
1b	310	Basic	11/Aug/2014	01h07	-4	71°17.644	097°41.477	Monster, LOKI↑	136	067	320	10	0.5	-0.14	1009.92	93	Bergy
1b	310	Basic	11/Aug/2014	01h43	-4	71°17.651	097°41.762	Agassiz Trawl ↓	134	252	330	10	0.6	-0.14	1010.11	92	Bergy
1b	310	Basic	11/Aug/2014	02h03	-4	71°17.115	097°41.625	Agassiz Trawl ↑	125	125	320	10	0.6	-0.14	1009.11	93	Bergy
1b	312	Basic	11/Aug/2014	15h55	-4	69°10.405	100°41.075	Secchi, PNF, plankton ↓	65	222	355	13	2.8	1.49	1011.36	99	9/10
1b	312	Basic	11/Aug/2014	16h05	-4	69°10.446	100°40.722	Secchi, PNF, plankton ↑	59	146	000	13	3.0	1.54	1011.36	99	9/10
1b	312	Basic	11/Aug/2014	16h16	-4	69°10.567	100°40.299	CTD-Rosette ↓	60	153	340	9	2.9	1.57	1011.35	99	9/10
1b	312	Basic	11/Aug/2014	16h36	-4	69°10.813	100°39.309	CTD-Rosette ↑	60	114	350	10	2.2	1.37	1012.18	99	9/10
1b	312	Basic	11/Aug/2014	17h00	-4	69°10.432	100°40.433	Tucker ↓	69	261	340	9	1.6	1.29	1012.00	99	9/10
1b	312	Basic	11/Aug/2014	17h10	-4	69°10.247	100°40.711	Tucker ↑	66	081	350	8	1.7	1.44	1011.97	99	9/10
1b	312	Basic	11/Aug/2014	18h05	-4	69°10.504	100°41.268	CTD-Rosette ↓	67	123	330	7	1.6	1.40	1012.60	99	9/10
1b	312	Basic	11/Aug/2014	18h21	-4	69°10.801	100°40.491	CTD-Rosette ↑	60	094	330	9	1.6	1.31	1012.64	97	9/10
1b	312	Basic	11/Aug/2014	18h49	-4	69°10.393	100°41.570	Monster, LOKI ↓	66	247	350	10	1.7	1.36	1011.20	96	9/10
1b	312	Basic	11/Aug/2014	18h56	-4	69°10.492	100°41.179	Monster, LOKI↑	65	254	350	3	1.9	1.36	1011.20	96	9/10
1b	312	Basic	11/Aug/2014	19h21	-4	69°10.213	100°41.790	Agassiz Trawl ↓	65	106	330	8	1.9	1.34	1011.35	93	9/10
1b	312	Basic	11/Aug/2014	19h32	-4	69°10.453	100°40.658	Agassiz Trawl ↑	60	059	320	10	1.6	1.35	1011.13	92	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					
1b	312	Basic	11/Aug/2014	19h58	-4	69°10.250	100°41.683	Box Core ↓	66	083	330	12	1.7	1.33	1011.24	92	9/10
1b	312	Basic	11/Aug/2014	20h00	-4	69°10.269	100°41.636	Box Core (bottom)	66	122	330	12	1.7	1.33	1011.24	92	9/10
1b	312	Basic	11/Aug/2014	20h03	-4	69°10.305	100°41.369	Box Core ↑	65	095	330	12	1.5	1.24	1011.27	93	9/10
1b	314	Full	12/Aug/2014	08h00	-4	68°58.270	105°27.904	Tucker ↓	76	214	90	3	5.8	3.62	1014.49	93	0/10
1b	314	Full	12/Aug/2014	08h12	-4	68°58.299	105°27.250	Tucker ↑	80	348	90	4	6.0	3.08	1014.64	91	0/10
1b	314	Full	12/Aug/2014	08h32	-4	68°58.059	105°28.179	Secchi, PNF, plankton ↓	76	296	70	3	5.7	3.11	1014.55	92	0/10
1b	314	Full	12/Aug/2014	08h53	-4	68°58.119	105°27.893	Secchi, PNF, plankton ↑	74	340	60	9	5.9	2.96	1014.68	92	0/10
1b	314	Full	12/Aug/2014	09h09	-4	68°58.221	105°28.281	CTD-Rosette ↓	80	096	70	6	5.4	2.62	1014.61	88	0/10
1b	314	Full	12/Aug/2014	09h32	-4	68°58.240	105°28.100	CTD-Rosette ↑	79	186	60	9	5.1	2.4	1014.55	87	0/10
1b	314	Full	12/Aug/2014	09h48	-4	68°58.151	105°28.561	Hydrobios ↓	77	135	60	8	5.2	2.35	1014.54	87	0/10
1b	314	Full	12/Aug/2014	09h56	-4	68°58.233	105°28.510	Hydrobios ↑	77	133	70	7	5.2	2.31	1014.46	88	0/10
1b	314	Full	12/Aug/2014	10h35	-4	68°58.231	105°28.072	CTD-Rosette ↓	80	171	70	7	5.2	1.93	1014.32	84	0/10
1b	314	Full	12/Aug/2014	10h58	-4	68°58.246	105°27.599	CTD-Rosette ↑	86	212	70	7	5.1	1.74	1014.16	85	0/10
1b	314	Full	12/Aug/2014	11h15	-4	68°58.240	105°28.479	Bioness ↓	82	319	105	6	5.3	1.85	1014.08	82	0/10
1b	314	Full	12/Aug/2014	11h25	-4	68°58.386	105°28.025	Bioness ↑	77	155	90	7	6.5	2.15	1014.07	79	0/10
1b	314	Full	12/Aug/2014	12h45	-4	68°58.202	105°28.160	Monster, LOKI ↓	80	103	120	5	5.6	1.94	1013.58	84	0/10
1b	314	Full	12/Aug/2014	12h54	-4	68°58.201	105°28.175	Monster, LOKI↑	80	095	110	5	5.5	1.74	1013.61	85	0/10
1b	314	Full	12/Aug/2014	13h10	-4	68°58.177	105°28.039	Agassiz Trawl ↓	75	073	130	6	5.5	1.57	1013.54	87	0/10
1b	314	Full	12/Aug/2014	13h27	-4	68°58.037	105°27.949	Agassiz Trawl ↑	78	076	150	3	5.6	1.92	1013.38	88	0/10
1b	314	Full	12/Aug/2014	15h25	-4	68°58.234	105°28.286	Box Core ↓	84	317	140	9	6.7	2.97	1012.63	84	0/10
1b	314	Full	12/Aug/2014	15h30	-4	68°58.234	105°28.268	Box Core (bottom)	84	319	140	9	6.7	2.97	1012.63	84	0/10
1b	314	Full	12/Aug/2014	15h27	-4	68°58.234	105°28.276	Box Core ↑	83	324	140	9	6.7	2.97	1012.63	84	0/10
1b	315	Nutrient	12/Aug/2014	19h44	-6	68°50.784	107°30.282	CTD-Rosette ↓	64	238	240	10	8.5	6.78	1010.24	83	0/10
1b	315	Nutrient	12/Aug/2014	20h00	-4	68°50.745	107°30.137	CTD-Rosette ↑	63	274	225	9	9.2	5.25	1010.32	79	0/10
1b	318	Nutrient	12/Aug/2014	22h00	-6	68°40.963	108°17.279	CTD-Rosette ↓	60	075	270	10	8.9	7.65	1009.41	78	0/10
1b	318	Nutrient	12/Aug/2014	22h16	-4	68°41.128	108°16.837	CTD-Rosette ↑	58	108	255	12	9.2	7.01	1009.39	79	0/10
1b	317	Nutrient	12/Aug/2014	23h00	-6	68°45.679	108°24.536	CTD-Rosette ↓	120	082	000	12	9.6	5.84	1009.16	76	0/10
1b	317	Nutrient	12/Aug/2014	23h25	-4	68°45.710	108°24.452	CTD-Rosette ↑	123		000	15	12.1	4.62	1009.56	70	0/10
1b	316	Nutrient	13/Aug/2014	00h05	-6	68°50.299	108°30.569	CTD-Rosette ↓	98	302	010	15	10.5	5.03	1009.50	75	0/10
1b	316	Nutrient	13/Aug/2014	00h22	-4	68°50.193	108°30.430	CTD-Rosette ↑	102	219	010	15	9.2	4.09	1009.96	83	0/10
2a	405	Basic	16/Aug/2014	7h47	-5	70°38.200	123°02.660	Secchi, PNF ↓	608	260	020	25	7.0	7.85	1012.86	91	0/10
2a	405	Basic	16/Aug/2014	7h55	-5	70°38.183	123°02.720	Secchi, PNF ↑	609	289	070	25	7.6	7.79	1012.70	89	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					
2a	405	Basic	16/Aug/2014	8h05	-5	70°38.232	123°02.700	HUP ↓↑	608	020	070	20	8.6	7.60	1012.70	86	0/10
2a	405	Basic	16/Aug/2014	20h20	-5	70°38.289	123°02.830	CTD-Rosette ↓	607	270	070	23	8.1	7.65	1013.00	87	0/10
2a	405	Basic	16/Aug/2014	21h23	-5	70°38.087	123°02.100	CTD-Rosette ↑	599	268	060	16	8.6	7.56	1013.20	86	0/10
2a	405	Basic	16/Aug/2014	21h23	-5	70°38.288	123°02.220	Tucker ↓	608	135	070	18	10.6	7.53	1013.20	78	0/10
2a	405	Basic	16/Aug/2014	21h42	-5	70°37.861	123°02.610	Tucker ↑	617	090	070	18	6.9	7.62	1012.90	92	0/10
2a	405	Basic	16/Aug/2014	22h27	-5	70°38.334	123°02.010	CTD-Rosette ↓	609	263	080	15	8.3	7.67	1013.30	86	0/10
2a	405	Basic	16/Aug/2014	23h27	-5	70°38.072	123°02.370	CTD-Rosette ↑	612	296	070	18	9.9	7.58	1013.50	78	0/10
2a	405	Basic	17/Aug/2014	00h24	-5	70°38.391	123°02.210	Monster ↓	610	106	070	16	7.0	7.6	1013.80	89	0/10
2a	405	Basic	17/Aug/2014	01h07	-5	70°38.291	123°02.220	Monster ↑	611	089	070	15	6.9	7.6	1014.10	90	0/10
2a	405	Basic	17/Aug/2014	01h44	-5	70°38.359	123°02.320	Box Core ↓	610	265	070	10	7.1	7.61	1014.30	89	0/10
2a	405	Basic	17/Aug/2014	01h56	-5	70°38.422	123°02.280	Box Core (bottom)	608	251	080	13	8.5	7.52	1014.40	82	0/10
2a	405	Basic	17/Aug/2014	02h08	-5	70°38.493	123°02.360	Box Core ↑	608	245	070	11	7.9	7.44	1014.50	84	0/10
2a	405	Basic	17/Aug/2014	02h30	-5	70°38.291	123°02.980	Agassiz Trawl ↓	606	115	070	16	7.4	7.44	1014.60	88	0/10
2a	405	Basic	17/Aug/2014	03h14	-5	70°38.505	123°02.010	Agassiz Trawl ↑	617	323	080	13	6.9	7.60	1015.00	91	0/10
2a	407	Basic	18/Aug/2014	06h01	-5	71°00.280	126°04.250	Secchi, PNF ↓	392	100	110	20	6.1	6.5	1011.4	93	0/10
2a	407	Basic	18/Aug/2014	06h03	-5	71°00.300	126°04.250	Secchi, PNF ↑	395	113	110	23	6.1	6.5	1011.4	93	0/10
2a	407	Basic	18/Aug/2014	06h06	-5	71°00.310	126°04.320	HVP ↓	392	128	110	25	6.1	6.5	1011.7	93	0/10
2a	407	Basic	18/Aug/2014	06h17	-5	71°00.270	126°04.450	HVP ↑	392	146	110	27	6.0	6.3	1011.8	92	0/10
2a	407	Basic	18/Aug/2014	06h32	-5	71°00.220	126°04.450	CTD-Rosette ↓	401	102	110	22	5.9	6.2	1011.7	93	0/10
2a	407	Basic	18/Aug/2014	07h09	-5	71°00.270	126°04.580	CTD-Rosette ↑	406	104	120	19	6.1	6.2	1012.1	92	0/10
2a	407	Basic	18/Aug/2014	07h59	-5	71°00.190	126°03.990	Tucker ↓	405	143	110	20	6.1	6.1	1012.1	92	0/10
2a	407	Basic	18/Aug/2014	08h14	-5	70°59.790	126°02.960	Tucker ↑	405	128	110	20	6.2	6.1	1012.1	91	0/10
2a	407	Basic	18/Aug/2014	08h37	-5	71°00.200	126°04.590	CTD-Rosette ↓	400	115	115	22	6.2	6.1	1012.2	91	0/10
2a	407	Basic	18/Aug/2014	09h29	-5	71°00.250	126°04.410	CTD-Rosette ↑	393	084	110	18	6.2	6.2	1012.1	88	0/10
2a	407	Basic	18/Aug/2014	09h51	-5	71°00.390	126°04.550	Monster ↓	392	104	120	19	6.2	6.1	1012.1	86	0/10
2a	407	Basic	18/Aug/2014	10h19	-5	71°00.350	126°04.690	Monster ↑	393	108	115	20	6.2	6.1	1012.2	84	0/10
2a	407	Basic	18/Aug/2014	10h47	-5	71°00.450	126°03.830	Box Core ↓	393	118	110	20	6.2	6.1	1012.0	82	0/10
2a	407	Basic	18/Aug/2014	10h57	-5	71°00.380	126°04.010	Box Core ↑	392	105	110	20	6.2	6.1	1012.0	81	0/10
2a	407	Basic	18/Aug/2014	11h16	-5	71°00.260	126°03.380	Agassiz Trawl ↓	394	130	110	20	6.2	6.1	1011.9	80	0/10
2a	407	Basic	18/Aug/2014	11h58	-5	70°59.150	126°01.540	Agassiz Trawl ↑	396	140	110	20	6.0	6.1	1012.0	81	0/10
2a	407	Basic	18/Aug/2014	13h15	-5	71°00.050	126°04.000	Beam Trawl ↓	397	140	110	27	6.1	6.1	1012.0	80	0/10
2a	407	Basic	18/Aug/2014	15h15	-5	70°56.300	125°58.000	Beam Trawl ↑	398	150	110	23	6.1	6.3	1011.7	83	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					
2a	407	Basic	18/Aug/2014	15h25	-5	70°56.300	125°58.000	Didson Caméra ↓	400	188	100	21	6.1	6.1	1011.7	83	0/10
2a	407	Basic	18/Aug/2014	15h58	-5	70°56.240	125°58.520	Didson Caméra ↑	404	124	100	26	6.2	6.2	1012.3	81	0/10
2a	n-a	Net+Cam	19/Aug/2014	02h10	-5	71°11.380	126°53.430	Trawl ↓	316	150	90	22	5.8	6.5	1013.4	89	0/10
2a	n-a	Net+Cam	19/Aug/2014	03h15	-5	71°09.020	125°53.850	Trawl ↑	310	180	90	21	5.9	7.0	1013.1	90	0/10
2a	437	Basic	19/Aug/2014	12h55	-5	71°47.170	126°29.770	Secchi, PNF ↓	317	168	330	8	5.4	5.7	1014.2	90	0/10
2a	437	Basic	19/Aug/2014	13h08	-5	71°47.160	126°30.110	Secchi, PNF ↑	320	248	000	10	5.8	6.3	1014.1	89	0/10
2a	437	Basic	19/Aug/2014	14h00	-5	71°47.220	126°29.400	CTD-Rosette ↓	309	035	350	11	5.7	6.4	1014.0	91	0/10
2a	437	Basic	19/Aug/2014	14h40	-5	71°47.220	126°30.690	CTD-Rosette ↑	321	045	000	12	5.8	6.1	1013.8	92	0/10
2a	437	Basic	19/Aug/2014	15h17	-5	71°47.300	126°29.140	Tucker ↓	314	140	000	14	8.7	6.5	1014.0	91	0/10
2a	437	Basic	19/Aug/2014	15h35	-5	71°46.900	126°28.410	Tucker ↑	315	095	350	12	5.5	6.6	1013.9	90	0/10
2a	437	Basic	19/Aug/2014	16h23	-5	71°47.190	126°30.020	CTD-Rosette ↓	319	011	000	16	3.4	6.7	1014.0	97	0/10
2a	437	Basic	19/Aug/2014	17h15	-5	71°46.990	126°31.190	CTD-Rosette ↑	334	070	350	17	2.4	6.2	1014.2	99	0/10
2a	437	Basic	19/Aug/2014	18h08	-5	71°47.340	126°29.840	Monster ↓	313	083	000	13	1.9	6.5	1014.4	99	0/10
2a	437	Basic	19/Aug/2014	18h29	-5	71°47.180	126°29.610	Monster ↑	314	067	345	14	1.4	6.5	1014.5	99	0/10
2a	437	Basic	19/Aug/2014	18h53	-5	71°47.210	126°29.800	Box Core ↓	318	330	350	16	1.5	6.6	1014.4	98	0/10
2a	437	Basic	19/Aug/2014	19h00	-5	71°47.180	126°29.980	Box Core (bottom)	318	342	000	15	1.3	6.5	1014.4	98	0/10
2a	437	Basic	19/Aug/2014	19h13	-5	71°47.140	126°29.080	Box Core ↑	318	012	340	17	1.3	6.5	1014.4	97	0/10
2a	437	Basic	19/Aug/2014	19h23	-5	71°47.100	126°29.180	Agassiz Trawl ↓	316	075	330	14	1.4	6.0	1014.5	97	0/10
2a	437	Basic	19/Aug/2014	19h49	-5	71°47.090	126°26.600	Agassiz Trawl ↑	290	075	350	12	1.6	6.5	1014.5	96	0/10
2a	410	Nutrient	19/Aug/2014	20h32	-5	71°41.860	126°29.660	CTD-Rosette ↓	412	188	350	19	3.6	6.5	1014.5	89	0/10
2a	410	Nutrient	19/Aug/2014	21h20	-5	71°41.810	126°30.480	CTD-Rosette ↑	420	224	350	20	4.8	5.9	1014.5	87	0/10
2a	411	CTD	19/Aug/2014	22h06	-5	71°37.710	126°42.090	CTD-Rosette ↓	439	189	350	22	3.5	5.6	1014.7	93	0/10
2a	411	CTD	19/Aug/2014	22h25	-5	71°37.580	126°42.100	CTD-Rosette ↑	436	193	350	19	5.4	5.0	1014.5	86	0/10
2a	412	Nutrient	19/Aug/2014	23h10	-5	71°33.690	126°55.530	CTD-Rosette ↓	415	194	360	20	5.3	5.3	1014.7	85	0/10
2a	412	Nutrient	19/Aug/2014	23h59	-5	71°33.230	126°55.960	CTD-Rosette ↑	417	128	010	17	5.0	5.3	1014.9	89	0/10
2a	413	CTD	20/Aug/2014	00h55	-5	71°29.660	127°08.600	CTD-Rosette ↓	372	248	030	19	7.3	5.7	1015.3	29	0/10
2a	413	CTD	20/Aug/2014	01h15	-5	71°29.520	127°08.910	CTD-Rosette ↑	372	180	050	19	7.9	5.8	1015.3	26	0/10
2a	414	Nutrient	20/Aug/2014	01h57	-5	71°25.300	127°21.930	CTD-Rosette ↓	307	030	050	18	5.7	5.9	1015.7	86	0/10
2a	414	Nutrient	20/Aug/2014	02h42	-5	71°25.150	127°23.000	CTD-Rosette ↑	298	055	050	17	5.4	6.0	1016.0	94	0/10
2a	GSC-4	Box Coring	20/Aug/2014	03h54	-5	71°20.960	126°47.720	Box Core ↓	400	215	120	10	5.5	6.0	1016.7	90	0/10
2a	GSC-4	Box Coring	20/Aug/2014	04h04	-5	71°21.020	126°47.720	Box Core (bottom)	397	202	130	12	5.3	6.3	1017.0	88	0/10
2a	GSC-4	Box Coring	20/Aug/2014	04h15	-5	71°21.070	126°47.030	Box Core ↑	395	214	130	7	5.4	6.3	1017.1	88	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					
2a	GSC-4	Piston Coring	20/Aug/2014	06h39	-5	71°20.870	126°47.750	Piston Core ↓	399	212	130	6	5.2	6.5	1018.9	80	0/10
2a	GSC-4	Piston Coring	20/Aug/2014	07h06	-5	71°20.850	126°47.820	Piston Core (bottom)	392	215	120	5	5.2	6.4	1019.1	79	0/10
2a	GSC-4	Piston Coring	20/Aug/2014	07h34	-5	71°20.870	126°47.720	Piston Core ↑	399	211	130	5	5.3	6.4	1019.2	74	0/10
2a	408	Full	20/Aug/2014	09h17	-5	71°18.780	127°34.490	Secchi, PNF, HUP ↓	209	209	120	5	5.5	6.4	1019.9	83	0/10
2a	408	Full	20/Aug/2014	09h32	-5	71°18.730	127°34.530	Secchi, PNF, HUP ↑	209	209	110	6	5.8	6.4	1020.0	82	0/10
2a	408	Full	20/Aug/2014	09h44	-5	71°18.720	127°34.520	CTD-Rosette ↓	208	208	130	6	6.0	6.3	1020.1	81	0/10
2a	408	Full	20/Aug/2014	10h20	-5	71°18.760	127°34.660	CTD-Rosette ↑	207	207	120	4	6.0	6.3	1020.2	80	0/10
2a	408	Full	20/Aug/2014	12h30	-5	71°18.750	127°35.030	Bioness ↓	211	211	160	5	7.9	6.3	1020.8	72	0/10
2a	408	Full	20/Aug/2014	12h47	-5	71°19.320	127°34.290	Bioness ↑	212	212	160	5	8.2	6.3	1021.0	72	0/10
2a	408	Full	20/Aug/2014	13h00	-5	71°18.930	127°34.010	Tucker ↓	211	211	170	5	6.2	6.4	1021.2	77	0/10
2a	408	Full	20/Aug/2014	13h20	-5	71°19.000	127°32.440	Tucker ↑	217	217	160	6	6.1	6.4	1021.3	77	0/10
2a	408	Full	20/Aug/2014	13h49	-5	71°18.700	127°35.200	Hydrobios ↓	203	203	120	6	5.9	6.4	1021.5	77	0/10
2a	408	Full	20/Aug/2014	14h04	-5	71°18.700	127°35.100	Hydrobios ↑	205	205	170	7	6.0	6.4	1021.5	79	0/10
2a	408	Full	20/Aug/2014	14h32	-5	71°18.720	127°34.800	CTD-Rosette ↓	205	205	170	7	6.3	6.4	1021.7	79	0/10
2a	408	Full	20/Aug/2014	15h14	-5	71°18.880	127°34.720	CTD-Rosette ↑	208	208	200	6	7.7	6.4	1022.0	74	0/10
2a	408	Full	20/Aug/2014	15h55	-5	71°18.840	127°34.930	Monster ↓	207	207	180	8	6.1	6.4	1022.2	79	0/10
2a	408	Full	20/Aug/2014	16h14	-5	71°18.940	127°34.820	Monster ↑	209	209	180	3	6.1	6.4	1022.3	79	0/10
2a	408	Full	20/Aug/2014	16h35	-5	71°18.790	127°35.010	Agassiz Trawl ↓	206	280	180	6	6.2	6.5	1022.4	80	0/10
2a	408	Full	20/Aug/2014	16h58	-5	71°18.900	127°37.350	Agassiz Trawl ↑	196	220	180	7	6.3	6.5	1022.4	80	0/10
2a	408	Full	20/Aug/2014	18h02	-5	71°19.390	127°34.960	Beam trawl ↓	212	000	255	4	6.1	6.5	1022.8	89	0/10
2a	408	Full	20/Aug/2014	18h58	-5	71°21.210	127°36.280	Beam trawl ↑	227	320	260	7	5.3	6.6	1022.8	91	0/10
2a	417	CTD	20/Aug/2014	20h24	-5	71°13.630	127°58.350	CTD-Rosette ↓	85	243	230	5	5.0	7.4	1022.9	88	0/10
2a	417	CTD	20/Aug/2014	20h32	-5	71°13.690	127°58.310	CTD-Rosette ↑	87	203	230	6	5.1	7.2	1022.9	88	0/10
2a	418	Nutrient	20/Aug/2014	21h23	-5	71°09.750	128°10.350	CTD-Rosette ↓	65	102	240	7	2.9	6.7	1023.0	99	0/10
2a	418	Nutrient	20/Aug/2014	21h45	-5	71°09.710	127°10.320	CTD-Rosette ↑	65	043	250	6	2.6	6.7	1023.2	99	0/10
2a	419	CTD	20/Aug/2014	22h26	-5	71°06.450	128°20.290	CTD-Rosette ↓	57	267	270	3	2.1	6.6	1023.3	99	0/10
2a	419	CTD	20/Aug/2014	22h35	-5	71°06.380	128°20.330	CTD-Rosette ↑	57	308	280	2	2.0	6.0	1023.4	99	0/10
2a	420	Basic	20/Aug/2014	23h13	-5	71°03.070	128°30.740	Secchi, PNF ↓	41	146	250	3	1.7	4.5	1023.4	99	0/10
2a	420	Basic	20/Aug/2014	23h19	-5	71°03.050	128°30.800	Secchi, PNF ↑	41	136	var.	n-a5	1.7	4.5	1023.4	99	0/10
2a	420	Basic	20/Aug/2014	23h29	-5	71°03.050	128°30.680	CTD-Rosette ↓	41	309	220	2	1.7	3.7	1023.5	99	0/10
2a	420	Basic	20/Aug/2014	23h52	-5	71°02.970	128°30.860	CTD-Rosette ↑	40	343	240	n-a5	1.2	3.8	1023.5	99	0/10
2a	420	Basic	21/Aug/2014	00h35	-5	71°03.150	128°30.770	Tucker ↓	42	318	n-a	n-a	0.6	3.6	1023.6	99	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					
2a	420	Basic	21/Aug/2014	00h45	-5	71°03.260	128°30.650	Tucker ↑	42	258	n-a	n-a	0.8	3.6	1023.6	99	0/10
2a	420	Basic	21/Aug/2014	01h10	-5	71°03.050	128°30.960	Monster ↓	40	218	n-a	n-a	0.9	3.4	1023.7	99	0/10
2a	420	Basic	21/Aug/2014	01h15	-5	71°03.030	128°30.940	Monster ↑	40	228	270	3	0.9	3.4	1023.7	99	0/10
2a	420	Basic	21/Aug/2014	01h34	-5	71°03.030	128°30.810	CTD-Rosette ↓	40	107	270	3	1.2	3.2	1023.8	99	0/10
2a	420	Basic	21/Aug/2014	01h50	-5	71°03.910	128°30.840	CTD-Rosette ↑	40	096	310	4	1.0	3.5	1023.9	99	0/10
2a	420	Basic	21/Aug/2014	01h03	-6	71°02.810	128°30.540	Agassiz Trawl ↓	40	100	n-a	n-a	1.2	3.5	1023.9	99	0/10
2a	420	Basic	21/Aug/2014	01h13	-6	71°02.890	128°29.930	Agassiz Trawl ↑	46	000	n-a	n-a	0.9	3.7	1024.0	99	0/10
2a	422	Nutrient	21/Aug/2014	14h32	-6	71°22.250	133°53.230	CTD ↓	1083	342	080	8	1.2	0.7	1024.7	99	0/10
2a	422	Nutrient	21/Aug/2014	15h45	-6	71°22.100	133°54.560	CTD ↑	1080	314	090	6	2.1	1.0	1024.6	99	0/10
2a	423	CTD	21/Aug/2014	16h40	-6	71°16.340	133°51.440	CTD ↓	802	069	080	13	1.4	1.1	1024.4	99	0/10
2a	423	CTD	21/Aug/2014	17h12	-6	71°16.410	133°51.810	CTD ↑	800	072	080	13	1.4	1.2	1024.2	99	0/10
2a	423	CTD	21/Aug/2014	17h54	-6	71°10.430	133°49.600	CTD ↓	581	082	080	13	1.5	1.1	1023.0	99	0/10
2a	423	CTD	21/Aug/2014	18h50	-6	71°10.430	133°50.020	CTD ↑	576	048	080	15	1.2	1.2	1024.2	99	0/10
2a	435	Basic	21/Aug/2014	19h33	-6	71°04.810	133°38.080	Secchi, PNF ↓	307	082	065	15	1.6	1.1	1024.1	99	0/10
2a	435	Basic	21/Aug/2014	19h37	-6	71°04.800	133°38.130	Secchi, PNF ↑	300	084	065	16	1.6	1.1	1024.1	99	0/10
2a	435	Basic	21/Aug/2014	19h47	-6	71°04.730	133°37.670	CTD-Rosette (nutrients) ↓	301	059	070	16	1.8	1.2	1024.6	99	0/10
2a	435	Basic	21/Aug/2014	20h34	-6	71°04.760	133°38.290	CTD-Rosette (nutrients) ↓	302	347	070	17	2.0	1.3	1024.4	99	0/10
2a	435	Basic	21/Aug/2014	20h45	-6	71°04.770	133°38.340	Tucker ↓	295	087	075	16	2.2	1.3	1023.9	99	0/10
2a	435	Basic	21/Aug/2014	21h02	-6	71°04.860	133°39.070	Tucker ↑	296	198	075	20	2.5	1.1	1024.0	99	0/10
2a	435	Basic	21/Aug/2014	21h20	-6	71°04.680	133°38.530	Monster ↓	292	070	070	18	2.4	1.0	1023.9	99	0/10
2a	435	Basic	21/Aug/2014	21h47	-6	71°04.510	133°39.330	Monster ↑	278	126	070	19	2.8	0.9	1024.5	99	0/10
2a	435	Basic	21/Aug/2014	22h16	-6	71°04.770	133°38.040	CTD-Rosette ↓	298	057	080	17	2.9	0.9	1024.3	99	0/10
2a	435	Basic	21/Aug/2014	22h53	-6	71°04.630	133°38.800	CTD-Rosette ↑	288	253	070	13	4.3	0.9	1024.5	99	0/10
2a	435	Basic	21/Aug/2014	23h52	-6	71°04.770	133°38.120	Box Core ↓	297	072	080	16	3.6	1.0	1024.5	99	0/10
2a	435	Basic	21/Aug/2014	23h59	-6	71°04.770	133°38.200	Box Core (bottom)	297	062	080	16	3.9	1.0	1024.7	99	0/10
2a	435	Basic	22/Aug/2014	00h10	-6	71°04.740	133°38.240	Box Core ↑	296	076	080	16	3.9	1.0	1024.8	99	0/10
2a	435	Basic	22/Aug/2014	00h23	-6	71°04.750	133°38.260	Agassiz Trawl ↓	302	090	080	15	3.9	1.0	1024.8	99	0/10
2a	435	Basic	22/Aug/2014	00h56	-6	71°03.860	133°38.270	Agassiz Trawl ↑	272	125	080	18	4.1	0.9	1024.9	99	0/10
2a	BS-1	Mooring	22/Aug/2014	04h39	-6	70°48.840	134°50.630	CTD-Rosette ↓	084	284	075	21	6.5	7.8	1021.6	83	0/10
2a	BS-1	Mooring	22/Aug/2014	04h53	-6	70°48.860	134°50.610	CTD-Rosette ↑	084	290	075	22	6.5	7.8	1021.5	80	0/10
2a	BS-1	Mooring	22/Aug/2014	06h36	-6	70°03.640	134°50.930	Mooring	081	310	090	20	6.6	7.8	1021.4	93	0/10
2a	BR-K	Mooring	22/Aug/2014	09h05	-6	70°51.730	135°01.220	Mooring	157	124	090	14	6.6	7.8	1020.6	94	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					
2a	BR-K	Mooring	22/Aug/2014	09h05	-6	70°51.880	135°00.570	CTD-Rosette ↓	155	287	080	20	7.5	7.8	1020.5	92	0/10
2a	BR-K	Mooring	22/Aug/2014	09h15	-6	70°51.850	135°00.720	CTD-Rosette ↑	155	272	090	16	8.2	7.8	1020.5	89	0/10
2a	BR-K	Mooring	22/Aug/2014	10h18	-6	70°51.660	135°01.930	Triangulation	à 511 m	1	n-a	n-a	n-a	n-a	n-a	n-a	0/10
2a	BR-K	Mooring	22/Aug/2014	10h28	-6	70°51.560	135°00.940	Triangulation	à 394 m	2	n-a	n-a	n-a	n-a	n-a	n-a	0/10
2a	BR-K	Mooring	22/Aug/2014	10h37	-6	70°51.930	135°01.100	Triangulation	à 384 m	3	n-a	n-a	n-a	n-a	n-a	n-a	0/10
2a	Pingo	Mooring	22/Aug/2014	15h32	-6	70°51.590	134°59.450	CTD-Rosette ↓	121	055	040	7	6.9	8.1	1020.2	99	0/10
2a	Pingo	Mooring	22/Aug/2014	16h01	-6	70°52.540	134°59.900	CTD-Rosette ↑	124	055	030	9	6.7	7.9	1020.3	99	0/10
2a	BS-2	Mooring	22/Aug/2014	17h15	-6	70°52.850	135°05.660	Mooring BS-2	300	137	030	11	4.9	8.0	1020.3	99	0/10
2a	BS-2	Mooring	22/Aug/2014	17h30	-6	70°52.930	135°06.070	Triangulation	à 470 m	1	n-a	n-a	n-a	n-a	n-a	n-a	0/10
2a	BS-2	Mooring	22/Aug/2014	17h37	-6	70°52.710	135°05.840	Triangulation	à 453 m	2	n-a	n-a	n-a	n-a	n-a	n-a	0/10
2a	BS-2	Mooring	22/Aug/2014	17h47	-6	70°52.970	135°05.120	Triangulation	à 502 m	3	n-a	n-a	n-a	n-a	n-a	n-a	0/10
2a	Pingo	Mooring	22/Aug/2014	18h13	-6	70°52.770	135°06.140	Vertical Net ↓	303	053	030	10	6.0	8.0	1020.2	99	0/10
2a	Pingo	Mooring	22/Aug/2014	18h25	-6	70°52.710	135°06.130	Vertical Net ↑	298	086	030	9	5.5	7.8	1020.3	99	0/10
2a	Pingo	Mooring	22/Aug/2014	18h40	-6	70°52.810	134°06.090	CTD-Rosette ↓	303	035	030	7	5.6	8.0	1020.4	99	0/10
2a	Pingo	Mooring	22/Aug/2014	19h03	-6	70°52.940	134°06.460	CTD-Rosette ↑	312	015	n-a	n-a	n-a	n-a	n-a	n-a	0/10
2a	434	Basic	22/Aug/2014	23h11	-6	70°10.240	133°33.140	CTD-Rosette Bio ↓	46	121	330	5	6.8	7.1	1020.4	99	0/10
2a	434	Basic	22/Aug/2014	23h31	-6	70°10.830	133°32.860	CTD-Rosette Bio ↑	47	085	330	3	6.8	6.7	1020.4	99	0/10
2a	434	Basic	22/Aug/2014	23h37	-6	70°10.870	133°32.750	Tucker ↓	47	075	330	4	6.8	6.7	1020.5	99	0/10
2a	434	Basic	22/Aug/2014	23h46	-6	70°11.160	133°32.580	Tucker ↑	47	278	330	4	6.8	6.6	1020.5	99	0/10
2a	434	Basic	23/Aug/2014	00h12	-6	70°10.760	133°32.970	Monster ↓	46	278	330	3	6.8	6.7	1020.6	99	0/10
2a	434	Basic	23/Aug/2014	00h17	-6	70°10.800	133°32.880	Monster ↑	46	318	340	4	6.8	6.2	1020.3	99	0/10
2a	434	Basic	23/Aug/2014	00h57	-6	70°10.740	133°33.360	CTD-Rosette nutrients ↓	46	085	270	5	6.5	5.9	1020.7	99	0/10
2a	434	Basic	23/Aug/2014	01h15	-6	70°10.850	133°33.170	CTD-Rosette nutrients ↑	47	117	270	7	6.8	6.1	1020.8	99	0/10
2a	434	Basic	23/Aug/2014	01h25	-6	70°10.910	133°33.050	Box Core ↓	47	123	270	7	7.3	6.1	1020.8	99	0/10
2a	434	Basic	23/Aug/2014	01h32	-6	70°10.950	133°32.990	Box Core ↑	46	132	270	8	7.3	6.1	1020.8	99	0/10
2a	434	Basic	23/Aug/2014	01h42	-6	70°11.070	133°32.580	Agassiz Trawl ↓	47	020	270	8	6.8	6.2	1020.8	99	0/10
2a	434	Basic	23/Aug/2014	01h52	-6	70°11.410	133°32.250	Agassiz Trawl ↑	48	347	280	7	6.8	6.3	1020.8	99	0/10
2a	433	CTD	23/Aug/2014	02h35	-6	70°17.350	133°34.890	CTD-Rosette ↓	56	168	290	13	7.0	6.8	1020.4	99	0/10
2a	433	CTD	23/Aug/2014	02h44	-6	70°17.330	133°34.780	CTD-Rosette ↑	57	188	300	13	7.4	7.4	1021.1	99	0/10
2a	432	Nutrient	23/Aug/2014	03h30	-6	70°23.770	133°36.490	CTD-Rosette ↓	63	195	310	15	6.6	8	1020.6	99	0/10
2a	432	Nutrient	23/Aug/2014	03h52	-6	70°23.660	133°36.320	CTD-Rosette ↑	62	214	320	13	6.8	7.6	1021.3	99	0/10
2a	431	CTD	23/Aug/2014	04h39	-6	70°29.580	133°37.150	CTD-Rosette ↓	68	211	335	13	6.2	7.8	1021.1	99	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					
2a	431	CTD	23/Aug/2014	04h44	-6	70°29.600	133°37.520	CTD-Rosette ↑	68	203	335	12	6.2	7.8	1021.1	99	0/10
2a	430	Nutrient	23/Aug/2014	05h36	-6	70°35.900	135°38.900	CTD-Rosette ↓	70	210	320	12	4.9	8.2	1020.4	99	0/10
2a	430	Nutrient	23/Aug/2014	05h56	-6	70°35.860	133°38.700	CTD-Rosette ↑	73	236	330	11	5.4	8.2	1020.7	99	0/10
2a	429	CTD	23/Aug/2014	06h48	-6	70°41.820	133°40.390	CTD-Rosette ↓	70	246	000	10	4.1	8.1	1020.7	99	0/10
2a	429	CTD	23/Aug/2014	06h54	-6	70°41.790	133°40.420	CTD-Rosette ↑	69	257	000	9	4.4	7.8	1020.1	99	0/10
2a	428	Nutrient	23/Aug/2014	07h39	-6	70°47.480	133°41.820	CTD-Rosette nutrients ↓	75	217	000	7	3.7	7.7	1019.8	99	0/10
2a	428	Nutrient	23/Aug/2014	08h03	-6	70°47.450	133°41.990	CTD-Rosette nutrients ↑	75	268	010	6	4.4	7.5	1020.6	99	0/10
2a	427	CTD	23/Aug/2014	09h02	-6	70°52.770	133°43.280	CTD-Rosette ↓	80	260	320	5	2.9	7.2	1020.8	99	0/10
2a	427	CTD	23/Aug/2014	09h09	-6	70°52.770	133°43.280	CTD-Rosette ↑	82	234	330	6	2.9	7.2	1020.8	99	0/10
2a	426	Nutrient	23/Aug/2014	10h10	-6	70°59.060	133°44.870	CTD-Rosette ↓	98	348	330	5	3.4	6.6	1021.6	99	0/10
2a	426	Nutrient	23/Aug/2014	10h39	-6	70°58.960	133°45.420	CTD-Rosette ↑	103	183	360	4	3.7	7.0	1021.9	99	0/10
2a	BS-3	Mooring	23/Aug/2014	14h20	-6	70°55.540	135°14.300	Mooring BS-3	500	000	210	3	4.6	7.3	1022.0	99	0/10
2a	BS-3	Mooring	23/Aug/2014	14h38	-6	70°55.380	135°14.080	Triangulation	à 652 m	1	n-a	n-a	n-a	n-a	n-a	n-a	0/10
2a	BS-3	Mooring	23/Aug/2014	14h48	-6	70°55.670	135°13.230	Triangulation	à 780 m	2	n-a	n-a	n-a	n-a	n-a	n-a	0/10
2a	BS-3	Mooring	23/Aug/2014	14h58	-6	70°55.770	135°14.440	Triangulation	à 683 m	3	n-a	n-a	n-a	n-a	n-a	n-a	0/10
2a	BS-3	Mooring	23/Aug/2014	15h23	-6	70°55.320	135°13.860	CTD-Rosette ↓	489	189	260	3	4.2	7.3	1022.0	99	0/10
2a	BS-3	Mooring	23/Aug/2014	15h52	-6	70°55.240	135°14.010	CTD-Rosette ↑	487	151	nn-aa	nn-aa	4.5	6.7	1022.0	99	0/10
2a	BR-G	Mooring	23/Aug/2014	17h30	-6	71°00.110	135°30.400	Mooring BR-G	702	045	n-a	n-a	5.4	6.0	1021.8	99	0/10
2a	BR-G	Mooring	23/Aug/2014	17h49	-6	70°59.980	135°31.080	Triangulation	à 824 m	1	n-a	n-a	n-a	n-a	n-a	99	0/10
2a	BR-G	Mooring	23/Aug/2014	17h58	-6	70°59.990	135°29.960	Triangulation	à 843 m	2	n-a	n-a	n-a	n-a	n-a	99	0/10
2a	BR-G	Mooring	23/Aug/2014	18h07	-6	71°00.260	135°30.350	Triangulation	à 761 m	3	n-a	n-a	n-a	n-a	n-a	99	0/10
2a	BR-G	Mooring	23/Aug/2014	18h32	-6	70°59.810	135°30.960	2 Net Samplers ↓	679	247	nn-aa	nn-aa	3.8	5.9	1021.7	99	0/10
2a	BR-G	Mooring	23/Aug/2014	18h44	-6	70°59.750	135°31.180	2 Net Samplers ↑	674	248	nn-aa	nn-aa	3.9	5.8	1021.6	99	0/10
2a	BR-G	Mooring	23/Aug/2014	18h59	-6	70°59.720	135°31.300	CTD-Rosette ↓	677	257	nn-aa	nn-aa	3.8	5.6	1021.4	99	0/10
2a	BR-G	Mooring	23/Aug/2014	19h24	-6	70°59.670	135°31.650	CTD-Rosette ↑	680	292	140	6	3.8	5.4	1021.3	99	0/10
2a	421	Full	24/Aug/2014	00h20	-6	71°27.240	133°53.620	CTD-Rosette nutrients ↓	1158	112	140	7	2.0	0.68	1020.3	99	7/10
2a	421	Full	24/Aug/2014	01h44	-6	71°26.980	133°54.400	CTD-Rosette nutrients ↑	1196	064	130	5	1.4	0.90	1020.0	99	7/10
2a	421	Full	24/Aug/2014	01h58	-6	71°26.980	133°54.500	Bioness ↓	1193	045	140	6	1.4	0.90	1020.0	99	7/10
2a	421	Full	24/Aug/2014	02h13	-6	71°27.160	133°52.210	Bioness ↑	1136	075	140	7	1.5	0.82	1019.8	99	7/10
2a	421	Full	24/Aug/2014	02h29	-6	71°27.100	133°51.690	Tucker ↓	1126	130	110	7	1.6	0.76	1019.8	99	7/10
2a	421	Full	24/Aug/2014	02h45	-6	71°27.140	133°50.180	Tucker ↑	1088	060	120	5	1.9	0.62	1019.7	99	7/10
2a	421	Full	24/Aug/2014	03h00	-6	71°26.960	133°50.800	Hydrobios ↓	1125	300	120	6	1.8	0.59	1019.6	99	7/10

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					
2a	421	Full	24/Aug/2014	04h05	-6	71°27.150	133°51.380	Hydrobios ↑	1110	249	120	6	0.3	0.72	1019.4	99	7/10
2a	421	Full	24/Aug/2014	04h25	-6	71°27.190	133°51.580	Monster ↓	1116	238	135	5	0.3	0.69	1019.3	99	7/10
2a	421	Full	24/Aug/2014	05h46	-6	71°27.500	133°52.640	Monster ↑	1093	221	130	4	1.0	0.78	1018.7	99	7/10
2a	421	Full	24/Aug/2014	06h22	-6	71°27.280	133°52.940	Secchi, PNF ↓	1137	075	115	5	0.9	0.76	1018.8	99	7/10
2a	421	Full	24/Aug/2014	06h27	-6	71°27.300	133°52.990	Secchi, PNF ↑	1136	064	120	6	0.9	0.76	1018.8	99	7/10
2a	421	Full	24/Aug/2014	06h41	-6	71°27.360	133°53.230	CTD-Rosette ↓	1132	333	190	6	0.8	0.63	1018.5	99	7/10
2a	421	Full	24/Aug/2014	07h48	-6	71°27.530	133°54.110	CTD-Rosette ↑	1160	029	120	9	1.2	0.67	1019.4	99	7/10
2a	421	Full	24/Aug/2014	08h50	-6	71°27.570	133°53.710	Box Core ↓	1140	105	110	9	0.6	0.55	1019.5	99	7/10
2a	421	Full	24/Aug/2014	09h11	-6	71°27.580	133°54.170	Box Core (bottom)	1165	094	120	10	0.5	0.53	1017.3	99	7/10
2a	421	Full	24/Aug/2014	09h31	-6	71°27.610	133°54.430	Box Core ↑	1168	108	110	9	0.7	0.61	1017.3	99	7/10
2a	421	Full	24/Aug/2014	09h53	-6	71°27.380	133°53.310	Agassiz Trawl ↓	1135	136	110	9	0.7	0.5	1018.0	99	7/10
2a	421	Full	24/Aug/2014	11h27	-6	71°27.010	133°52.560	Agassiz Trawl ↑	1162	251	110	9	1.0	0.3	1016.5	99	7/10
2a	0214-02	UQAR Coring	24/Aug/2014	14h42	-6	71°27.950	133°29.500	Box Core ↓	890	057	110	6	1.4	0.52	1016.4	99	7/10
2a	0214-02	UQAR Coring	24/Aug/2014	14h49	-6	cancelled	cancelled	Box Core ↑	n-a	n-a	n-a	n-a	n-a	n-a	n-a	n-a	n-a
2a	0214-02	UQAR Coring	24/Aug/2014	15h42	-6	71°22.970	133°34.360	Box Core ↓	1000	010	090	6	2.2	0.65	1014.5	99	7/10
2a	0214-02	UQAR Coring	24/Aug/2014	16h02	-6	71°22.970	133°34.340	Box Core (bottom)	998	031	090	7	1.9	0.42	1015.6	99	7/10
2a	0214-02	UQAR Coring	24/Aug/2014	16h20	-6	71°22.960	133°34.280	Box Core ↑	999	046	090	7	1.8	0.31	1015.7	99	7/10
2a	0214-02	UQAR Coring	24/Aug/2014	17h01	-6	71°22.900	133°34.050	Piston Core ↓	997	029	090	7	1.7	0.20	1013.9	99	7/10
2a	0214-02	UQAR Coring	24/Aug/2014	17h19	-6	71°22.910	133°34.040	Piston Core (bottom)	998	034	090	8	1.9	0.25	1014.4	99	7/10
2a	0214-02	UQAR Coring	24/Aug/2014	17h38	-6	71°22.940	133°34.030	Piston Core ↑	996	075	090	8	2.9	0.27	1014.6	99	7/10
2a	460	Basic	25/Aug/2014	00h12	-6	72°08.820	130°48.880	High Volume Pump	962	270	140	7	2.3	1.10	1011.9	99	7/10
2a	460	Basic	25/Aug/2014	00h22	-6	72°08.810	130°48.840	High Volume Pump	962	282	140	6	2.2	0.68	1011.9	99	7/10
2a	460	Basic	25/Aug/2014	00h27	-6	72°08.810	130°48.840	CTD-Rosette ↓	962	290	140	6	2.2	0.68	1011.9	99	7/10
2a	460	Basic	25/Aug/2014	00h12	-6	72°08.640	130°49.290	CTD-Rosette ↑	961	295	180	6	2.9	1.06	1011.3	99	7/10
2a	460	Basic	25/Aug/2014	01h54	-6	72°08.460	130°49.600	Tucker ↓	965	120	150	7	2.5	1.05	1011.1	99	7/10
2a	460	Basic	25/Aug/2014	02h13	-6	72°08.740	130°48.220	Tucker ↑	953	348	120	6	2.2	1.03	1011.1	99	7/10
2a	460	Basic	25/Aug/2014	02h35	-6	72°09.190	130°49.550	Monster ↓	976	284	150	6	2.2	1.03	1011.1	99	7/10
2a	460	Basic	25/Aug/2014	03h55	-6	72°09.050	130°49.650	Monster ↑	973	296	150	7	2.5	1.10	1010.9	99	7/10
2a	460	Basic	25/Aug/2014	04h19	-6	72°09.940	130°49.590	Box Core ↓	965	256	160	5	2.1	0.99	1010.9	99	7/10
2a	460	Basic	25/Aug/2014	04h38	-6	72°08.900	130°48.950	CASQ Core (bottom)	961	276	150	6	2.1	1.07	1010.9	99	7/10
2a	460	Basic	25/Aug/2014	04h54	-6	72°08.870	130°48.990	Box Core ↑	963	253	150	5	2.2	1.18	1010.7	99	7/10
2a	460	Basic	25/Aug/2014	05h03	-6	72°08.810	130°49.160	Agassiz Trawl ↓	962	208	150	5	2.2	1.23	1010.6	99	7/10

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					
2a	460	Basic	25/Aug/2014	06h02	-6	72°08.570	130°48.880	Agassiz Trawl ↑	962	120	150	6	2.4	0.80	1010.4	99	7/10
2a	460	Basic	25/Aug/2014	06h23	-6	72°09.390	130°48.870	Secchi, PNF ↓	973	052	160	5	2.1	1.00	1010.2	99	7/10
2a	460	Basic	25/Aug/2014	06h27	-6	72°09.380	130°48.850	Secchi, PNF ↑	974	057	160	4	2.1	1.00	1010.2	99	7/10
2a	460	Basic	25/Aug/2014	06h39	-6	72°09.500	130°49.160	CTD-Rosette (Biomass) ↓	982	291	160	4	2.2	0.86	1010.1	99	7/10
2a	460	Basic	25/Aug/2014	07h39	-6	72°09.320	130°49.280	CTD-Rosette (Biomass) ↑	974	237	190	3	1.5	1.13	1010.0	99	7/10
2a	460	Basic	25/Aug/2014	08h24	-6	72°09.110	130°49.430	Beam trawl ↓	973	130	290	4	1.2	1.74	1009.8	99	7/10
2a	460	Basic	25/Aug/2014	10h10	-6	72°09.330	130°48.290	Beam trawl ↑	1039	154	290	4	1.7	1.82	1009.4	99	7/10
2a	460	Basic	25/Aug/2014	19h46	-6	72°40.280	127°18.330	Piston Core ↓	123	340	310	11	1.4	3.38	1008.2	99	1/10
2a	460	Basic	25/Aug/2014	19h51	-6	72°40.290	127°18.320	Piston Core (bottom)	122	326	310	11	1.4	3.38	1008.2	99	1/10
2a	460	Basic	25/Aug/2014	19h56	-6	72°40.290	127°18.320	Piston Core ↑	123	331	310	12	1.3	3.35	1008.2	99	1/10
2a	460	Basic	25/Aug/2014	21h08	-6	72°40.260	127°18.180	Box Core ↓	122	351	350	15	0.3	3.29	1008.2	99	1/10
2a	460	Basic	25/Aug/2014	21h11	-6	72°40.240	127°18.090	Box Core (bottom)	124	360	350	15	0.3	3.29	1008.2	99	1/10
2a	460	Basic	25/Aug/2014	21h15	-6	72°40.220	127°18.020	Box Core ↑	126	357	350	15	0.3	3.29	1008.2	99	1/10
2a	PCBC-3	GSC Coring	26/Aug/2014	05h48	-6	72°26.540	129°26.760	Piston Core ↓	452	340	340	14	-1.0	3.46	1009.2	99	0/10
2a	PCBC-3	GSC Coring	26/Aug/2014	05h59	-6	72°26.720	129°26.760	Piston Core (bottom)	453	340	330	12	-1.3	3.36	1009.3	99	0/10
2a	PCBC-3	GSC Coring	26/Aug/2014	06h12	-6	72°26.540	129°26.750	Piston Core ↑	452	347	340	10	-1.4	3.46	1009.4	99	0/10
2a	PCBC-3	GSC Coring	26/Aug/2014	07h35	-6	72°26.530	129°26.770	Box Core ↓	453	344	330	11	-1.0	3.51	1009.9	99	races de glac
2a	PCBC-3	GSC Coring	26/Aug/2014	08h26	-6	72°26.570	129°26.730	Box Core (bottom)	453	343	340	10	-1.2	3.46	1010.5	99	0/10
2a	PCBC-3	GSC Coring	26/Aug/2014	08h36	-6	72°26.500	129°26.760	Box Core ↑	453	333	340	10	-1.2	3.48	1010.5	99	0/10
2a	PCBC-3	GSC Coring	26/Aug/2014	21h58	-6	73°20.560	128°17.030	Bouée UP - Tempo	346	247	320	5	-2.0	0.85	1011.6	99	7/10
2a	BR-3	Mooring	27/Aug/2014	07h35	-6	73°24.580	129°21.400	Mooring	699	263	170	2	-3.9	0.38	1011.3	99	7/10
2a	BR-3	Mooring	27/Aug/2014	07h54	-6	73°24.640	129°20.570	Triangulation	à 855 m	1	n-a	n-a	n-a	n-a	n-a	99	7/10
2a	BR-3	Mooring	27/Aug/2014	08h04	-6	73°24.720	129°21.970	Triangulation	à 856 m	2	n-a	n-a	n-a	n-a	n-a	99	7/10
2a	BR-3	Mooring	27/Aug/2014	08h13	-6	73°24.360	129°21.600	Triangulation	à 762 m	3	n-a	n-a	n-a	n-a	n-a	99	7/10
2a	BR-3	Mooring	27/Aug/2014	08h49	-6	73°24.270	129°21.370	CTD-Rosette ↓	689	160	150	4	-3.2	0.05	1011.2	99	7/10
2a	BR-3	Mooring	27/Aug/2014	09h27	-6	73°24.210	129°21.290	CTD-Rosette ↑	689	035	170	5	-2.3	0.33	1011.2	99	7/10
2a	BR-3	Mooring	27/Aug/2014	09h40	-6	73°24.190	129°21.230	Tucker ↓	689	018	170	5	-2.1	0.42	1011.1	99	6/10
2a	BR-3	Mooring	27/Aug/2014	09h49	-6	73°24.180	129°21.160	Tucker ↑	689	022	170	5	-2.1	0.42	1011.1	99	6/10
2a	BR-4	Mooring	28/Aug/2014	07h20	-6	73°13.210	127°02.840	Mooring	157	005	135	14	2.5	1.73	1007.2	99	3/10
2a	BR-4	Mooring	28/Aug/2014	07h33	-6	73°13.150	127°03.760	Triangulation	à 527 m	1	n-a	n-a	n-a	n-a	n-a	n-a	3/10
2a	BR-4	Mooring	28/Aug/2014	07h41	-6	73°13.030	127°02.490	Triangulation	à 471 m	2	n-a	n-a	n-a	n-a	n-a	n-a	3/10
2a	BR-4	Mooring	28/Aug/2014	07h49	-6	73°13.390	127°02.470	Triangulation	à 377 m	3	n-a	n-a	n-a	n-a	n-a	n-a	3/10

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					
2a	BR-4	Mooring	28/Aug/2014	08h26	-6	73°13.600	127°03.520	CTD-Rosette ↓	158	165	130	14	2.1	1.64	1007.1	99	3/10
2a	BR-4	Mooring	28/Aug/2014	08h56	-6	73°13.080	127°03.580	CTD-Rosette ↑	158	058	130	16	2.4	1.66	1006.8	99	3/10
2a	UP-Tempo-2	Ice	28/Aug/2014	14h43	-6	73°39.910	127°58.050	Buoy deployment	210	150	120	9	2.0	0.28	1003.6	99	1/10
2a	UP-Tempo-2	Ice	28/Aug/2014	21h35	-6	73°29.590	126°48.630	Ice Work	121	347	130	12	4.4	0.68	1002.7	99	3/10
2a	UP-Tempo-2	Ice	28/Aug/2014	23h00	-6	73°29.720	126°48.610	Ice Work	119	6	150	11	3.8	0.98	1002.6	99	3/10
2a	PCBC-2	GSC Coring	29/Aug/2014	14h31	-6	73°15.750	128°30.840	Box Core ↓	414	115	130	14	2.8	0.20	1000.8	99	8/10
2a	PCBC-2	GSC Coring	29/Aug/2014	14h41	-6	73°15.760	128°30.820	Box Core (bottom)	413	126	130	14	2.9	0.10	1000.7	99	8/10
2a	PCBC-2	GSC Coring	29/Aug/2014	14h50	-6	73°15.760	128°30.950	Box Core ↑	415	146	130	15	2.9	0.05	1000.7	99	8/10
2a	PCBC-2	GSC Coring	29/Aug/2014	15h33	-6	73°15.780	128°30.680	Piston Core ↓	413	140	140	14	3.3	-0.01	1000.5	99	8/10
2a	PCBC-2	GSC Coring	29/Aug/2014	15h41	-6	73°15.770	128°30.700	Piston Core (bottom)	413	140	120	14	3.4	0.00	1000.5	99	8/10
2a	PCBC-2	GSC Coring	29/Aug/2014	15h52	-6	73°15.820	128°30.790	Piston Core ↑	414	115	140	15	3.2	-0.06	1000.4	99	8/10
2a	UP-Tempo	Ice	29/Aug/2014	18h42	-6	73°16.890	128°33.450	Ice Work	429	126	140	15	3.3	-0.14	1000.2	99	8/10
2a	UP-Tempo	Ice	29/Aug/2014	19h17	-6	73°17.030	128°33.380	Ice Work	430	129	140	16	3.5	-0.13	1000.1	99	8/10
2a	UP-Tempo	Ice	29/Aug/2014	20h17	-6	73°17.400	128°33.180	Buoy deployment	430	179	140	15	3.5	-0.04	1000.0	99	8/10
2a	UP-Tempo	Ice	30/Aug/2014	10h58	-6	72°31.930	129°47.260	SX 90	898	222	340	21	0.5	2.49	1001.4	99	8/10
2a	PCBC-8	GSC Coring	31/Aug/2014	06h22	-6	70°39.780	136°18.360	Piston Core ↓	605	120	120	14	5.0	6.62	1006.6	81	0/10
2a	PCBC-8	GSC Coring	31/Aug/2014	06h35	-6	70°39.690	136°18.290	Piston Core (bottom)	601	132	130	15	5.0	6.51	1006.5	82	0/10
2a	PCBC-8	GSC Coring	31/Aug/2014	06h49	-6	70°39.710	136°18.350	Piston Core ↑	602	136	130	14	5.0	6.64	1006.5	82	0/10
2a	PCBC-8	GSC Coring	31/Aug/2014	08h05	-6	70°39.750	136°18.260	Box Core ↓	601	153	130	16	5.0	7.29	1006.1	81	0/10
2a	PCBC-8	GSC Coring	31/Aug/2014	08h51	-6	70°39.740	136°18.440	Box Core (bottom)	603	142	130	15	4.9	7.60	1006.1	83	0/10
2a	PCBC-8	GSC Coring	31/Aug/2014	09h04	-6	70°39.760	136°18.390	Box Core ↑	602	108	130	17	4.9	7.61	1006.1	82	0/10
2a	PCBC-12	GSC Coring	31/Aug/2014	10h12	-6	70°41.420	136°25.750	Box Core ↓	775	095	140	14	4.9	6.20	1005.9	82	0/10
2a	PCBC-12	GSC Coring	31/Aug/2014	10h29	-6	70°41.430	136°25.780	Box Core (bottom)	778	122	130	15	4.9	6.16	1005.8	82	0/10
2a	PCBC-12	GSC Coring	31/Aug/2014	10h43	-6	70°41.470	136°25.730	Box Core ↑	780	107	130	17	5.0	6.15	1005.7	82	0/10
2a	GAC-05	core Non décle	31/Aug/2014	12h32	-6	70°44.470	136°38.560	Box Core ↓	1243	130	140	15	5.0	6.28	1005.7	84	0/10
2a	GAC-05	core Non décle	31/Aug/2014	12h58	-6	70°44.470	136°38.730	Box Core (bottom)	1246	126	130	16	5.0	6.31	1005.7	85	0/10
2a	GAC-05	core Non décle	31/Aug/2014	13h25	-6	70°44.640	136°38.550	Box Core ↑	1247	123	130	16	5.1	6.32	1005.6	86	0/10
2a	PCBC-5	GSC Coring	31/Aug/2014	15h33	-6	70°44.550	136°38.550	Piston Core ↓	1245	123	120	17	5.5	6.68	1005.30	88	0/10
2a	PCBC-5	GSC Coring	31/Aug/2014	15h58	-6	70°44.490	136°38.490	Piston Core (bottom)	1247	129	120	20	5.6	6.64	1005.30	87	0/10
2a	PCBC-5	GSC Coring	31/Aug/2014	16h28	-6	70°44.540	136°39.500	Piston Core ↑	1255	162	120	18	5.6	6.63	1005.30	88	0/10
2a	PCBC-5	GSC Coring	31/Aug/2014	18h32	-6	70°44.530	136°38.560	Box Core ↓	1246	122	110	18	6.4	6.70	1004.77	90	0/10
2a	PCBC-5	GSC Coring	31/Aug/2014	19h02	-6	70°44.500	136°38.500	Box Core (bottom)	1248	141	110	20	5.9	6.52	1004.70	91	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					
2a	PCBC-5	GSC Coring	31/Aug/2014	19h27	-6	70°44.590	136°38.610	Box Core ↑	1243	149	110	16	5.9	6.52	1004.81	91	0/10
2a	UQAR-PCBC	UQAR Coring	01/Sept/2014	06h24	-6	70°33.040	137°31.940	Piston Core ↓	1046	068	n-a	n-a	6.4	8.44	1004.2	86	0/10
2a	UQAR-PCBC	UQAR Coring	01/Sept/2014	06h41	-6	70°33.030	137°31.910	Piston Core (bottom)	1051	165	90	4	6.2	8.57	1004.1	85	0/10
2a	UQAR-PCBC	UQAR Coring	01/Sept/2014	07h01	-6	70°33.090	137°31.910	Piston Core ↑	1046	096	90	5	6.3	8.63	1003.8	86	0/10
2a	UQAR-PCBC	UQAR Coring	01/Sept/2014	08h25	-6	70°33.020	137°31.920	Box Core ↓	1056	135	130	12	4.4	8.53	1002.8	99	0/10
2a	UQAR-PCBC	UQAR Coring	01/Sept/2014	08h41	-6	70°33.060	137°32.000	Box Core (bottom)	1048	161	130	17	4.6	8.65	1002.5	99	0/10
2a	UQAR-PCBC	UQAR Coring	01/Sept/2014	09h01	-6	70°33.090	137°32.100	Box Core ↑	1057	155	130	16	4.5	8.68	1002.2	99	0/10
2a	UQAR-PCBC	UQAR Coring	01/Sept/2014	09h24	-6	70°33.260	137°32.530	CTD-Rosette ↓	1072	320	110	14	4.6	8.48	1001.8	99	0/10
2a	UQAR-PCBC	UQAR Coring	01/Sept/2014	10h25	-6	70°33.310	137°32.360	CTD-Rosette ↑	1064	320	130	13	8.2	6.60	1000.3	87	0/10
2a	BR-1	Mooring	01/Sept/2014	15h26	-6	70°25.830	139°01.150	Mooring Position	759	210	210	11	6.8	7.32	995.70	74	0/10
2a	BR-1	Mooring	01/Sept/2014	15h46	-6	70°26.400	139°01.720	Triangulation	à 1230 m	1	n-a	n-a	n-a	n-a	n-a	n-a	n-a
2a	BR-1	Mooring	01/Sept/2014	15h56	-6	70°25.730	139°02.360	Triangulation	à 1043 m	2	n-a	n-a	n-a	n-a	n-a	n-a	n-a
2a	BR-1	Mooring	01/Sept/2014	16h05	-6	70°25.780	139°00.320	Triangulation	à 1039 m	3	n-a	n-a	n-a	n-a	n-a	n-a	n-a
2a	BR-1	Mooring	01/Sept/2014	16h27	-6	70°25.630	139°01.560	CTD-Rosette ↓	744	193	190	10	6.9	7.44	995.5	76	0/10
2a	BR-1	Mooring	01/Sept/2014	17h00	-6	70°25.650	139°01.250	CTD-Rosette ↑	752	204	190	11	7.0	7.49	995.5	71	0/10
2a	BR-1	Mooring	01/Sept/2014	17h15	-6	70°25.660	139°01.140	2 Net Samplers ↓	756	210	200	10	7.2	7.52	995.50	72	0/10
2a	BR-1	Mooring	01/Sept/2014	17h24	-6	70°25.670	139°01.080	2 Net Samplers ↑	760	213	200	8	7.1	7.53	995.50	75	0/10
2a	482	Basic	01/Sept/2014	18h39	-6	70°31.460	139°22.870	Secchi, PNF ↓	828	310	180	6	7.0	7.24	994.9	82	0/10
2a	482	Basic	01/Sept/2014	18h42	-6	70°31.480	139°22.870	Secchi, PNF ↑	826	300	180	7	7.0	7.24	994.9	82	0/10
2a	482	Basic	01/Sept/2014	18h42	-6	70°31.480	139°22.870	HV Pump	826	300	180	7	7.0	7.24	994.9	82	0/10
2a	482	Basic	01/Sept/2014	18h51	-6	70°31.530	139°22.850	HV Pump	829	307	180	7	6.7	7.01	994.9	84	0/10
2a	482	Basic	01/Sept/2014	19h06	-6	70°31.490	139°22.890	CTD-Rosette Bio ↓	832	182	160	6	6.6	6.86	995.0	84	0/10
2a	482	Basic	01/Sept/2014	20h07	-6	70°31.610	139°23.240	CTD-Rosette Bio ↑	828	237	160	5	6.9	6.73	994.8	85	0/10
2a	482	Basic	01/Sept/2014	20h16	-6	70°31.540	139°23.370	Tucker ↓	825	179	160	6	6.9	6.81	994.8	80	0/10
2a	482	Basic	01/Sept/2014	20h38	-6	70°31.740	139°22.420	Tucker ↑	834	292	170	7	7.3	6.84	994.6	72	0/10
2a	482	Basic	01/Sept/2014	20h59	-6	70°31.790	139°23.210	Monster ↓	833	198	150	6	7.5	7.07	994.70	56	0/10
2a	482	Basic	01/Sept/2014	22h13	-6	70°31.830	139°23.760	Monster ↑	833	116	020	8	8.3	7.01	994.66	45	0/10
2a	482	Basic	01/Sept/2014	22h32	-6	70°31.540	139°23.200	CTD-Rosette Nutrients ↓	828	190	345	15	7.7	7.13	994.39	61	0/10
2a	482	Basic	01/Sept/2014	23h36	-6	70°31.490	139°23.660	CTD-Rosette Nutrients ↑	823	079	340	10	6.6	6.99	994.73	85	0/10
2a	482	Basic	01/Sept/2014	23h42	-6	70°31.500	139°23.410	Agassiz Trawl ↓	828	073	340	10	6.6	7.09	994.84	85	0/10
2a	482	Basic	02/Sept/2014	00h40	-6	70°30.890	139°25.260	Agassiz Trawl ↑	809	140	320	12	6.5	6.98	995.40	83	0/10
2a	482	Basic	02/Sept/2014	01h20	-6	70°31.470	139°22.900	Box Core ↓	826	186	310	13	7.5	7.24	995.80	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					
2a	482	Basic	02/Sept/2014	01h35	-6	70°31.460	139°22.950	Box Core (bottom)	826	193	300	14	7.0	7.17	995.80	87	0/10
2a	482	Basic	02/Sept/2014	01h50	-6	70°31.450	139°22.910	Box Core ↑	824	187	300	15	6.4	7.23	996.00	91	0/10
2a	482	Basic	02/Sept/2014	02h22	-6	70°31.110	139°23.270	IKMT ↓	816	206	300	17	6.1	7.19	996.30	90	0/10
2a	482	Basic	02/Sept/2014	03h36	-6	70°31.550	139°21.850	IKMT ↑	832	072	330	25	4.8	7.05	997.40	91	0/10
2a	PCBC-6	GSC Coring	02/Sept/2014	09h31	-6	70°35.090	136°00.750	Box Core ↓	133	344	340	19	2.5	7.04	998.8	81	0/10
2a	PCBC-6	GSC Coring	02/Sept/2014	09h36	-6	70°35.090	136°00.740	Box Core (bottom)	132	022	330	17	2.5	7.04	998.8	81	0/10
2a	PCBC-6	GSC Coring	02/Sept/2014	09h40	-6	70°35.060	136°00.730	Box Core ↑	130	360	340	17	2.5	7.04	998.8	81	0/10
2a	PCBC-6	GSC Coring	02/Sept/2014	10h56	-6	70°35.110	136°00.840	Piston Core ↓	133	033	330	13	2.5	7.04	999.6	79	0/10
2a	PCBC-6	GSC Coring	02/Sept/2014	11h00	-6	70°35.100	136°00.810	Piston Core (bottom)	133	038	330	13	2.5	7.11	999.7	79	0/10
2a	PCBC-6	GSC Coring	02/Sept/2014	11h04	-6	70°35.100	136°00.840	Piston Core ↑	133	356	335	12	2.5	7.11	999.7	79	0/10
2a	BC-10	GSC Coring	02/Sept/2014	12h20	-6	70°35.950	136°04.180	Box Core ↓	215	100	345	7	1.8	7.06	1000.4	85	0/10
2a	BC-10	GSC Coring	02/Sept/2014	12h25	-6	70°35.950	136°04.180	Box Core (bottom)	215	088	330	7	1.8	7.06	1000.4	85	0/10
2a	BC-10	GSC Coring	02/Sept/2014	12h30	-6	70°35.960	136°04.090	Box Core ↑	215	084	330	6	1.8	7.12	1000.4	85	0/10
2a	BC-11	GSC Coring	02/Sept/2014	13h23	-6	70°37.820	136°11.340	Box Core ↓	502	070	300	6	2.6	7.64	1001.0	82	0/10
2a	BC-11	GSC Coring	02/Sept/2014	13h33	-6	70°37.850	136°11.300	Box Core (bottom)	504	090	270	5	2.8	7.68	1001.1	83	0/10
2a	BC-11	GSC Coring	02/Sept/2014	13h45	-6	70°37.910	136°11.040	Box Core ↑	503	100	290	6	3.5	7.75	1001.1	87	0/10
2a	BC-14	GSC Coring	02/Sept/2014	14h35	-6	70°31.600	136°20.340	Box Core ↓	328	330	260	3	3.0	7.84	1001.0	85	0/10
2a	BC-14	GSC Coring	02/Sept/2014	14h45	-6	70°31.600	136°20.240	Box Core (bottom)	320	033	260	3	3.0	7.84	1001.0	85	0/10
2a	BC-14	GSC Coring	02/Sept/2014	14h53	-6	70°31.640	136°19.990	Box Core ↑	320	023	n-a	n-a	n-a	n-a	n-a	n-a	n-a
2a	BC-15	GSC Coring	02/Sept/2014	15h36	-6	70°34.350	136°30.990	Box Core ↓	547	321	300	2	3.0	7.84	1001.0	85	0/10
2a	BC-15	GSC Coring	02/Sept/2014	15h47	-6	70°31.330	136°30.580	Box Core (bottom)	548	325	270	1	3.0	7.84	1001.0	85	0/10
2a	BC-15	GSC Coring	02/Sept/2014	15h57	-6	70°34.450	136°30.250	Box Core ↑	570	310	300	3	3.0	7.84	1001.0	85	0/10
2a	PCBC-7	GSC Coring	02/Sept/2014	17h51	-6	70°41.430	136°43.050	Piston Core ↓	1068	275	320	7	3.0	7.84	1001.0	85	0/10
2a	PCSC-7	GSC Coring	02/Sept/2014	18h12	-6	70°41.540	136°43.100	Piston Core (bottom)	1065	299	280	7	2.9	5.77	1003.2	86	0/10
2a	PCSC-7	GSC Coring	02/Sept/2014	18h34	-6	70°41.470	136°43.020	Piston Core ↑	1062	271	280	9	3.3	5.77	1003.3	86	0/10
2a	PCSC-7	GSC Coring	02/Sept/2014	19h02	-6	70°41.620	136°43.340	Box Core ↓	1069	281	280	12	4.0	5.56	1003.3	73	0/10
2a	PCSC-7	GSC Coring	02/Sept/2014	19h21	-6	70°41.530	136°43.170	Box Core (bottom)	1068	289	280	10	4.0	5.64	1003.5	75	0/10
2a	PCSC-7	GSC Coring	02/Sept/2014	19h39	-6	70°41.440	136°42.920	Box Core ↑	1058	290	260	18	4.1	5.64	1003.6	79	0/10
2a	BC-16	GSC Coring	02/Sept/2014	20h31	-6	70°38.770	136°48.690	Box Core ↓	1093	281	270	11	3.9	5.79	1003.8	80	0/10
2a	BC-16	GSC Coring	02/Sept/2014	20h55	-6	70°38.740	136°48.280	Box Core (bottom)	1086	283	280	13	3.6	5.79	1003.8	83	0/10
2a	BC-16	GSC Coring	02/Sept/2014	21h09	-6	70°38.730	136°48.130	Box Core ↑	1087	332	280	15	3.4	5.78	1003.8	84	0/10
2a	BR-2	Mooring	03/Sept/2014	10h18	-6	69°59.720	137°58.600	Mooring BR-2	160	290	290	32	4.6	6.7	1002.6	70	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					
2a	BR-2	Mooring	03/Sept/2014	10h35	-6	69°59.750	137°58.090	Triangulation	à 381 m	1	n-a	n-a	n-a	n-a	n-a	n-a	0/10
2a	BR-2	Mooring	03/Sept/2014	10h40	-6	69°59.870	137°58.940	Triangulation	à 370 m	2	n-a	n-a	n-a	n-a	n-a	n-a	0/10
2a	BR-2	Mooring	03/Sept/2014	10h45	-6	69°59.520	137°58.920	Triangulation	à 485 m	3	n-a	n-a	n-a	n-a	n-a	n-a	0/10
2a	BR-2	Mooring	03/Sept/2014	11h18	-6	70°00.040	137°58.830	CTD-Rosette ↓	162	325	295	31	3.3	7.0	1002.9	76	0/10
2a	BR-2	Mooring	03/Sept/2014	11h30	-6	70°00.040	137°58.700	CTD-Rosette ↑	164	329	295	29	3.6	6.9	1003.1	69	0/10
2a	Orion - A	Basic	04/Sept/2014	15h44	-6	69°21.950	138°14.020	Secchi, PNF ↓	48	297	295	33	2.5	6.0	1011.8	85	0/10
2a	Orion - A	Basic	04/Sept/2014	15h49	-6	69°21.950	138°14.010	Secchi, PNF ↑	48	304	295	34	3.1	6.1	1011.8	80	0/10
2a	Orion - A	Basic	04/Sept/2014	16h04	-6	69°21.970	138°14.010	CTD-Rosette ↓	48	292	270	26	2.9	6.1	1012.0	83	0/10
2a	Orion - A	Basic	04/Sept/2014	16h27	-6	69°21.920	138°13.980	CTD-Rosette ↑	49	293	285	24	2.8	6.1	1012.4	79	0/10
2a	Orion - A	Basic	04/Sept/2014	16h42	-6	69°22.070	138°14.510	Tucker ↓	48	296	285	30	2.6	6.1	1012.3	82	0/10
2a	Orion - A	Basic	04/Sept/2014	16h49	-6	69°22.180	138°15.160	Tucker ↑	49	216	280	24	2.5	6.1	1012.2	83	0/10
2a	Orion - A	Basic	04/Sept/2014	17h12	-6	69°21.840	138°13.980	Monster ↓	48	300	290	28	2.4	6.0	1012.5	85	0/10
2a	Orion - A	Basic	04/Sept/2014	17h22	-6	69°21.650	138°14.040	Monster ↑	48	170	290	27	2.3	6.0	1012.5	86	0/10
2a	Orion - A	Basic	04/Sept/2014	17h54	-6	69°21.950	138°13.960	Box Core ↓	48	296	280	38	3.0	6.2	1011.7	77	0/10
2a	Orion - A	Basic	04/Sept/2014	17h55	-6	69°21.960	138°13.970	Box Core (bottom)	48	302	280	38	3.0	6.2	1011.7	77	0/10
2a	Orion - A	Basic	04/Sept/2014	17h57	-6	69°21.970	138°13.960	Box Core ↑	49	292	280	35	2.7	6.2	1012.4	73	0/10
2a	Orion - A	Basic	04/Sept/2014	18h08	-6	69°22.020	138°14.150	Agassiz Trawl ↓	49	303	280	33	2.4	5.9	1012.8	77	0/10
2a	Orion - A	Basic	04/Sept/2014	18h15	-6	69°22.190	138°14.510	Agassiz Trawl ↑	48	311	280	37	2.4	5.9	1012.8	77	0/10
2a	Orion - A	Basic	04/Sept/2014	18h39	-6	69°21.820	138°12.620	Beam trawl ↓	50	321	280	27	2.0	5.3	1013.1	83	0/10
2a	Orion - A	Basic	04/Sept/2014	19h08	-6	69°22.630	138°13.730	Beam trawl ↑	51	314	290	34	2.3	5.2	1012.7	82	0/10
2a	470	Nutrient	06/Sept/2014	06h50	-6	69°25.820	137°59.080	CTD-Rosette ↓	52	316	320	14	2.1	4.4	1025.9	76	0/10
2a	470	Nutrient	06/Sept/2014	07h09	-6	69°25.810	137°59.210	CTD-Rosette ↑	52	339	320	16	2.0	4.4	1025.9	78	0/10
2a	472 B	Full	06/Sept/2014	08h18	-6	69°36.570	138°13.510	Secchi, PNF, HUP ↓	129	307	310	13	1.7	4.3	1025.7	82	0/10
2a	472 B	Full	06/Sept/2014	08h27	-6	69°36.530	138°13.520	Secchi, PNF, HUP ↑	130	345	310	12	1.8	4.4	1025.9	77	0/10
2a	472 B	Full	06/Sept/2014	08h44	-6	69°36.530	138°13.260	CTD-Rosette ↓	129	300	300	13	1.9	4.4	1026.2	78	0/10
2a	472 B	Full	06/Sept/2014	09h20	-6	69°36.240	138°12.540	CTD-Rosette ↑	127	154	290	12	2.0	4.4	1026.2	79	0/10
2a	472 B	Full	06/Sept/2014	09h34	-6	69°36.310	138°11.460	Tucker ↓	129	129	295	17	2.0	4.4	1026.2	78	0/10
2a	472 B	Full	06/Sept/2014	09h49	-6	69°36.790	138°11.220	Tucker ↑	129	129	315	13	1.6	4.3	1026.2	78	0/10
2a	472 B	Full	06/Sept/2014	10h11	-6	69°36.710	138°12.400	Monster ↓	125	125	300	8	1.0	4.3	1026.3	89	0/10
2a	472 B	Full	06/Sept/2014	10h19	-6	69°36.640	138°12.230	Monster ↑	124	124	300	10	1.1	4.3	1026.3	89	0/10
2a	472 B	Full	06/Sept/2014	10h40	-6	69°36.500	138°12.060	CTD-Rosette ↓	123	123	300	11	1.8	4.3	1026.4	83	0/10
2a	472 B	Full	06/Sept/2014	11h13	-6	69°36.340	138°11.190	CTD-Rosette ↑	122	122	310	8	2.3	4.3	1026.5	80	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					
2a	472 B	Full	06/Sept/2014	12h05	-6	69°36.730	138°12.920	2 Net Samplers ↓	124	124	310	11	1.5	4.2	1026.7	85	0/10
2a	472 B	Full	06/Sept/2014	12h14	-6	69°36.730	138°12.660	2 Net Samplers ↑	125	125	300	11	1.7	4.2	1026.7	85	0/10
2a	472 B	Full	06/Sept/2014	12h33	-6	69°36.650	138°13.430	Box Core ↓	125	125	300	11	1.7	4.2	1026.7	85	0/10
2a	472 B	Full	06/Sept/2014	12h37	-6	69°36.630	138°13.360	Box Core (bottom)	125	125	310	9	1.7	4.2	1026.9	85	0/10
2a	472 B	Full	06/Sept/2014	12h40	-6	69°36.610	138°13.290	Box Core ↑	125	125	320	8	1.7	4.2	1026.9	84	0/10
2a	472 B	Full	06/Sept/2014	12h47	-6	69°36.750	138°13.090	Agassiz Trawl ↓	125	125	300	9	1.6	4.1	1027.0	84	0/10
2a	472 B	Full	06/Sept/2014	13h00	-6	69°37.060	138°13.560	Agassiz Trawl ↑	127	127	300	10	1.6	4.1	1027.0	84	0/10
2a	472 B	Full	06/Sept/2014	13h15	-6	69°36.550	138°13.300	Camera ↓	125	125	310	8	2.3	4.2	1027.0	77	0/10
2a	472 B	Full	06/Sept/2014	13h33	-6	69°36.450	138°12.820	Camera↑	125	125	310	8	1.9	4.1	1027.0	79	0/10
2a	474	Basic	06/Sept/2014	14h41	-6	69°47.860	138°26.140	CTD-Rosette ↓	173	267	300	8	1.6	4.6	1027.0	77	0/10
2a	474	Basic	06/Sept/2014	15h20	-6	69°47.580	138°25.920	CTD-Rosette ↑	172	247	330	3	2.0	4.8	1027.4	76	0/10
2a	476	Nutrient	06/Sept/2014	17h00	-6	69°58.990	138°39.880	CTD-Rosette (nutrient) ↓	267	230	000	4	2.2	4.9	1027.6	79	0/10
2a	476	Nutrient	06/Sept/2014	17h43	-6	69°58.920	138°39.030	CTD-Rosette (nutrient) ↑	267	300	350	8	2.0	4.9	1027.6	79	0/10
2a	476	Nutrient	06/Sept/2014	18h00	-6	69°58.790	138°38.950	Beam trawl ↓	265	228	330	4	1.2	4.9	1027.6	87	0/10
2a	476	Nutrient	06/Sept/2014	19h06	-6	69°59.030	138°36.320	Beam trawl ↑	266	210	330	4	1.1	5.0	1027.6	81	0/10
2a	478	Basic	06/Sept/2014	20h26	-6	70°10.060	138°54.600	CTD-Rosette ↓	374	331	030	9	1.3	5.1	1027.3	81	0/10
2a	478	Basic	06/Sept/2014	21h11	-6	70°09.910	138°54.480	CTD-Rosette ↑	374	302	040	6	2.0	4.8	1027.6	82	0/10
2a	480	Nutrient	06/Sept/2014	22h49	-6	70°20.230	139°08.890	CTD-Rosette (nutrient) ↓	570	013	070	4	1.0	4.9	1027.6	87	0/10
2a	480	Nutrient	06/Sept/2014	23h45	-6	70°20.090	139°09.100	CTD-Rosette (nutrient) ↑	569	012	070	5	0.8	4.9	1027.8	89	0/10
2a	PCBC-09	GSC Coring	07/Sept/2014	06h20	-6	70°38.350	139°00.950	Piston Core ↓	1501	193	120	6	-1.3	3.1	1027.8	95	0/10
2a	PCBC-09	GSC Coring	07/Sept/2014	06h51	-6	70°38.340	139°00.920	Piston Core (bottom)	1504	180	090	3	-1.4	2.9	1027.6	94	0/10
2a	PCBC-09	GSC Coring	07/Sept/2014	07h23	-6	70°38.380	139°01.340	Piston Core ↑	1502	204	120	6	-1.3	2.9	1027.5	93	0/10
2a	PCBC-09	GSC Coring	07/Sept/2014	08h40	-6	70°38.370	139°00.890	Box Core ↓	1501	099	120	6	-1.2	3.4	1027.6	97	0/10
2a	PCBC-09	GSC Coring	07/Sept/2014	09h20	-6	70°38.410	139°00.900	Box Core (bottom)	1502	232	100	5	-0.1	3.6	1027.5	94	0/10
2a	PCBC-09	GSC Coring	07/Sept/2014	09h39	-6	70°38.380	139°00.860	Box Core ↑	1497	226	140	7	-1	3.6	1027.5	97	0/10
2a	PCBC-09	GSC Coring	07/Sept/2014	10h25	-6	70°38.320	139°01.010	Piston Core ↓	1500	208	120	9	-0.7	3.7	1027.2	90	0/10
2a	PCBC-09	GSC Coring	07/Sept/2014	10h55	-6	70°38.340	139°00.980	Piston Core (bottom)	1500	031	120	12	-0.1	3.9	1027.2	89	0/10
2a	PCBC-09	GSC Coring	07/Sept/2014	11h26	-6	70°38.350	139°01.040	Piston Core ↑	1502	032	120	12	0	4.0	1027.9	90	0/10
2b	1040	Basic	10/Sept/2014	07h03	-6	71°14.810	157°10.020	CTD-Rosette ↓	47	287	140	21	1.8	7.1	1020.8	94	0/10
2b	1040	Basic	10/Sept/2014	07h18	-6	71°14.690	157°10.400	CTD-Rosette ↑	47	300	160	20	4.4	7.0	1020.6	82	0/10
2b	1040	Basic	10/Sept/2014	08h14	-6	71°14.780	157°09.640	Horizontal Net ↓	46	083	080	21	1.6	6.7	1020.3	90	0/10
2b	1040	Basic	10/Sept/2014	08h23	-6	71°14.960	157°09.410	Horizontal Net ↑	47	306	080	22	1.6	6.6	1020.2	91	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					
2b	1040	Basic	10/Sept/2014	08h47	-6	71°14.750	157°10.150	Vertical Net ↓	47	107	080	19	1.6	6.6	1020.4	92	0/10
2b	1040	Basic	10/Sept/2014	08h52	-6	71°14.710	157°10.260	Vertical Net ↑	48	130	090	17	1.5	6.5	1020.4	94	0/10
2b	1040	Basic	10/Sept/2014	09h16	-6	71°14.750	157°10.060	NORPAC Net ↓	47	075	080	16	1.6	6.6	1020.4	92	0/10
2b	1040	Basic	10/Sept/2014	09h20	-6	71°14.750	157°10.100	NORPAC Net ↑	47	071	080	18	1.7	6.6	1020.5	93	0/10
2b	1040	Basic	10/Sept/2014	09h25	-6	71°14.760	157°10.110	Van Veen Grab ↓	48	076	080	16	1.7	6.6	1020.5	93	0/10
2b	1040	Basic	10/Sept/2014	09h29	-6	71°14.770	157°10.140	Van Veen Grab ↑	48	070	080	16	1.7	6.6	1020.5	93	0/10
2b	1040	Basic	10/Sept/2014	09h32	-6	71°14.780	157°10.190	Van Veen Grab ↓	47	063	080	15	1.6	6.6	1020.4	92	0/10
2b	1040	Basic	10/Sept/2014	09h40	-6	71°14.800	157°10.200	Van Veen Grab ↑	48	076	090	15	1.5	6.6	1020.4	92	0/10
2b	1040	Basic	10/Sept/2014	09h43	-6	71°14.810	157°10.190	Gravity Core ↓	47	081	080	16	1.5	6.6	1020.4	92	0/10
2b	1040	Basic	10/Sept/2014	09h45	-6	71°14.810	157°10.170	Gravity Core ↑	47	091	080	16	1.5	6.6	1020.4	92	0/10
2b	1040	Basic	10/Sept/2014	09h46	-6	71°14.810	157°10.180	Gravity Core ↓	47	089	080	16	1.5	6.6	1020.4	94	0/10
2b	1040	Basic	10/Sept/2014	09h50	-6	71°14.790	157°10.240	Gravity Core ↑	47	099	090	18	1.4	6.6	1020.5	94	0/10
2b	1040	Basic	10/Sept/2014	09h56	-6	71°14.720	157°10.120	Agassiz Trawl ↓	47	120	090	19	1.4	6.6	1020.5	94	0/10
2b	1040	Basic	10/Sept/2014	10h02	-6	71°14.580	157°09.660	Agassiz Trawl ↑	45	119	090	19	1.4	6.5	1020.5	94	0/10
2b	1041	Nutrient	10/Sept/2014	10h49	-6	71°19.840	157°19.780	Zodiac Deployment	91	175	090	14	2.0	6.7	1020.9	94	0/10
2b	1041	Nutrient	10/Sept/2014	11h40	-6	71°19.720	157°20.320	Zodiac Recovery	91	168	080	18	2.7	5.0	1020.9	90	0/10
2b	1041	Nutrient	10/Sept/2014	11h01	-6	71°19.790	157°20.030	CTD-Rosette ↓	91	291	080	17	2.1	5.4	1020.9	93	0/10
2b	1041	Nutrient	10/Sept/2014	11h32	-6	71°19.720	157°20.120	CTD-Rosette ↑	91	301	070	18	2.7	5.0	1020.9	89	0/10
2b	1041	Nutrient	10/Sept/2014	12h35	-6	71°19.860	157°19.860	NORPAC Net ↓	92	101	080	20	1.9	4.9	1020.9	92	0/10
2b	1041	Nutrient	10/Sept/2014	12h45	-6	71°19.830	157°19.770	NORPAC Net ↑	92	098	075	22	1.9	4.9	1020.8	91	0/10
2b	1041	Nutrient	10/Sept/2014	12h50	-6	71°19.820	157°19.790	Van Veen Grab ↓	92	110	080	24	1.9	4.8	1020.6	90	0/10
2b	1041	Nutrient	10/Sept/2014	13h20	-6	71°19.810	157°19.620	Van Veen Grab ↑	91	115	070	21	2.0	4.9	1020.8	89	0/10
2b	1041	Nutrient	10/Sept/2014	13h25	-6	71°19.810	157°19.550	Gravity Core ↓	91	093	080	16	2.0	4.9	1020.8	89	0/10
2b	1041	Nutrient	10/Sept/2014	13h30	-6	71°19.820	157°19.420	Gravity Core ↑	91	075	070	18	1.9	5.0	1020.8	89	0/10
2b	1042	Basic	10/Sept/2014	14h10	-6	71°24.620	157°29.310	CTD-Rosette ↓	126	078	060	15	1.9	3.8	1021.3	88	0/10
2b	1042	Basic	10/Sept/2014	14h45	-6	71°24.560	157°29.120	CTD-Rosette ↑	127	081	060	16	2.0	2.9	1021.4	88	0/10
2b	1042	Basic	10/Sept/2014	14h55	-6	71°24.500	157°28.950	Horizontal Net ↓	127	102	060	14	2.0	2.8	1021.3	87	0/10
2b	1042	Basic	10/Sept/2014	15h14	-6	71°24.640	157°29.380	Horizontal Net ↑	127	100	060	15	2.1	2.8	1021.3	87	0/10
2b	1042	Basic	10/Sept/2014	15h40	-6	71°24.640	157°29.130	Vertical Net, LOKI ↓	126	053	050	17	2.2	2.7	1021.2	87	0/10
2b	1042	Basic	10/Sept/2014	15h50	-6	71°24.600	157°28.890	Vertical Net, LOKI ↑	126	050	050	16	1.5	2.6	1021.3	94	0/10
2b	1042	Basic	10/Sept/2014	16h16	-6	71°24.570	157°28.840	NORPAC Net ↓	128	055	050	17	1.5	2.6	1021.3	94	0/10
2b	1042	Basic	10/Sept/2014	16h28	-6	71°24.540	157°29.020	NORPAC Net ↑	128	058	050	15	1.6	2.5	1021.3	93	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					
2b	1042	Basic	10/Sept/2014	16h34	-6	71°24.600	157°29.220	Van Veen Grab ↓	127	038	050	16	1.5	2.5	1021.4	94	0/10
2b	1042	Basic	10/Sept/2014	17h27	-6	71°24.660	157°29.490	Van Veen Grab ↑	127	039	050	17	1.5	2.6	1021.6	94	0/10
2b	1042	Basic	10/Sept/2014	18h33	-6	71°24.650	157°29.470	MOKI ↓	126	071	050	17	1.4	2.5	1021.6	93	0/10
2b	1042	Basic	10/Sept/2014	18h49	-6	71°24.650	157°29.470	MOKI (bottom)	125	066	050	16	1.5	2.6	1021.6	93	0/10
2b	1042	Basic	10/Sept/2014	19h21	-6	71°24.650	157°29.470	MOKI ↑	125	058	050	20	1.5	2.8	1021.6	93	0/10
2b	1042	Basic	10/Sept/2014	19h28	-6	71°24.650	157°29.460	Gravity Core ↓	125	045	050	16	1.5	2.9	1021.6	94	0/10
2b	1042	Basic	10/Sept/2014	19h31	-6	71°24.650	157°29.470	Gravity Core (bottom)	125	054	050	16	1.5	2.9	1021.6	94	0/10
2b	1042	Basic	10/Sept/2014	19h34	-6	71°24.650	157°29.470	Gravity Core ↑	125	054	050	16	1.5	2.9	1021.6	94	0/10
2b	1042	Basic	10/Sept/2014	19h37	-6	71°24.620	157°29.620	Agassiz Trawl ↓	127	110	050	16	1.5	2.9	1021.6	94	0/10
2b	1042	Basic	10/Sept/2014	19h50	-6	71°24.430	157°28.020	Agassiz Trawl ↑	127	101	050	20	1.6	2.9	1021.6	94	0/10
2b	1042	Basic	10/Sept/2014	20h36	-6	71°24.560	157°28.860	Box Core ↓	128	042	060	15	1.5	2.8	1021.6	93	0/10
2b	1042	Basic	10/Sept/2014	20h38	-6	71°24.560	157°28.890	Box Core (bottom)	128	025	060	15	1.5	2.8	1021.6	93	0/10
2b	1042	Basic	10/Sept/2014	20h42	-6	71°24.570	157°28.940	Box Core ↑	127	345	060	17	1.5	2.8	1021.6	93	0/10
2b	1042	Basic	10/Sept/2014	20h59	-6	71°24.340	157°29.220	Beam trawl ↓	128	119	080	17	1.3	2.8	1021.7	94	0/10
2b	1042	Basic	10/Sept/2014	21h32	-6	71°24.250	157°25.110	Beam trawl ↓	127	065	080	17	1.5	2.8	1021.6	93	0/10
2b	1043	Nutrient	10/Sept/2014	22h27	-6	71°29.820	157°40.150	CTD-Rosette ↓	83	253	060	22	1.8	2.84	1022.2	91	0/10
2b	1043	Nutrient	10/Sept/2014	22h55	-6	71°29.680	157°40.580	CTD-Rosette ↑	85	206	060	23	2.5	3.22	1022.2	88	0/10
2b	1043	Nutrient	10/Sept/2014	23h12	-6	71°29.520	157°41.560	NORPAC Net ↓	86	075	050	23	1.8	3.27	1022.4	90	0/10
2b	1043	Nutrient	10/Sept/2014	23h16	-6	71°29.470	157°41.620	NORPAC Net ↑	88	156	050	18	1.8	3.27	1022.4	91	0/10
2b	1043	Nutrient	10/Sept/2014	23h31	-6	71°29.800	157°40.080	Gravity Core ↓	84	065	050	23	1.5	3.25	1022.2	92	0/10
2b	1043	Nutrient	10/Sept/2014	23h35	-6	71°29.770	157°40.090	Gravity Core ↑	86	084	050	22	1.5	3.25	1022.2	92	0/10
2b	1043	Nutrient	11/Sept/2014	00h21	-6	71°29.970	157°39.610	Van Veen Grab ↓	87	046	060	20	1.4	3.31	1022.6	92	0/10
2b	1043	Nutrient	11/Sept/2014	00h35	-6	71°30.000	157°39.610	Van Veen Grab ↑	88	050	045	22	1.4	3.32	1022.6	92	0/10
2b	1044	Basic	11/Sept/2014	01h12	-6	71°34.680	157°50.340	CTD-Rosette ↓	65	043	050	18	1.5	3.22	1023.0	91	0/10
2b	1044	Basic	11/Sept/2014	01h35	-6	71°34.600	157°50.610	CTD-Rosette ↑	65	100	050	25	1.3	3.17	1023.3	92	0/10
2b	1044	Basic	11/Sept/2014	01h43	-6	71°34.580	157°50.290	Horizontal Net ↓	66	120	060	23	1.2	3.12	1023.2	92	0/10
2b	1044	Basic	11/Sept/2014	01h50	-6	71°34.270	157°50.610	Horizontal Net ↑	66	160	060	20	1.6	3.11	1023.3	90	0/10
2b	1044	Basic	11/Sept/2014	02h15	-6	71°34.690	157°50.610	Vertical Net, LOKI ↓	66	065	060	18	1.4	3.11	1023.6	91	0/10
2b	1044	Basic	11/Sept/2014	02h20	-6	71°34.650	157°50.610	Vertical Net, LOKI ↑	66	060	060	21	1.3	3.11	1023.7	91	0/10
2b	1044	Basic	11/Sept/2014	02h40	-6	71°34.650	157°50.610	NORPAC Net ↓	66	040	050	20	1.4	3.07	1023.6	93	0/10
2b	1044	Basic	11/Sept/2014	02h43	-6	71°34.630	157°50.610	NORPAC Net ↑	66	050	050	22	1.4	3.07	1023.6	93	0/10
2b	1044	Basic	11/Sept/2014	03h02	-6	71°34.670	157°50.610	MOKI ↓	65	060	050	23	1.2	3.01	1023.8	92	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					
2b	1044	Basic	11/Sept/2014	03h54	-6	71°34.650	157°50.610	MOKI (bottom)	68	050	050	20	1.0	3.00	1023.9	94	0/10
2b	1044	Basic	11/Sept/2014	04h10	-6	71°34.650	157°50.610	MOKI ↑	65	052	060	18	1.0	2.99	1024.1	94	0/10
2b	1044	Basic	11/Sept/2014	04h14	-6	71°34.660	157°50.610	Van Veen Grab ↓	66	059	060	20	1.0	2.99	1024.1	94	0/10
2b	1044	Basic	11/Sept/2014	04h31	-6	71°34.680	157°50.610	Van Veen Grab ↑	67	063	060	19	1.0	2.94	1024.2	94	0/10
2b	1044	Basic	11/Sept/2014	04h33	-6	71°34.690	157°50.610	Gravity Core ↓	65	056	060	20	1.0	2.89	1024.3	94	0/10
2b	1044	Basic	11/Sept/2014	04h36	-6	71°34.690	157°50.610	Gravity Core ↑	66	065	060	20	1.0	2.89	1024.3	94	0/10
2b	1044	Basic	11/Sept/2014	04h39	-6	71°34.640	157°50.610	Agassiz Trawl ↓	66	094	050	22	0.9	2.82	1024.3	95	0/10
2b	1044	Basic	11/Sept/2014	04h47	-6	71°34.500	157°50.610	Agassiz Trawl ↑	65	089	050	21	0.9	2.82	1024.3	95	0/10
2b	1044	Basic	11/Sept/2014	05h06	-6	71°34.710	157°50.610	Box Core ↓	66	072	060	20	1.0	2.82	1024.3	95	0/10
2b	1044	Basic	11/Sept/2014	05h08	-6	71°34.710	157°50.610	Box Core (bottom)	65	080	060	21	1.0	2.82	1024.3	95	0/10
2b	1044	Basic	11/Sept/2014	05h10	-6	71°34.700	157°50.610	Box Core ↑	65	081	060	21	1.0	2.82	1024.4	93	0/10
2b	1044	Basic	11/Sept/2014	05h25	-6	71°34.670	157°50.610	Beam trawl ↓	66	085	050	21	1.0	2.84	1024.4	93	0/10
2b	1044	Basic	11/Sept/2014	05h53	-6	71°34.370	157°50.610	Beam trawl ↑	66	090	050	23	0.9	2.98	1024.2	95	0/10
2b	1044	Basic	11/Sept/2014	06h32	-6	71°34.650	157°50.610	Zodiac Deployment	66	135	050	18	0.9	3.07	1024.4	95	0/10
2b	1044	Basic	11/Sept/2014	06h51	-6	71°34.200	157°50.610	Zodiac Recovery	66	138	060	12	0.9	3.10	1024.7	95	0/10
2b	BCC-13	Mooring	11/Sept/2014	13h50	-6	71°43.550	155°11.690	Mooring Recovery	285	n-a	020	17	1.5	2.76	1026.1	88	0/10
2b	BCE-13	Mooring	11/Sept/2014	15h10	-6	n-a	n-a	Déclenchement ↑ Surface	n-a	n-a	n-a	n-a	n-a	n-a	n-a	n-a	0/10
2b	BCE-13	Mooring	11/Sept/2014	15h40	-6	71°40.450	154°58.580	Mooring Recovery	116	080	075	14	1.3	5.96	1026.2	87	0/10
2b	BCW-13	Mooring	11/Sept/2014	17h02	-6	n-a	n-a	Déclenchement ↑ Surface	n-a	n-a	n-a	n-a	n-a	n-a	n-a	n-a	0/10
2b	BCW-13	Mooring	11/Sept/2014	17h13	-6	71°47.610	155°20.440	Mooring Recovery	163	053	110	12	0.8	3.64	1026.1	87	0/10
2b	1036	Nutrient	11/Sept/2014	18h20	-6	71°43.560	155°24.810	CTD-Rosette ↓	174	272	080	14	1.1	3.36	1025.8	87	0/10
2b	1036	Nutrient	11/Sept/2014	18h53	-6	71°43.440	155°24.990	CTD-Rosette ↑	175	308	080	14	3.1	3.06	1025.8	81	0/10
2b	1038	Basic	11/Sept/2014	23h08	-6	71°34.410	155°45.500	CTD-Rosette ↓	164	291	100	15	1.3	6.10	1024.7	89	0/10
2b	1038	Basic	11/Sept/2014	23h41	-6	71°34.420	155°45.830	CTD-Rosette ↑	165	261	100	18	1.8	5.91	1024.8	87	0/10
2b	1038	Basic	11/Sept/2014	23h50	-6	71°34.300	155°45.620	Horizontal Net ↓	160	096	090	19	1.1	5.98	1024.7	90	0/10
2b	1038	Basic	12/Sept/2014	00h08	-6	71°34.470	155°46.420	Horizontal Net ↑	167	230	100	18	1.3	5.95	1024.5	89	0/10
2b	1038	Basic	12/Sept/2014	00h28	-6	71°34.330	155°45.610	Vertical Net, LOKI ↓	162	105	100	16	6.2	6.25	1024.4	91	0/10
2b	1038	Basic	12/Sept/2014	00h40	-6	71°34.330	155°45.560	Vertical Net, LOKI ↑	161	060	090	15	6.1	6.11	1024.4	91	0/10
2b	1038	Basic	12/Sept/2014	01h03	-6	71°34.350	155°45.700	NORPAC Net ↓	163	132	080	18	6.0	6	1024.5	91	0/10
2b	1038	Basic	12/Sept/2014	01h10	-6	71°34.370	155°46.150	NORPAC Net ↑	165	215	110	15	6.1	6.1	1024.3	91	0/10
2b	1038	Basic	12/Sept/2014	01h55	-6	71°34.330	155°45.550	MOKI ↓	160	097	090	18	6.2	6.19	1024.3	91	0/10
2b	1038	Basic	12/Sept/2014	02h10	-6	71°34.320	155°45.510	MOKI (bottom)	160	104	100	16	6.0	6.01	1024.3	91	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					
2b	1038	Basic	12/Sept/2014	02h45	-6	71°34.320	155°45.520	MOKI ↑	160	098	120	17	6.0	5.97	1024.0	90	0/10
2b	1038	Basic	12/Sept/2014	02h50	-6	71°34.330	155°45.530	Van Veen Grab ↓	161	103	100	19	6.0	6.01	1023.9	91	0/10
2b	1038	Basic	12/Sept/2014	03h20	-6	71°34.340	155°45.510	Van Veen Grab ↑	162	102	080	14	6.2	6.17	1023.7	91	0/10
2b	1038	Basic	12/Sept/2014	03h25	-6	71°34.340	155°45.500	Gravity Core ↓	161	100	080	14	6.2	6.17	1023.7	91	0/10
2b	1038	Basic	12/Sept/2014	03h30	-6	71°34.320	155°45.470	Gravity Core ↑	160	170	090	19	6.2	6.16	1023.6	92	0/10
2b	1038	Basic	12/Sept/2014	03h35	-6	71°34.210	155°45.510	Agassiz Trawl ↓	158	187	090	20	6.2	6.16	1023.6	92	0/10
2b	1038	Basic	12/Sept/2014	03h47	-6	71°33.740	155°45.270	Agassiz Trawl ↑	151	181	090	15	6.2	6.16	1023.5	94	0/10
2b	1038	Basic	12/Sept/2014	04h02	-6	71°34.360	155°45.670	Box Core ↓	164	087	100	15	6.3	6.26	1023.2	92	0/10
2b	1038	Basic	12/Sept/2014	04h04	-6	71°34.370	155°45.670	Box Core (bottom)	164	090	090	16	6.3	6.26	1023.2	92	0/10
2b	1038	Basic	12/Sept/2014	04h08	-6	71°34.390	155°45.680	Box Core ↑	165	092	090	19	6.3	6.26	1023.2	92	0/10
2b	1038	Basic	12/Sept/2014	04h20	-6	71°34.360	155°45.020	Beam trawl ↓	160	160	090	20	6.0	6.03	1023.1	91	0/10
2b	1038	Basic	12/Sept/2014	05h00	-6	71°32.900	155°44.990	Beam trawl ↑	126	163	090	20	5.9	5.85	1023.0	91	0/10
2b	1038	Basic	12/Sept/2014	05h53	-6	71°34.370	155°45.950	Zodiac Deployment	165	185	090	16	1.9	6.01	1022.8	88	0/10
2b	1038	Basic	12/Sept/2014	06h09	-6	71°34.260	155°47.050	Zodiac Recovery	166	179	090	18	1.1	6.01	1022.8	91	0/10
2b	1045	Basic	12/Sept/2014	08h00	-6	71°38.550	154°54.920	CTD-Rosette ↓	60	098	080	18	1.1	5.67	1022.4	91	0/10
2b	1045	Basic	12/Sept/2014	08h07	-6	71°38.570	154°54.960	CTD-Rosette ↑	60	103	080	17	1.1	5.29	1022.3	91	0/10
2b	BCE-14	Mooring	12/Sept/2014	10h13	-6	71°40.360	154°59.510	Mooring Deployment	106	120	100	17	1.2	6.28	1021.4	90	0/10
2b	BCE-14	Mooring	12/Sept/2014	10h56	-6	71°40.360	154°59.770	Mooring (bottom)	108	141	110	20	1.1	6.27	1021.3	90	0/10
2b	1046	Basic	12/Sept/2014	12h06	-6	71°41.900	154°05.100	CTD-Rosette ↓	171	087	090	16	1.2	3.68	1021.1	89	0/10
2b	1046	Basic	12/Sept/2014	12h18	-6	71°41.930	154°05.950	CTD-Rosette ↑	170	120	075	18	1.4	3.41	1021.1	89	0/10
2b	BCC-13	Mooring	12/Sept/2014	13h35	-6	71°43.640	155°10.920	Dragging for Mooring	285	055	080	15	1.4	3.29	1020.9	89	0/10
2b	BCC-13	Mooring	12/Sept/2014	15h25	-6	71°43.290	155°10.400	No Recovery	264	186	100	21	1.7	3.17	1020.00	89	0/10
2b	BCC-13	Mooring	12/Sept/2014	16h29	-6	71°43.660	155°10.930	Dragging for Mooring	286	099	080	18	1.8	3.13	1019.40	89	0/10
2b	BCC-13	Mooring	12/Sept/2014	17h28	-6	71°43.030	155°10.790	No Recovery	254	120	080	23	1.6	3.09	1018.9	89	0/10
2b	BCC-13	Mooring	12/Sept/2014	18h20	-6	71°43.660	155°11.940	Mooring Recovery	292	195	090	18	1.8	3.02	1018.6	89	0/10
2b	1047	Basic	12/Sept/2014	18h46	-6	71°45.960	155°16.180	CTD-Rosette ↓	213	082	070	19	2.2	2.97	1018.4	89	0/10
2b	1047	Basic	12/Sept/2014	18h57	-6	71°45.950	155°16.220	CTD-Rosette ↑	212	107	070	21	1.9	3.06	1018.3	90	0/10
2b	BCW-14	Mooring	12/Sept/2014	20h03	-6	71°47.740	155°20.560	Mooring Deployment	195	089	080	22	1.7	3.41	1017.58	90	0/10
2b	BCW-14	Mooring	12/Sept/2014	20h37	-6	71°47.740	155°20.800	Mooring (bottom)	174	103	070	25	1.7	3.41	1017.5	90	0/10
2b	BCW-14	Mooring	12/Sept/2014	20h59	-6	71°47.560	155°21.560	CTD-Rosette ↓	161	117	060	24	1.5	3.41	1017.60	89	0/10
2b	BCW-14	Mooring	12/Sept/2014	21h10	-6	71°47.510	155°21.610	CTD-Rosette ↑	157	117	070	22	1.7	3.44	1017.6	89	0/10
2b	1034	Full	12/Sept/2014	22h13	-6	71°54.440	154°58.180	CTD-Rosette ↓	416	096	070	19	1.4	3.33	1016.70	89	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					
2b	1034	Full	12/Sept/2014	23h03	-6	71°54.460	154°58.750	CTD-Rosette ↑	440	088	080	23	1.2	3.33	1017.34	89	0/10
2b	1034	Full	12/Sept/2014	23h10	-6	71°54.360	154°58.390	Horizontal Net ↓	441	108	080	22	1.2	3.33	1017.1	89	0/10
2b	1034	Full	12/Sept/2014	23h25	-6	71°54.220	154°56.940	Horizontal Net ↑	470	098	080	22	1.3	3.33	1017.1	90	0/10
2b	1034	Full	12/Sept/2014	23h43	-6	71°54.620	154°58.030	Vertical Net, LOKI ↓	420	085	080	24	1.6	3.32	1017.2	89	0/10
2b	1034	Full	13/Sept/2014	00h10	-6	71°54.440	154°57.740	Vertical Net, LOKI ↑	441	100	080	27	1.7	3.36	1017.00	87	0/10
2b	1034	Full	13/Sept/2014	00h28	-6	71°54.480	154°58.480	NORPAC Net ↓	410	100	080	20	1.7	3.36	1017.00	87	0/10
2b	1034	Full	13/Sept/2014	00h35	-6	71°54.440	154°58.040	NORPAC Net ↑	410	100	080	23	1.5	3.36	1016.8	89	0/10
2b	1034	Full	13/Sept/2014	01h23	-6	71°54.500	154°57.960	MOKI ↓	444	093	080	22	1.6	3.37	1016.9	88	0/10
2b	1034	Full	13/Sept/2014	02h14	-6	71°54.260	154°58.600	MOKI ↑	372	107	070	20	1.4	3.37	1016.8	89	0/10
2b	1034	Full	13/Sept/2014	02h24	-6	71°54.490	154°58.040	Van Veen Grab ↓	415	077	090	24	1.5	3.37	1016.7	89	0/10
2b	1034	Full	13/Sept/2014	03h05	-6	71°54.510	154°57.910	Van Veen Grab ↑	444	080	075	22	1.3	3.36	1016.5	90	0/10
2b	1034	Full	13/Sept/2014	03h08	-6	71°54.510	154°57.910	Gravity Core ↓	452	095	075	22	1.3	3.35	1016.5	90	0/10
2b	1034	Full	13/Sept/2014	03h21	-6	71°54.500	154°57.910	Gravity Core ↑	448	100	080	22	1.3	3.34	1216.5	90	0/10
2b	1034	Full	13/Sept/2014	03h35	-6	71°54.540	154°57.880	CTD-Rosette ↓	453	080	080	23	1.3	3.34	1016.5	89	0/10
2b	1034	Full	13/Sept/2014	04h25	-6	71°54.460	154°57.930	CTD-Rosette ↑	439	097	080	22	1.3	3.35	1016.4	90	0/10
2b	1034	Full	13/Sept/2014	04h34	-6	71°54.350	154°57.580	Agassiz Trawl ↓	460	110	090	22	1.3	3.35	1016.4	90	0/10
2b	1034	Full	13/Sept/2014	05h11	-6	71°53.320	154°55.950	Agassiz Trawl ↑	433	130	075	25	1.3	3.3	1015.9	90	0/10
2b	1034	Full	13/Sept/2014	06h30	-6	71°54.500	154°57.710	IKMT ↓	467	122	080	26	1.3	3.33	1016.0	90	0/10
2b	1034	Full	13/Sept/2014	07h03	-6	71°53.400	154°54.230	IKMT ↑	424	121	085	25	1.3	3.3	1015.7	91	0/10
2b	1034	Full	13/Sept/2014	08h18	-6	71°54.520	154°57.970	Hydrobios ↓	431	070	080	24	1.1	3.31	1015.6	94	0/10
2b	1034	Full	13/Sept/2014	08h47	-6	71°54.620	154°58.260	Hydrobios ↑	373	074	080	24	1.2	3.32	1015.6	95	0/10
2b	1034	Full	13/Sept/2014	09h09	-6	71°54.500	154°58.430	Acoustic Camera ↓	365	080	080	21	1.2	3.34	1015.6	93	0/10
2b	1034	Full	13/Sept/2014	09h41	-6	71°54.370	154°58.850	Acoustic Camera ↑	343	096	070	22	1.8	3.34	1015.6	90	0/10
2b	1034	Full	13/Sept/2014	09h57	-6	71°54.460	154°57.990	Beam trawl ↓	436	129	080	23	2.0	3.35	1015.4	90	0/10
2b	1034	Full	13/Sept/2014	10h47	-6	71°52.650	154°55.160	Beam trawl ↑	369	140	070	26	2.4	3.29	1015.5	87	0/10
2b	BCC-14	Mooring	13/Sept/2014	13h30	-6	71°44.610	155°07.410	Mooring Deployment	289	128	070	24	3.3	3.22	1014.5	81	0/10
2b	BCC-14	Mooring	13/Sept/2014	14h05	-6	71°44.010	155°09.550	Mooring (bottom)	287	246	070	24	3.4	3.21	1014.5	77	0/10
2b	BCC-14	Mooring	13/Sept/2014	14h50	-6	71°43.950	155°10.130	CTD-Rosette ↓	290	073	070	22	3.2	3.17	1014.4	79	0/10
2b	BCC-14	Mooring	13/Sept/2014	15h05	-6	71°43.900	155°10.410	CTD-Rosette ↑	290	080	070	20	3.2	3.17	1014.4	79	0/10
2b	1032	Nutrient	13/Sept/2014	18h15	-6	72°03.300	154°37.260	CTD-Rosette ↓	1310	078	070	27	1.5	3.22	1015.5	97	0/10
2b	1032	Nutrient	13/Sept/2014	19h21	-6	72°03.340	154°38.300	CTD-Rosette ↑	1298	079	070	24	1.1	3.47	1015.2	99	0/10
2b	1030	Basic	13/Sept/2014	21h15	-6	72°12.370	153°56.500	CTD-Rosette ↓	2068	083	080	27	0.7	3.87	1015.4	99	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					
2b	1030	Basic	13/Sept/2014	22h45	-6	72°12.510	153°57.420	CTD-Rosette ↑	2098	097	080	26	0.7	3.68	1015.4	99	0/10
2b	1030	Basic	13/Sept/2014	22h52	-6	72°12.700	153°57.790	Horizontal Net ↓	2077	113	080	27	0.6	3.68	1015.40	99	0/10
2b	1030	Basic	13/Sept/2014	23h05	-6	72°12.050	153°55.920	Horizontal Net ↑	2036	095	080	27	0.7	3.67	1015.3	99	0/10
2b	1030	Basic	14/Sept/2014	00h38	-6	72°12.450	153°56.470	Hydrobios ↓	2070	090	080	28	1.1	3.71	1014.90	98	0/10
2b	1030	Basic	14/Sept/2014	03h30	-6	72°12.450	153°56.470	Hydrobios ↑	n-a	n-a	075	32	1.1	3.69	1015.40	93	0/10
2b	1030	Basic	14/Sept/2014	04h14	-6	72°12.340	153°55.750	NORPAC Net ↓	2057	101	080	28	1.3	3.6	1015.0	95	0/10
2b	1030	Basic	14/Sept/2014	04h20	-6	72°12.330	153°55.810	NORPAC Net ↑	2055	095	080	26	1.2	3.59	1015.1	93	0/10
2b	NORPAC 1	Net	14/Sept/2014	09h12	-6	72°28.790	157°01.350	NORPAC Net ↓	673	085	080	26	4.4	3.04	1014.2	80	0/10
2b	NORPAC 1	Net	14/Sept/2014	09h20	-6	72°28.840	157°01.810	NORPAC Net ↑	642	098	080	27	1.8	3.95	1014.4	90	0/10
2b	NORPAC 2	Net	14/Sept/2014	14h20	-6	73°03.630	159°21.180	NORPAC Net ↓	409	100	080	31	0.5	2.60	1014.4	93	0/10
2b	NORPAC 2	Net	14/Sept/2014	14h26	-6	73°03.650	159°21.480	NORPAC Net ↑	407	114	080	32	0.5	2.60	1014.4	93	0/10
2b	NORPAC 3	Net	14/Sept/2014	19h06	-6	73°45.190	161°14.470	NORPAC Net ↓	870	91	080	25	0.3	2.21	1015.3	91	0/10
2b	NORPAC 3	Net	14/Sept/2014	19h12	-6	73°45.250	161°14.480	NORPAC Net ↑	877	93	080	22	0.2	2.27	1015.80	91	0/10
2b	NORPAC 3	Net	14/Sept/2014	19h19	-6	73°45.320	161°14.130	X CTD ↓	907	101	080	28	0.2	2.32	1015.7	90	0/10
2b	NORPAC 3	Net	14/Sept/2014	19h26	-6	73°45.310	161°12.870	X CTD ↑	926	87	080	29	0.2	2.32	1015.73	90	0/10
2b	NORPAC 3	Net	15/Sept/2014	11h12	-6	74°42.200	163°25.700	X CTD ↓	1500	178	080	20	-0.3	1.80	1016.7	93	0/10
2b	NORPAC 3	Net	15/Sept/2014	12h30	-6	74°45.900	164°43.100	X CTD ↑	500	280	075	20	-0.2	1.49	1016.90	92	0/10
2b	CAP 12 T	Mooring	15/Sept/2014	21h18	-6	75°12.340	172°33.940	Mooring Recovery	439	045	055	18	-2	-0.36	1017.6	93	0/10
2b	CAP 12 T	Mooring	15/Sept/2014	22h14	-6	75°12.140	172°33.690	Mooring on board	439	088	060	18	-1.8	-0.4	1017.7	91	0/10
2b	CAP 12 T	Mooring	15/Sept/2014	22h52	-6	75°11.860	172°34.200	CTD-Rosette ↓	440	051	050	18	-1.8	-0.45	1017.4	91	0/10
2b	CAP 12 T	Mooring	15/Sept/2014	23h11	-6	75°11.860	172°34.490	CTD-Rosette ↑	444	065	060	18	-2	-0.47	1017.2	95	0/10
2b	NORPAC 4	Net	16/Sept/2014	04h34	-6	75°12.420	169°49.460	NORPAC Net ↓	304	069	050	21	-1.7	0.44	1016.2	92	0/10
2b	NORPAC 4	Net	16/Sept/2014	04h41	-6	75°12.440	169°49.400	NORPAC Net ↑	303	084	050	20	-1.7	0.46	1016.5	88	0/10
2b	NORPAC 4	Net	16/Sept/2014	04h50	-6	75°12.400	169°49.450	CTD-Rosette ↓	303	076	030	18	-1.7	0.48	1016.5	89	0/10
2b	NORPAC 4	Net	16/Sept/2014	05h28	-6	75°12.300	169°49.990	CTD-Rosette ↑	303	072	040	16	-1.6	0.48	1016.4	91	0/10
2b	NORPAC 4	Net	16/Sept/2014	08h16	-6	75°08.000	168°27.440	X CTD	175	102	060	25	-1.8	0.6	1014.8	89	0/10
2b	NORPAC 4	Net	16/Sept/2014	10h41	-6	75°04.930	167°33.610	MVP ↓ (1 plongée 11h05)	183	102	060	20	-1.8	0.63	1014.3	90	0/10
2b	NORPAC 4	Net	16/Sept/2014	11h10	-6	75°04.200	167°29.490	MVP ↓ (2 plongée 11h10)	188	097	055	20	-1.8	0.75	1014.4	89	0/10
2b	NORPAC 4	Net	16/Sept/2014	12h20	-6	75°03.700	167°09.500	MVP ↑	236	100	060	20	-1.6	0.86	1014.00	89	0/10
2b	1085	Basic	16/Sept/2014	13h05	-6	75°03.690	167°08.400	CTD-Rosette ↓	245	060	050	15	-1.7	0.99	1014.30	93	0/10
2b	1085	Basic	16/Sept/2014	13h48	-6	75°03.630	167°08.640	CTD-Rosette ↑	247	071	030	18	-1.6	1.01	1014.20	91	0/10
2b	1085	Basic	16/Sept/2014	13h55	-6	75°03.450	167°08.000	Horizontal Net ↓	254	120	080	23	-1.7	1.01	1014.10	88	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					
2b	1085	Basic	16/Sept/2014	14h12	-6	75°03.000	167°07.340	Horizontal Net ↑	263	170	070	21	-1.6	1.04	1013.80	88	0/10
2b	1085	Basic	16/Sept/2014	14h44	-6	75°03.850	167°08.660	Vertical Net, LOKI ↓	245	060	075	20	-1.8	1.05	1014.00	87	0/10
2b	1085	Basic	16/Sept/2014	15h00	-6	75°03.860	167°08.880	Vertical Net, LOKI ↑	243	045	070	18	-1.8	1.05	1014.00	87	0/10
2b	1085	Basic	16/Sept/2014	15h15	-6	75°03.970	167°09.210	NORPAC Net ↓	250	070	050	18	-1.8	1.06	1014.00	87	0/10
2b	1085	Basic	16/Sept/2014	15h23	-6	75°03.970	167°09.290	NORPAC Net ↑	250	075	070	20	-2	1.07	1014.00	88	0/10
2b	1085	Basic	16/Sept/2014	16h01	-6	75°03.740	167°08.270	MOKI ↓	245	083	050	21	-2	1.07	1014.00	87	0/10
2b	1085	Basic	16/Sept/2014	17h05	-6	75°03.790	167°08.250	MOKI ↑	249	081	060	19	-2	1.23	1014.00	87	0/10
2b	1085	Basic	16/Sept/2014	17h10	-6	75°03.790	167°08.500	Van Veen Grab ↓	246	080	060	16	-2	1.28	1014.00	87	0/10
2b	1085	Basic	16/Sept/2014	17h41	-6	75°03.710	167°08.080	Van Veen Grab ↑	252	096	050	17	-2	1.35	1013.9	90	0/10
2b	1085	Basic	16/Sept/2014	17h50	-6	75°03.700	167°08.020	Gravity Core ↓	248	089	060	17	-2	1.36	1013.8	89	0/10
2b	1085	Basic	16/Sept/2014	17h57	-6	75°03.690	167°08.060	Gravity Core ↑	247	092	060	18	-2	1.36	1013.8	89	0/10
2b	1085	Basic	16/Sept/2014	18h01	-6	75°03.640	167°07.860	Agassiz Trawl ↓	249	132	060	20	-2	1.38	1013.70	92	0/10
2b	1085	Basic	16/Sept/2014	18h27	-6	75°03.930	167°06.420	Agassiz Trawl ↑	272	131	060	21	-2.1	1.42	1013.8	87	0/10
2b	1085	Basic	16/Sept/2014	18h44	-6	75°03.680	167°08.330	Box Core ↓	248	090	040	22	-1.7	1.38	1013.40	87	0/10
2b	1085	Basic	16/Sept/2014	18h49	-6	75°03.680	167°08.300	Box Core (bottom)	249	074	045	22	-2	1.38	1013.4	92	0/10
2b	1085	Basic	16/Sept/2014	18h56	-6	75°03.690	167°08.360	Box Core ↑	245	083	040	20	-2	1.38	1013.4	92	0/10
2b	1085	Basic	16/Sept/2014	19h10	-6	75°03.480	167°08.680	Beam trawl ↓	253	132	050	20	-2.2	1.38	1013.3	89	0/10
2b	1085	Basic	16/Sept/2014	19h53	-6	75°03.130	167°05.140	Beam trawl ↑	284	132	040	13	-2.2	1.37	1013.2	87	0/10
2b	1085	Basic	16/Sept/2014	20h18	-6	75°03.100	167°00.930	MVP ↓	393	065	040	25	-2.1	1.37	1012.5	86	0/10
2b	1085	Basic	16/Sept/2014	23h22	-6	75°03.980	165°39.720	MVP ↑	550	090	040	20	-2.4	1.42	1012.2	89	0/10
2b	NORPAC 5	Net	17/Sept/2014	02h15	-6	75°04.270	164°21.910	NORPAC Net ↓	596	075	040	19	-2.3	1.28	1011.70	88	0/10
2b	NORPAC 5	Net	17/Sept/2014	02h22	-6	75°04.260	164°21.970	NORPAC Net ↓	598	066	050	17	-2.3	1.29	1011.70	91	0/10
2b	NORPAC 5	Net	17/Sept/2014	02h35	-6	75°04.280	164°21.880	CTD-Rosette ↓	596	075	075	19	-2.3	1.28	1011.80	88	0/10
2b	NORPAC 5	Net	17/Sept/2014	03h30	-6	75°04.290	164°21.960	CTD-Rosette ↑	598	070	070	19	-2.5	1.30	1011.8	88	0/10
2b	NORPAC 5	Net	17/Sept/2014	04h14	-6	74°59.760	164°54.370	X CTD 1[er]	1095	125	125	25	-2.9	1.20	1010.9	90	0/10
2b	NORPAC 5	Net	17/Sept/2014	04h21	-6	74°58.860	163°49.990	X CTD 2 [e]	1174	125	125	25	-2.9	1.18	1010.7	91	0/10
2b	NORPAC 5	Net	17/Sept/2014	04h29	-6	74°57.790	163°44.710	X CTD ↑	1243	126	126	19	-2.8	1.17	1010.5	90	0/10
2b	NORPAC 5	Net	17/Sept/2014	04h54	-6	74°54.700	163°29.420	X CTD 3 [e]	1505	125	125	25	-2.6	1.17	1010.4	91	0/10
2b	NORPAC 5	Net	17/Sept/2014	04h59	-6	74°54.060	163°26.200	X CTD ↑	1528	124	124	23	-2.4	1.17	1010.1	91	0/10
2b	NAP-13	Mooring	17/Sept/2014	08h10	-6	74°36.120	161°56.290	CTD-Rosette ↓	1764	053	050	21	-1.5	1.30	1008.8	97	0/10
2b	NAP-13	Mooring	17/Sept/2014	09h05	-6	74°36.270	161°57.330	CTD-Rosette ↑	1767	045	045	22	-1.5	1.32	1008.7	96	0/10
2b	NAP-13	Mooring	17/Sept/2014	11h15	-6	74°31.230	161°56.270	Mooring Recovery	1683	026	060	20	-1	1.08	1008.4	94	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					
2b	NAP-13	Mooring	17/Sept/2014	13h03	-6	74°31.680	161°57.450	Mooring on board	1681	092	050	24	-0.7	1.20	1008.1	95	0/10
2b	NAP-12	Mooring	17/Sept/2014	16h33	-6	75°00.260	162°00.670	Mooring Recovery	1965	086	050	20	-1	0.67	1009.4	98	0/10
2b	NAP-12	Mooring	17/Sept/2014	17h57	-6	75°00.580	162°00.130	Mooring on board	1965	088	060	22	-1.2	0.67	1009.3	96	0/10
2b	NAP-12	Mooring	17/Sept/2014	18h36	-6	75°00.210	162°00.180	CTD-Rosette ↓	1968	056	060	23	-1.3	0.62	1009.2	93	0/10
2b	NAP-12	Mooring	17/Sept/2014	19h30	-6	75°00.740	162°00.900	CTD-Rosette ↑	1970	065	050	19	-1.3	0.64	1009.3	91	0/10
2b	1100	Full	17/Sept/2014	21h09	-6	75°04.020	161°15.860	Zodiac Deployment	1979	156	060	20	-1.3	0.71	1008.95	89	0/10
2b	1100	Full	17/Sept/2014	21h29	-6	75°03.470	161°16.800	Zodiac Recovery	1951	138	070	21	-1.4	0.65	1009.47	90	0/10
2b	1100	Full	17/Sept/2014	21h47	-6	75°04.090	161°15.650	CTD-Rosette ↓	1983	098	070	26	-1.2	0.65	1009.05	91	0/10
2b	1100	Full	17/Sept/2014	23h17	-6	75°04.340	161°16.680	CTD-Rosette ↑	1999	093	080	24	-1.1	0.58	1004.64	89	0/10
2b	1100	Full	17/Sept/2014	23h25	-6	75°04.160	161°16.250	Horizontal Net ↓	1985	095	080	24	-1.1	0.58	1009.7	89	0/10
2b	1100	Full	17/Sept/2014	23h37	-6	75°03.900	161°15.000	Horizontal Net ↑	1975	041	080	24	-1.1	0.58	1009.7	89	0/10
2b	1100	Full	18/Sept/2014	00h33	-6	75°04.150	161°15.670	Vertical 2 Net ↓	1984	072	070	28	-1	0.57	1009.8	86	0/10
2b	1100	Full	18/Sept/2014	02h15	-6	75°03.930	161°16.940	Vertical 2 Net ↑	1968	064	070	26	-1	0.56	1010.00	85	0/10
2b	1100	Full	18/Sept/2014	02h25	-6	75°04.080	161°16.290	NORPAC Net ↓	1981	075	070	22	-1	0.56	1010.10	85	0/10
2b	1100	Full	18/Sept/2014	02h32	-6	75°04.050	161°16.200	NORPAC Net ↑	1983	080	070	25	-1	0.56	1010.10	84	0/10
2b	1100	Full	18/Sept/2014	02h40	-6	75°04.160	161°15.710	Box Core ↓	1989	083	070	26	-1	0.56	1010.10	84	0/10
2b	1100	Full	18/Sept/2014	03h10	-6	75°04.070	161°15.930	Box Core (bottom)	1985	080	070	30	-1.1	0.55	1010.20	83	0/10
2b	1100	Full	18/Sept/2014	03h46	-6	75°04.050	161°16.060	Box Core ↑	1979	070	070	25	-1.1	0.56	1010.1	83	0/10
2b	1100	Full	18/Sept/2014	04h28	-6	75°04.180	161°15.550	Box Core ↓	1977	071	060	26	-1.2	0.48	1010.1	84	0/10
2b	1100	Full	18/Sept/2014	05h01	-6	75°04.190	161°15.750	Box Core (bottom)	1978	073	070	25	-1.1	0.49	1010.1	82	0/10
2b	1100	Full	18/Sept/2014	05h39	-6	75°04.260	161°15.800	Box Core ↑	1982	061	065	28	-1.1	0.49	101025.0	85	0/10
2b	1100	Full	18/Sept/2014	06h08	-6	75°04.200	161°16.980	IKMT ↓	1982	094	070	30	-1.2	0.51	1010.2	84	0/10
2b	1100	Full	18/Sept/2014	06h54	-6	75°03.370	161°10.120	IKMT ↑	1917	100	070	26	-1.2	0.54	1010.1	86	0/10
2b	1100	Full	18/Sept/2014	08h12	-6	75°04.120	161°15.790	CTD-Rosette ↓	1987	081	070	29	-1.3	0.55	1010.3	86	0/10
2b	1100	Full	18/Sept/2014	08h50	-6	75°05.050	161°16.090	CTD-Rosette ↑	1985	082	070	25	-1.4	0.56	1010.6	88	0/10
2b	n-a	XCTD	18/Sept/2014	16h17	-6	74°15.170	158°16.050	X CTD ↓	947	095	070	29	-1.7	0.42	1010.70	87	2/10
2b	n-a	XCTD	18/Sept/2014	16h22	-6	74°51.110	158°13.150	X CTD	950	101	075	34	-1.7	0.34	1010.8	86	2/10
2b	n-a	XCTD	18/Sept/2014	16h28	-6	74°47.200	157°34.530	X CTD ↑	1018	090	080	30	-2.1	0.04	1011.00	87	3/10
2b	1105	Nutrient	18/Sept/2014	17h38	-6	74°47.230	157°34.120	CTD-Rosette ↓	1297	098	070	34	-2.1	0.04	1011.1	87	3/10
2b	1105	Nutrient	18/Sept/2014	18h55	-6	74°47.910	157°34.680	CTD-Rosette ↑	1139	091	080	26	-2.5	0.04	1012.03	87	3/10
2b	1105	Nutrient	18/Sept/2014	19h09	-6	74°48.080	157°34.770	NORPAC Net ↓	1131	091	080	29	-2.5	0.02	1011.8	88	3/10
2b	1105	Nutrient	18/Sept/2014	19h16	-6	74°48.110	157°34.790	NORPAC Net ↑	1112	107	080	28	-2.5	0.02	1011.8	88	3/10

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					
2b	1105	Nutrient	18/Sept/2014	19h39	-6	74°45.940	157°26.820	X CTD ↓	1565	147	075	37	-2.7	0.00	1011.7	89	3/10
2b	1105	Nutrient	18/Sept/2014	19h45	-6	74°45.270	157°23.300	X CTD ↑	1686	101	075	35	-2.6	-0.03	1011.7	89	3/10
2b	1105	Nutrient	18/Sept/2014	21h04	-6	74°39.440	156°39.180	X CTD ↓	4368	090	075	27	-3	-0.24	1012.5	89	3/10
2b	1105	Nutrient	18/Sept/2014	21h08	-6	74°39.410	156°35.850	X CTD ↑	4368	074	075	28	-3	-0.24	1012.5	89	3/10
2b	1105	Nutrient	18/Sept/2014	22h23	-6	74°37.260	155°51.670	X CTD ↓	4645	090	075	31	-3.1	-0.4	1012.0	89	3/10
2b	1105	Nutrient	18/Sept/2014	22h30	-6	74°36.730	155°47.950	X CTD ↑	4645	090	075	31	-3.1	-0.4	1012.0	89	3/10
2b	1107	Basic	19/Sept/2014	00h25	-6	74°36.590	155°49.720	Vertical Net ↓	3860	076	075	30	-3.5	-0.45	1013.30	92	3/10
2b	1107	Basic	19/Sept/2014	01h32	-6	74°36.460	155°43.890	Vertical Net ↑	3862	065	080	30	-3.8	-0.42	1013.30	92	3/10
2b	1107	Basic	19/Sept/2014	02h08	-6	74°36.340	155°49.850	Hydrobios ↓	3859	080	075	26	-2.8	-0.45	1013.70	89	3/10
2b	1107	Basic	19/Sept/2014	03h45	-6	74°36.630	155°51.080	Hydrobios ↑	3853	048	080	23	-4	-0.39	1013.80	89	3/10
2b	1107	Basic	19/Sept/2014	04h05	-6	74°36.810	155°54.080	NORPAC Net ↓	3861	082	070	22	-2.2	-0.41	1014.0	82	3/10
2b	1107	Basic	19/Sept/2014	04h11	-6	74°36.810	155°54.230	NORPAC Net ↑	3861	084	075	26	-3.5	-0.43	1014.0	87	3/10
2b	1107	Basic	19/Sept/2014	06h05	-6	74°37.160	155°58.820	CTD-Rosette ↓	3848	074	075	25	-4.1	-0.47	1013.9	91	3/10
2b	1107	Basic	19/Sept/2014	07h20	-6	74°37.440	155°59.610	CTD-Rosette ↑	3847	100	080	24	-4.1	-0.45	1014.3	92	3/10
2b	1107	Basic	19/Sept/2014	08h36	-6	74°37.980	156°01.970	Zodiac Deployment	4441	191	080	22	-4.1	-0.46	1014.1	90	3/10
2b	1107	Basic	19/Sept/2014	09h01	-6	74°38.220	156°01.360	Zodiac Recovery	3852	163	070	20	-3.1	-0.45	1014.40	89	3/10
2b	n-a	XCTD	19/Sept/2014	15h37	-6	74°28.450	154°25.850	X CTD ↓	nn-aa	000	080	26	-4.9	-0.59	1014.90	92	3/10
2b	n-a	XCTD	19/Sept/2014	19h57	-6	74°20.150	152°18.060	X CTD ↓	nn-aa	089	065	24	-5.1	-0.59	1014.5	93	Borgy bits
2b	n-a	XCTD	19/Sept/2014	20h01	-6	74°20.160	152°14.280	X CTD ↑	nn-aa	090	065	23	-5.2	-0.61	1014.40	92	nn-aa
2b	1110	Nutrient	19/Sept/2014	23h38	-6	74°20.320	149°56.340	X CTD ↓	nn-aa	080	080	23	-5.3	-0.64	1015.2	87	1/10
2b	1110	Nutrient	19/Sept/2014	23h44	-6	74°20.460	149°53.600	X CTD ↑	nn-aa	080	080	23	-5.3	-0.64	1015.2	87	1/10
2b	1110	Nutrient	20/Sept/2014	05h34	-6	74°19.680	148°16.730	CTD-Rosette ↓	3800	081	065	20	-6.5	0.18	1015.3	96	2/10
2b	1110	Nutrient	20/Sept/2014	07h00	-6	74°20.170	148°17.780	CTD-Rosette ↑	3799	069	075	20	-7	0.21	1015.7	96	2/10
2b	1110	Nutrient	20/Sept/2014	07h11	-6	74°20.170	148°18.540	NORPAC Net ↓	3800	068	075	22	-7.2	0.22	1015.5	96	2/10
2b	1110	Nutrient	20/Sept/2014	07h20	-6	74°20.200	148°18.740	NORPAC Net ↑	3791	085	075	20	-7.2	0.20	1015.7	95	2/10
2b	1115	Basic	20/Sept/2014	12h15	-6	73°54.090	147°08.990	Zodiac Deployment	3760	070	070	20	-6.1	0.85	1014.10	94	3/10
2b	1115	Basic	20/Sept/2014	12h43	-6	73°54.300	147°10.130	Zodiac Recovery	3768	070	070	18	-6	0.89	1013.70	95	3/10
2b	1115	Basic	20/Sept/2014	12h58	-6	73°54.250	147°11.160	Horizontal Net ↓	3768	070	070	23	-6.3	0.88	1014.00	96	3/10
2b	1115	Basic	20/Sept/2014	13h13	-6	73°53.820	147°12.580	Horizontal Net ↑	3768	070	070	27	-6	0.90	1014.10	96	3/10
2b	1115	Basic	20/Sept/2014	13h37	-6	73°54.110	147°13.230	Vertical Net, LOKI ↓	3767	080	080	24	-6.1	0.90	1014.10	96	3/10
2b	1115	Basic	20/Sept/2014	14h40	-6	73°54.300	147°13.220	Vertical Net, LOKI ↑	3767	080	080	22	-6.4	0.91	1014.10	93	3/10
2b	1115	Basic	20/Sept/2014	15h36	-6	73°55.450	147°16.380	Hydrobios ↓	3770	080	080	24	-6.3	0.88	1013.80	93	3/10

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					
2b	1115	Basic	20/Sept/2014	17h14	-6	73°55.910	147°17.830	Hydrobios ↑	3771	070	070	24	-5.7	0.92	1013.70	94	3/10
2b	1115	Basic	20/Sept/2014	17h35	-6	73°55.990	147°20.720	NORPAC Net ↓	3771	070	070	24	-6	0.89	1013.88	93	3/10
2b	1115	Basic	20/Sept/2014	17h48	-6	73°56.030	147°20.840	NORPAC Net ↑	3772	065	065	27	-5.5	0.88	1013.61	93	3/10
2b	1115	Basic	20/Sept/2014	19h20	-6	73°56.430	147°17.480	POPS deployment	3770	065	065	24	-5.4	0.89	1013.71	95	3/10
2b	1115	Basic	20/Sept/2014	20h08	-6	73°56.600	147°22.450	CTD-Rosette ↓	3772	060	060	26	-4	0.86	1013.80	89	3/10
2b	1115	Basic	20/Sept/2014	21h35	-6	73°56.790	147°24.590	CTD-Rosette ↑	3774	060	060	20	-4.1	0.96	1013.37	87	3/10
2b	1115	Basic	21/Sept/2014	01h22	-6	73°27.620	145°53.240	X CTD ↓	3673	070	070	25	-6.2	0.16	1011.60	97	1/10
2b	1115	Basic	21/Sept/2014	01h28	-6	73°27.130	145°52.030	X CTD ↑	3675	070	070	23	-6.2	0.16	1011.60	97	1/10
2b	1125	Nutrient	21/Sept/2014	06h02	-6	73°00.070	144°40.170	CTD-Rosette ↓	3555	069	060	22	-4.9	1.48	1010.2	98	1/10
2b	1125	Nutrient	21/Sept/2014	07h33	-6	73°00.810	144°42.990	CTD-Rosette ↑	3558	088	065	28	-4.9	1.62	1010.1	98	1/10
2b	1125	Nutrient	21/Sept/2014	07h42	-6	73°00.890	144°43.240	NORPAC Net ↓	3557	066	065	28	-4.9	1.63	1010.00	98	1/10
2b	1125	Nutrient	21/Sept/2014	07h50	-6	73°00.930	144°43.240	NORPAC Net ↑	3560	n-a	080	29	-4.8	1.65	1009.00	98	1/10
2b	1125	Nutrient	21/Sept/2014	09h50	-6	72°54.550	144°43.240	X CTD ↓	3488	100	070	31	-4.3	1.84	1009.0	96	1/10
2b	1125	Nutrient	21/Sept/2014	09h12	-6	72°54.290	144°43.240	X CTD ↑	4386	100	070	34	-4.3	1.82	1009.1	96	1/10
2b	1125	Nutrient	21/Sept/2014	10h10	-6	72°44.940	144°43.240	X CTD ↓	3430	138	065	36	-4.2	0.85	1008.6	97	3/10
2b	1125	Nutrient	21/Sept/2014	10h17	-6	72°43.860	144°43.240	X CTD ↑	3424	119	070	28	-4.2	0.85	1008.6	97	3/10
2b	1125	Nutrient	21/Sept/2014	11h16	-6	72°39.840	144°43.240	X CTD ↓	3417	105	070	34	-3.6	1.19	1008.4	97	3/10
2b	1125	Nutrient	21/Sept/2014	11h21	-6	72°39.620	144°43.240	X CTD ↑	3390	105	075	29	-3.5	1.12	1007.8	97	3/10
2b	1125	Nutrient	21/Sept/2014	14h38	-6	72°27.810	144°43.240	X CTD ↓	3244	080	075	32	-1.5	1.32	1005.80	97	2/10
2b	1125	Nutrient	21/Sept/2014	n-a	-6	72°35.000	144°43.240	X CTD	Cancelled	n-a	n-a	n-a	n-a	n-a	n-a	n-a	2/10
2b	1125	Nutrient	21/Sept/2014	15h50	-6	72°35.110	144°43.240	X CTD ↑	3298	330	090	24	-2.2	0.14	1008.20	96	5/10
2b	1130	Basic	21/Sept/2014	20h46	-6	72°36.300	141°43.960	Zodiac Deployment	3235	194	080	26	-2.8	-0.48	1007.8	98	2/10
2b	1130	Basic	21/Sept/2014	21h18	-6	72°36.120	141°43.310	Zodiac Recovery	3236	204	080	25	-2.8	-0.45	1008.4	98	2/10
2b	1130	Basic	21/Sept/2014	21h29	-6	72°35.860	141°44.400	Horizontal Net ↓	3232	192	085	20	-2.9	-0.44	1007.7	98	1/10
2b	1130	Basic	21/Sept/2014	21h45	-6	72°35.500	141°45.780	Horizontal Net ↑	3229	230	095	27	-2.9	-0.44	1007.6	98	1/10
2b	1130	Basic	21/Sept/2014	22h03	-6	72°36.230	141°44.540	Vertical Net, LOKI ↓	3235	091	085	26	-2.5	-0.43	1005.6	98	1/10
2b	1130	Basic	21/Sept/2014	23h08	-6	72°35.930	141°45.610	Vertical Net, LOKI ↑	3232	093	085	23	-2.5	-0.43	1007.3	98	1/10
2b	1130	Basic	21/Sept/2014	23h24	-6	72°35.990	141°46.220	NORPAC Net ↓	3207	076	090	22	-2.4	-0.42	1006.00	98	1/10
2b	1130	Basic	21/Sept/2014	23h30	-6	72°35.990	141°46.320	NORPAC Net ↑	3233	095	090	24	-2.5	-0.43	1006.6	98	1/10
2b	1130	Basic	22/Sept/2014	00h20	-6	72°35.780	141°50.150	CTD-Rosette ↓	3300	078	090	22	-2.3	-0.42	1005.90	97	1/10
2b	1130	Basic	22/Sept/2014	01h44	-6	72°36.170	141°50.860	CTD-Rosette ↑	3300	095	090	23	-2.4	-0.36	1006.90	98	1/10
2b	1130	Basic	22/Sept/2014	02h00	-6	72°36.110	141°52.990	Hydrobios ↓	3297	090	090	18	-2.5	-0.38	1006.50	98	1/10

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					
2b	1130	Basic	22/Sept/2014	03h40	-6	72°36.870	141°55.820	Hydrobios ↑	3300	100	090	23	-2.4	-0.31	1006.30	97	1/10
2b	1130	Basic	22/Sept/2014	03h57	-6	72°36.830	141°58.100	CTD-Rosette ↓	3305	083	090	22	-2.7	-0.3	1006.10	98	1/10
2b	1130	Basic	22/Sept/2014	04h37	-6	72°37.070	141°58.490	CTD-Rosette ↑	3306	107	090	22	-2.5	-0.28	1005.90	98	1/10
2b	1130	Basic	22/Sept/2014	10h08	-6	72°24.700	139°58.470	Ice Work ↓	2848	359	100	19	-1.9	-0.28	1004.71	97	6/10
2b	1130	Basic	22/Sept/2014	12h10	-6	72°25.040	140°00.770	Ice Work ↑	2910	000	100	14	-1.4	-0.28	1004.74	97	6/10
2b	1130	Basic	22/Sept/2014	12h43	-6	72°24.830	140°03.310	X CTD ↓	2903	160	100	18	-1.4	-0.37	1004.8	97	6/10
2b	1130	Basic	22/Sept/2014	13h03	-6	72°24.560	140°03.900	X CTD ↑	2895	156	100	12	-1.9	-0.4	1004.6	98	6/10
2b	1130	Basic	22/Sept/2014	14h50	-6	72°18.260	139°37.140	Ice Work ↓	2805	046	110	8	-0.9	-0.39	1004.3	99	7/10
2b	1130	Basic	22/Sept/2014	14h56	-6	72°18.280	139°37.200	Ice Work ↑	2800	048	110	10	-0.9	-0.39	1004.3	99	7/10
2b	1130	Basic	22/Sept/2014	15h45	-6	72°18.110	139°42.050	Ice Work ↓	2799	056	120	10	-1	-0.35	1004.1	99	7/10
2b	1130	Basic	22/Sept/2014	17h25	-6	72°18.320	139°43.080	Ice Work ↑	2801	050	130	7	-0.8	-0.36	1004.4	99	7/10
2b	1130	Basic	22/Sept/2014	22h28	-6	71°55.760	139°29.020	X CTD ↓	2595	135	315	5	-1.4	1.05	1003.1	99	0/10
2b	1130	Basic	22/Sept/2014	22h36	-6	71°55.060	139°26.760	X CTD ↑	2595	134	315	5	-1.4	1.04	1003.1	99	0/10
2b	1130	Basic	23/Sept/2014	06h05	-6	71°21.830	135°48.150	X CTD ↓	1504	110	calm	calm	0.2	1.11	1003.6	99	0/10
2b	1130	Basic	23/Sept/2014	06h10	-6	71°21.320	135°44.440	X CTD ↑	1477	111	calm	calm	0.2	1.11	1003.6	99	0/10
2b	1130	Basic	23/Sept/2014	07h13	-6	71°16.050	135°03.880	X CTD ↓	1052	110	calm	calm	0.6	1.16	1002.9	99	0/10
2b	1130	Basic	23/Sept/2014	07h14	-6	71°15.550	135°00.250	X CTD ↑	980	110	calm	calm	0.6	1.16	1002.9	99	0/10
2b	1130	Basic	23/Sept/2014	08h43	-6	71°07.980	134°02.600	X CTD ↓	456	110	270	5	0.8	1.66	1003.0	99	0/10
2b	1130	Basic	23/Sept/2014	08h46	-6	71°07.800	134°01.070	X CTD ↑	464	110	270	5	0.8	1.66	1003.0	99	0/10
2b	435	Basic	23/Sept/2014	09h31	-6	71°04.700	133°38.120	CTD-Rosette ↓	294	320	250	5	1.3	1.95	1003.2	99	0/10
2b	435	Basic	23/Sept/2014	10h07	-6	71°04.540	133°39.090	CTD-Rosette ↑	279	043	240	3	0.8	1.65	1003.3	99	0/10
2b	435	Basic	23/Sept/2014	10h19	-6	71°04.860	133°38.190	NORPAC Net ↓	303	062	250	3	1.1	1.59	1003.3	99	0/10
2b	435	Basic	23/Sept/2014	10h25	-6	71°04.800	133°38.470	NORPAC Net ↑	297	080	calm	calm	1.1	1.59	1003.2	99	0/10
2b	435	Basic	23/Sept/2014	10h34	-6	71°04.770	133°37.590	Van Veen Grab ↓	304	074	calm	calm	1.6	1.66	1003.4	99	0/10
2b	435	Basic	23/Sept/2014	10h45	-6	71°04.680	133°37.820	Van Veen Grab ↑	304	077	calm	calm	1.5	1.83	1003.5	99	0/10
2b	435	Basic	23/Sept/2014	11h03	-6	71°04.550	133°38.320	Van Veen Grab ↑	288	078	calm	calm	2.0	1.97	1003.5	99	0/10
2b	435	Basic	23/Sept/2014	11h15	-6	71°04.610	133°37.650	Beam trawl ↓	290	060	calm	calm	1.5	2.00	1003.6	99	0/10
2b	435	Basic	23/Sept/2014	12h02	-6	71°04.560	133°38.230	Beam trawl ↑	289	318	255	8	0.9	1.85	1002.70	99	0/10
2b	435	Basic	23/Sept/2014	12h20	-6	71°03.910	133°38.750	Zodiac Deployment	266	150	255	8	0.9	1.54	1002.30	99	0/10
2b	435	Basic	23/Sept/2014	12h40	-6	71°03.420	133°38.220	Zodiac Recovery	244	120	260	8	1.0	1.52	1003.00	99	0/10
3	PCBC-2	GSC Coring	30/Sept/2014	15h35	-6	71°05.460	071°50.910	CTD-Rosette ↓	696	285	310	15	-3.2	2.52	1003.80	57	0/10
3	PCBC-2	GSC Coring	30/Sept/2014	16h45	-6	71°05.310	071°50.720	CTD-Rosette ↑	696	151	320	13	-2.5	2.74	1003.3	54	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					
3	PCBC-2	GSC Coring	30/Sept/2014	17h05	-6	71°05.320	071°50.740	Piston Core ↓	696	158	320	12	-2.3	2.75	1003.5	54	0/10
3	PCBC-2	GSC Coring	30/Sept/2014	17h25	-6	71°05.320	071°50.760	Piston Core (bottom)	696	168	330	13	-4.2	2.77	1003.6	53	0/10
3	PCBC-2	GSC Coring	30/Sept/2014	17h41	-6	71°05.290	071°50.820	Piston Core ↑	696	166	330	17	-4	2.78	1003.8	56	0/10
3	PCBC-2	GSC Coring	30/Sept/2014	19h15	-6	71°05.300	071°50.570	Box Core ↓	696	141	320	6	-3.7	2.67	1004.0	49	0/10
3	PCBC-2	GSC Coring	30/Sept/2014	19h31	-6	71°05.320	071°50.660	Box Core (bottom)	696	130	330	8	-3.8	2.74	1004.5	52	0/10
3	PCBC-2	GSC Coring	30/Sept/2014	19h47	-6	71°05.320	071°50.650	Box Core ↑	696	143	330	5	-4	2.72	1004.5	49	0/10
3	PCBC-2	GSC Coring	30/Sept/2014	20h12	-6	71°05.330	071°50.680	Box Core ↓	696	135	330	15	-3.5	2.73	1004.6	51	0/10
3	PCBC-2	GSC Coring	30/Sept/2014	20h23	-6	71°05.250	071°50.750	Box Core (bottom)	696	136	330	15	-4.4	2.74	1004.6	52	0/10
3	PCBC-2	GSC Coring	30/Sept/2014	20h37	-6	71°05.140	071°50.540	Box Core ↑	696	087	345	5	-4.6	2.73	1004.7	54	0/10
3	PCBC-2	GSC Coring	30/Sept/2014	20h56	-6	71°05.200	071°50.610	Box Core ↓	695	089	300	10	-3.2	2.71	1005.0	52	0/10
3	PCBC-2	GSC Coring	30/Sept/2014	21h07	-6	71°05.180	071°50.570	Box Core (bottom)	695	096	270	5	-3.8	2.72	1005.00	51	0/10
3	PCBC-2	GSC Coring	30/Sept/2014	21h20	-6	71°05.120	071°50.240	Box Core ↑	670	049	290	10	-4.2	2.75	1005.1	52	0/10
3	PCBC-2	GSC Coring	30/Sept/2014	21h36	-6	71°05.110	071°50.330	Agassiz Trawl ↓	599	136	300	10	-4.2	2.73	1005.2	53	0/10
3	PCBC-2	GSC Coring	30/Sept/2014	22h30	-6	71°05.010	071°48.720	Agassiz Trawl ↑	695	325	300	15	-3.9	2.67	1005.0	56	0/10
3	PCBC-2	GSC Coring	30/Sept/2014	22h50	-6	71°04.980	071°49.830	Tucker ↓	580	150	300	10	-3.6	2.67	1005.4	55	0/10
3	PCBC-2	GSC Coring	30/Sept/2014	23h03	-6	71°04.950	071°49.610	Tucker ↑	642	177	300	15	-4.1	2.67	1005.2	54	0/10
3	PCBC-2	GSC Coring	30/Sept/2014	23h28	-6	71°05.590	071°50.230	Vertical Net, Monster, LOKI ↓	695	081	240	10	-4.4	2.66	1005.2	51	0/10
3	PCBC-2	GSC Coring	01/Oct/2014	00h15	-6	71°05.510	071°49.950	Monster, LOKI ↑	695	064	240	12	-3.8	2.67	1005.40	54	0/10
3	PCBC-2	GSC Coring	01/Oct/2014	00h40	-6	71°05.570	071°50.250	MOKI ↓	695	069	260	11	-3	2.67	1005.7	51	0/10
3	PCBC-2	GSC Coring	01/Oct/2014	01h05	-6	71°05.570	071°50.150	MOKI ↑	695	086	250	11	-3.5	2.70	1003.6	53	0/10
3	PCBC-2	GSC Coring	01/Oct/2014	01h20	-6	71°05.510	071°49.100	Hydrobios ↓	695	106	250	10	-2.7	2.70	1005.6	53	0/10
3	PCBC-2	GSC Coring	01/Oct/2014	01h57	-6	71°05.590	071°49.170	Hydrobios ↑	691	064	250	14	-3.7	2.69	1005.40	56	0/10
3	Gibbs-B	Full	01/Oct/2014	09h11	-6	70°46.030	072°15.620	CTD-Rosette ↓	442	007	160	25	-7.9	2.41	1008.2	69	ceberg in sigh
3	Gibbs-B	Full	01/Oct/2014	10h15	-6	70°46.430	072°16.250	CTD-Rosette ↑	436	032	190	25	-4.6	2.96	1008.4	64	ceberg in sigh
3	Gibbs-B	Full	01/Oct/2014	10h55	-6	70°45.630	072°13.630	Horizontal Net, Tucker ↓	117	041	210	25	-7.6	3.00	1007.9	67	ceberg in sigh
3	Gibbs-B	Full	01/Oct/2014	11h12	-6	70°46.200	072°14.460	Horizontal Net, Tucker ↑	310	260	210	25	-7.7	2.73	1007.9	66	ceberg in sigh
3	Gibbs-B	Full	01/Oct/2014	11h47	-6	70°45.940	072°15.830	Vertical Net, Monster, LOKI ↓	444	040	200	25	-7.3	2.79	1007.5	65	0/10
3	Gibbs-B	Full	01/Oct/2014	12h22	-6	70°46.030	072°15.350	Vertical Net, Monster, LOKI ↑	441	017	190	22	-6.5	2.85	1008.1	63	0/10
3	Gibbs-B	Full	01/Oct/2014	12h45	-6	70°46.350	072°15.240	Agassiz Trawl ↓	442	315	190	11	-5.5	2.85	1008.2	64	0/10
3	Gibbs-B	Full	01/Oct/2014	13h35	-6	70°46.700	072°14.990	Agassiz Trawl ↑	439	218	200	22	-6.4	2.87	1008.0	64	0/10
3	Gibbs-B	Full	01/Oct/2014	14h05	-6	70°45.860	072°15.590	Box Core ↓	443	002	140	18	-5.3	2.92	1008.1	63	0/10
3	Gibbs-B	Full	01/Oct/2014	14h35	-6	70°45.860	072°15.590	Box Core ↑	442	010	180	15	-5.2	2.83	1008.10	64	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					
3	Gibbs-B	Full	01/Oct/2014	15h05	-6	70°45.760	072°15.330	Piston Core ↓	441	022	190	18	-3.5	2.93	1008.3	60	0/10
3	Gibbs-B	Full	01/Oct/2014	15h20	-6	70°45.770	072°15.330	Piston Core (bottom)	443	012	190	18	-2.7	2.94	1008.3	56	0/10
3	Gibbs-B	Full	01/Oct/2014	15h30	-6	70°45.770	072°15.350	Piston Core ↑	442	020	190	17	-3.5	2.90	1008.30	57	0/10
3	Gibbs-B	Full	01/Oct/2014	18h53	-6	71°07.370	070°57.670	CTD-Rosette ↓	447	107	280	14	-1.3	2.20	1006.6	56	0/10
3	Gibbs-B	Full	01/Oct/2014	19h52	-6	71°07.520	070°56.480	CTD-Rosette ↑	428	088	280	14	1.4	2.20	1006.7	52	0/10
3	176	Nutrient	02/Oct/2014	09h09	-6	69°35.530	065°26.060	CTD-Rosette ↓	195	152	310	10	-1.6	2.28	1007.5	62	0/10
3	176	Nutrient	02/Oct/2014	09h50	-6	69°35.270	065°25.290	CTD-Rosette ↑	217	131	300	7	-0.8	2.23	1007.6	62	0/10
3	179	Nutrient	03/Oct/2014	04h31	-6	67°20.390	062°37.030	CTD-Rosette ↓	103	190	320	13	-2.3	1.55	1009.9	87	0/10
3	179	Nutrient	03/Oct/2014	05h02	-6	67°20.230	062°36.330	CTD-Rosette ↑	132	186	310	10	-1.8	1.64	1010.0	82	0/10
3	179	Nutrient	03/Oct/2014	06h20	-6	67°24.980	062°11.020	CTD-Rosette ↓	187	117	310	14	-1	2.12	1009.7	66	0/10
3	179	Nutrient	03/Oct/2014	07h00	-6	67°24.770	062°10.190	CTD-Rosette ↑	198	100	310	22	-0.4	2.20	1009.9	60	0/10
3	180	Basic	03/Oct/2014	08h19	-6	67°28.380	061°42.330	Horizontal Net, Tucker ↓	179	103	300	20	-3.6	2.06	1009.9	83	0/10
3	180	Basic	03/Oct/2014	08h33	-6	67°28.270	061°45.340	Horizontal Net, Tucker ↑	182	152	300	20	-2.9	2.07	1009.8	88	0/10
3	180	Basic	03/Oct/2014	08h56	-6	67°27.850	061°44.730	/ertical Net, Monster, LOKI ↓	181	145	300	23	-0.5	2.08	1010.0	85	0/10
3	180	Basic	03/Oct/2014	09h13	-6	67°27.550	061°44.660	Vertical Net, Monster, LOKI ↑	175	094	310	20	-2.4	2.07	1009.9	93	0/10
3	180	Basic	03/Oct/2014	09h55	-6	67°28.670	061°45.340	CTD-Rosette ↓	210	164	310	20	-2.1	2.09	1009.7	84	0/10
3	180	Basic	03/Oct/2014	10h36	-6	67°28.320	061°43.680	CTD-Rosette ↑	207	176	300	20	1.6	2.10	1010.1	71	0/10
3	180	Basic	03/Oct/2014	10h58	-6	67°28.720	061°44.580	MOKI ↓	208	124	290	20	-1	2.13	1010.0	77	0/10
3	180	Basic	03/Oct/2014	11h32	-6	67°28.170	061°44.220	MOKI ↑	178	113	310	15	-2.4	2.13	1010.2	78	0/10
3	181	Nutrient	03/Oct/2014	12h36	-6	67°33.210	061°22.610	CTD-Rosette ↓	1119	144	300	20	-1.6	2.59	1009.9	77	0/10
3	181	Nutrient	03/Oct/2014	13h54	-6	67°33.010	061°22.120	CTD-Rosette ↑	1112	114	300	17	0.2	2.49	1010.40	70	0/10
3	Big Nose	Piston Core	04/Oct/2014	07h01	-6	66°57.040	062°16.770	Piston Core ↓	83	234	100	5	-2.3	1.53	1016.0	86	Bergy
3	Big Nose	Piston Core	04/Oct/2014	07h04	-6	66°57.040	062°16.760	Piston Core (bottom)	83	239	250	3	-1.9	1.44	1016.2	85	Bergy
3	Big Nose	Piston Core	04/Oct/2014	07h07	-6	66°57.040	062°16.750	Piston Core ↑	80	248	250	3	-1.9	1.44	1016.2	85	Bergy
3	Akpait-3	Piston Core	04/Oct/2014	10h11	-6	66°53.350	061°49.460	Piston Core ↓	145	250	270	20	-1	1.60	1016.49	83	0/10
3	Akpait-3	Piston Core	04/Oct/2014	10h15	-6	66°53.340	061°49.420	Piston Core (bottom)	144	265	270	20	-1	1.60	1016.49	83	0/10
3	Akpait-3	Piston Core	04/Oct/2014	10h19	-6	66°53.350	061°49.420	Piston Core ↑	144	285	270	20	-1	1.60	1016.49	83	0/10
3	Akpait-1	Piston Core	04/Oct/2014	12h20	-6	66°52.960	061°44.640	Piston Core ↓	116	264	240	14	0.1	1.70	1017.0	66	0/10
3	Akpait-1	Piston Core	04/Oct/2014	12h25	-6	66°52.970	061°44.620	Piston Core (bottom)	117	237	240	14	0.1	1.69	1017.4	67	0/10
3	Akpait-1	Piston Core	04/Oct/2014	12h35	-6	66°53.000	061°44.770	Piston Core ↑	113	263	240	14	0.4	1.69	1017.5	66	0/10
3	Forbiche 1	Piston Core	06/Oct/2014	07h29	-6	63°38.410	068°37.230	Piston Core ↓	135	304	130	15	5.7	1.25	1014.8	75	0/10
3	Forbiche 1	Piston Core	06/Oct/2014	07h33	-6	63°38.420	068°37.200	Piston Core (bottom)	135	327	130	16	4.6	1.27	1014.9	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					
3	Forbiche 1	Piston Core	06/Oct/2014	07h36	-6	63°38.440	068°37.220	Piston Core ↑	135	328	130	16	4.6	1.27	1014.9	79	0/10
3	640	Nutrient	07/Oct/2014	13h17	-6	58°55.500	062°09.280	CTD-Rosette ↓	145	112	260	8	3.3	3.18	1014.2	98	0/10
3	640	Nutrient	07/Oct/2014	13h53	-6	58°55.280	062°09.120	CTD-Rosette ↑	146	171	300	1	5.1	2.73	1014.7	93	0/10
3	645	Nutrient	08/Oct/2014	12h15	-6	56°42.200	059°42.210	CTD-Rosette ↓	120	144	190	4	7.2	2.97	1015.90	76	0/10
3	645	Nutrient	08/Oct/2014	12h45	-6	56°42.200	059°42.820	CTD-Rosette ↑	120	39	170	3	6.9	2.87	1016.1	79	0/10
3	650	Nutrient	08/Oct/2014	15h48	-6	53°48.290	055°26.060	CTD-Rosette ↓	207	72	180	20	7.4	4.02	1015.7	83	0/10
3	650	Nutrient	08/Oct/2014	16h33	-6	56°48.210	055°26.680	CTD-Rosette ↑	205	323	170	16	6.9	3.88	1016.7	84	0/10

Appendix 3 - CTD Logbook for Leg 1 of the 2014 ArcticNet / *Amundsen* Expedition

Cast number	Station ID	Station Type	Date start UTC	Time UTC	Latitude (N)	Longitude (W)	Bottom depth (m)	Cast depth (db)	Comments	Init
001	ROV1	ROV	15/7/14	08:20	69°22.026	064°51.965	718	707	RS (avant deploiement ROV)	VD
002	ROV2	ROV	16/7/14	10:22	71°30.500	070°17.623	614	600	éponge bloqué dans CT	VD
003	323	FULL -B	17/7/14	21:22	74°09.455	080°28.560	850	100	RS[Full- B (Biomass)]	SM
004	323	FULL - A	18/7/14	00:04	74°09.390	080°29.304	794	780	RS [Full - A Nutrients]	SM
005	300	NUTS	18/7/14	06:11	74°19.001	080°30.146	702	680	RS	VD
006	322	NUTS	18/7/14	08:14	74°29.774	080°32.132	660	660	RS	SM
007	324	NUTS	18/7/14	23:25	73°58.969	080°28.412	773	769	RS	SM
008	325	NUTS	19/7/14	01:36	73°49.058	080°29.395	685	678	RS	VD
009	301	BASIC - B	19/7/14	12:22	74°06.389	083°24.545	671	673	RS [Basic - B(Biomass)]	SM
010	301	BASIC - A	19/7/14	18:37	74°05.988	083°23.276	665	651	RS [Basic - A(Nutrients)]	VD
011	346	NUTS	20/7/14	15:01	74°08.860	091°34.486	260	244	RS	VD
012	304	FULL - B	20/7/14	16:45	74°14.372	091°32.218	310	100	RS [Full - Biomass]	SM
013	304	FULL - A	20/7/14	18:53	74°14.102	091°30.168	309	300	RS [Full - A Nutrients]	VD
014	305	FULL - B	22/7/14	09:90	74°19.104	094°54.385	188	178	RS [Full - Biomass]	SM
015	305	FULL-A	22/7/14	11:19	74°19.303	094°52.631	190	177	RS[Full- A (Nutrients)]	VD
016	305 A	NUTS	22/7/14	23:06	74°12.990	094°12.902	171	162	RS	SM
017	305 B	NUTS	23/7/14	03:11	74°13.732	095°54.469	186	177	RS	SM
018	305 C	NUTS	23/7/14	04:42	74°21.575	095°48.608	181	172	RS	SM
019	305 D	NUTS	23/7/14	06:07	74°27.378	095°42.168	195	180	RS	VD
020	305 E	NUTS	23/7/14	07:56	74°35.323	095°03.718	128	113	RS	VD
021	200	BASIC-B	27/7/14	11:08	73°16.753	063°38.208	1461	101	RS [Basic- Biomass]	VD
022	200	BASIC-A	27/7/14	13:59	73°16.703	063°37.972	1470	1460	RS [Basic-Nutrients]	MH
023	200	BASIC-C	27/7/14	18:06	73°16.746	063°37.750	1453	1456	RS [Basic-Deep Water¨]	VD
024	204	BASIC-B	28/7/14	13:29	73°15.750	057°52.850	998	470	RS [Basic-Biomass]	MH
025	204	BASIC-A	28/7/14	16:36	73°15.690	057°53.310	996	984	RS [Basic-Nutrients]	VD
026	206	NUTS	29/7/14	05:11	74°04.360	059°02.675	181	174.86	RS	MH
027	208	CTD	29/7/14	09:15	74°44.470	059°59.437	852	847	RS	VD
028	210	BASIC-B	29/7/14	17:15	75°24.445	061°38.957	1138	405	RS	MH
029	210	BASIC-N	29/7/14	21:18	75°24.017	061°39.059	1157	1013	RS	MH
030	212	CTD	30/7/14	07:17	75°37.966	064°36.104	499	489	RS	MH
031	214	NUTS	30/7/14	12:20	75°47.665	067°57.094	278	273	RS	VD
032	115	FULL-B	30/7/14	18:11	76°20.087	071°12.870	676	406	RS	MH
033	115	FULL-A	30/7/14	20:48	76°19.601	071°09.916	674	663	RS	MH
034	115	FULL-C	30/7/14	23:41	76°19.870	071°13.926	666	422	RS	VD
035	114	CTD	31/7/14	05:52	76°19.505	071°47.065	615	606	RS	MH
036	113	NUTS	31/7/14	07:17	76°19.139	072°12.456	553	546	pompe off lors du 1er profil.	MH
037	112	CTD	31/7/14	09:03	76°19.064	072°42.350	573	563	UVP ne semble pas avoir fonctionner	MH
038	111	BASIC-B	31/7/14	11:10	76°18.384	073°13.361	592	102	UVP ne semble pas avoir fonctionner	VD
039	111	BASIC-A	31/7/14	12:54	76°18.402	073°13.012	598	582	UVP ne semble pas avoir fonctionner	VD

Appendix 3 - CTD Logbook for Leg 1 of the 2014 ArcticNet / *Amundsen* Expedition

Cast number	Station ID	Station Type	Date start UTC	Time UTC	Latitude (N)	Longitude (W)	Bottom depth (m)	Cast depth (db)	Comments	Init
040	110	NUTS	31/7/14	18:00	76°17.910	073°37.634	532	525	UVP en panne	MH
041	109	CTD	31/7/14	19:48	76°17.302	074°06.508	452	442	UVP en panne.	MH
042	108	FULL-A	31/7/14	21:57	76°16.163	074°36.144	448	437	RS	VD
043	108	FULL-B	1/8/14	05:52	76°16.301	074°35.992	445	101	RS	VD
044	107	NUTS	1/8/14	07:17	76°16.926	074°58.885	443	431	RS	VD
045	106	CTD	1/8/14	08:55	76°18.491	075°21.666	379	367	RS	VD
046	105	BASIC-A	1/8/14	10:05	76°19.052	075°46.534	333	329	RS	MH
047	105	BASIC-B	1/8/14	13:34	76°19.444	075°46.939	334	104	RS	MH
048	104	CTD	1/8/14	17:10	76°20.462	076°10.422	194	178	RS	MH
049	103	NUTS	1/8/14	17:57	76°21.233	076°34.476	149	139	RS	MH
050	102	CTD	1/8/14	19:11	76°22.398	076°58.540	241	233	UVP n'a pas marché.	MH
051	101	FULL-A	1/8/14	21:03	76°22.585	077°23.990	360	359	UVP OK	MH
052	101	FULL-B	2/8/14	05:38	76°23.056	077°23.788	350	330	RS	VD
053	KEN01	FULL-B	3/8/14	12:57	81°22.022	064°10.619	497	208	RS	MH
054	KEN01	FULL-A	3/8/14	17:59	81°22.136	063°56.405	549	542	RS	MH
055	KEN02	NUTS	4/8/14	02:50	81°04.726	065°49.919	387	375	RS	VD
056	KEN03	BASIC-B	4/8/14	05:52	80°47.539	067°18.023	403	102	RS	VD
057	KEN03	BASIC-A	4/8/14	07:34	80°48.022	067°17.83	408	392	RS	VD
058	KEN04	NUTS	4/8/14	12:36	80°23.980	068°48.340	369	360	RS	MH
059	KANE01	BASIC-B	4/8/14	16:33	79°59.087	069°46.830	245	238	RS	MH
060	KANE01	BASIC-A	4/8/14	18:34	79°59.933	069°45.380	245	235	RS	MH
061	KANE02	NUTS	5/8/14	04:36	79°40.266	070°44.663	236	223	RS	VD
062	KANE03	BASIC-B	5/8/14	07:21	79°21.637	071°51.670	223	203	RS	VD
063	KANE03	BASIC-A	5/8/14	08:51	79°21.042	071°51.929	213	202	RS	VD
064	KANE04	NUTS	5/8/14	13:16	79°00.371	070°29.284	356	340	RS	MH
065	134	CTD	5/8/14	15:10	78°59.998	071°17.990	211	198	Station Ice Island.	MH
066	ii2	CTD	5/8/14	19:11	79°03.739	071°40.562	208	199	Station Ice Island.	MH
067	ii1	CTD	5/8/14	19:37	79°03.230	071°42.160	209	201	Station Ice Island.	MH
068	ii3	CTD	5/8/14	20:46	79°03.713	071°39.097	208	199	Station Ice Island.	MH
069	ii4	CTD	5/8/14	21:20	79°04.668	071°37.225	203	191	Station Ice Island.	MH
070	ii5	CTD	5/8/14	22:02	79°04.446	071°40.848	197	182	Station Ice Island.	VD
071	132b	CTD	6/8/14	00:36	78°59.978	072°16.992	252	235	RS	VD
072	KANE05	BASIC-B	6/8/14	02:25	79°00.400	073°12.404	244	100	RS	VD
073	KANE05	BASIC-A	6/8/14	03:58	79°00.056	073°12.154	251	238	RS	VD
074	127	NUTS	6/8/14	09:45	78°18.017	074°28.895	526	507	RS	VD
075	120	BASIC-B	6/8/14	16:28	77°19.438	075°41.608	562	403	RS	MH
076	120	BASIC-A	6/8/14	18:37	77°19.333	075°42.104	560	550	RS	MH
077	335	BASIC-B	9/8/14	00:51	74°25.678	098°49.444	129	117	La bouteille 2 n'a pas fermé	MH
078	335	BASIC-A	9/8/14	02:54	74°25.343	098°47.594	122	110	RS	MH

Appendix 3 - CTD Logbook for Leg 1 of the 2014 ArcticNet / *Amundsen* Expedition

Cast number	Station ID	Station Type	Date start UTC	Time UTC	Latitude (N)	Longitude (W)	Bottom depth (m)	Cast depth (db)	Comments	Init
079	309	BASIC-B	10/8/14	09:33	72°57.125	096°09.373	338	102	RS	MH
080	309	BASIC-A	10/8/14	13:25	72°57.901	096°03.769	324	318	RS	MH
081	310	BASIC-B	11/8/14	02:05	71°17.850	097°41.340	137	100	RS	MH
082	310	BASIC-A	11/8/14	04:10	71°17.700	097°42.072	132	116	RS	VD
083	312	BASIC-B	11/8/14	20:19	69°10.604	100°40.139	60	49	UVP en mode I/O	MH
084	312	BASIC-A	11/8/14	22:08	69°10.558	100°41.185	65	50	UVP en mode I/O	VD
085	314	FULL-B	12/8/14	13:13	68°58.223	105°28.249	80	70	RS	MH
086	314	FULL-A	12/8/14	14:40	68°58.249	105°27.972	80	69	RS	MH
087	315	NUTS	12/8/14	23:48	68°50.768	107°30.235	64	51	RS	VD
088	318	NUTS	13/8/14	02:04	68°40.992	108°17.215	58	47	RS	VD
089	317	NUTS	13/8/14	03:03	68°45.685	108°24.504	120	106	RS	VD
090	316	NUTS	13/8/14	04:05	68°50.298	108°30.535	96	86	RS	VD

Appendix 3 - CTD Logbook for Leg 1 of the 2014 ArcticNet / *Amundsen* Expedition

Cast number	Station ID	Station Type	Date start UTC	Time UTC	Latitude (N)	Longitude (W)	Bottom depth (m)	Cast depth (db)	Comments	Init
001	405	Basic	17/8/14				604	594	pump off, no data	PG LT
002	405	Basic	17/8/14	1:31	70°38.285	123°02.791	604	594	replace cast 001	
003	405	Basic	17/8/14	3:30	70°38.338	123°01.942	610	605		
004	407	Basic	18/8/14	11:33	71°00.222	126°04.465	401	385	Forte houle	
005	407	Basic	18/8/14	13:38	71°00.218	126°04.013	398	384	Forte houle	
006	437	Basic	19/8/14	19:00	71°47.219	126°29.426	311	311		PG
007	437	Basic	19/8/14	21:25	71°47.174	126°30.043	317	307		LT
008	410	Nut	20/8/14	1:33	71°41.881	126°29.680	412	405		PG
009	411	CTD	20/8/14	3:08	71°37.723	126°42.089	439	420		LT
010	412	Nut	20/8/14	4:10	71°33.720	126°55.500	415	402		LT
011	413	CTD	20/8/14	5:58	71°29.663	127°08.570	372	360		PG
012	414	Nut	20/8/14	7:00	71°25.321	127°22.007	306	294		PG
013	408	Full	20/8/14	14:44	71°18.732	127°34.538	209	197		PG
014	408	FULL	20/8/14	19:30	71°18.708	127°34.844	206	195		PG
015	417	CTD	21/8/14	1:25	71°13.666	127°58.304	85	75	oublié de déclancher arch donnée des surface"	LT
016	418	Nut	21/8/14	2:22	71°09.752	128°10.390	65	55		LT
017	419	CTD	21/8/14	3:26	71°06.452	128°20.239	57	47		LT
018	420	Basic	21/8/14	4:30	71°03.044	128°30.653	40	32		PG
019	420	Basic	21/8/14	6:35	71°03.040	128°30.832	40	30		PG
020	422	Nutrient	21/8/14	20:30	71°22.241	133°53.238	1083	1000		LT
021	423	CTD	21/8/14	22:40	71°16.342	133°51.493	801	794		PG
022	424	Nutrient	21/8/14	23:51	71°10.433	133°49.646	581	571		LT
023	435	Basic	22/8/14	1:50	71°04.720	133°37.710	301	291		LT
024	435	Basic	22/8/14	4:12	71°04.764	133°38.095	298	289	Deck unit redémarré	LT
025	BS-1	Moorings	22/8/14	10:40	70°48.836	134°50.581	81	72		PG
026	BR-K	Moorings	22/8/14	15:04	70°51.884	135°00.553	154	146		PG
027	PINGO	CH4	22/8/14	21:33	70°51.593	134°59.485	120	116		PG
028	BS-2	BS2	23/8/14	0:37	70°52.804	135°06.109	306	298		LT
029	434	Basic	23/8/14	5:16	70°10.761	133°33.118	45	35		LT
030	434	Basic	23/8/14	6:57	70°10.734	133°33.386	46	34		LT
031	433	CTD	23/8/14	8:36	70°17.358	133°34.878	55	45		PG
032	432	Nut	23/8/14	9:30	70°23.785	133°36.470	62	52		PG
033	431	CTD	23/8/14	10:40	70°29.646	133°37.550	67	57		PG
034	430	Nuts	23/8/14	11:37	70°35.917	133°38.945	70	60		PG
035	429	CTD	23/8/14	12:48	70°41.826	133°40.343	68	58		PG
036	428	Nuts	23/8/14	13:40	70°47.489	133°41.784	74	63		PG
037	427	CTD	23/8/14	15:01	70°52.777	133°43.232	80	70		LT
038	426	Nuts	23/8/14	16:10	70°59.040	133°45.050	113	95		LT

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Cast number	Station ID	Station Type	Date start UTC	Time UTC	Latitude (N)	Longitude (W)	Bottom depth (m)	Cast depth (db)	Comments	Init
039	BS-3	CTD	23/8/14	21:24	70°55.310	135°13.847	488	478		LT
040	BR-G	CTD	24/8/14	1:00	70°59.719	135°31.248	677	671		PG
041	421	Full-Nut	24/8/14	6:20	71°27.246	133°53.654	1160	1171		LT
042	421	Full-Biom	24/8/14	12:42	71°27.349	133°53.220	1132	1000		PG
043	460	Basic-Nut	25/8/14	6:28	72°08.803	130°48.810	962	959		LT
044	460	Basic-Biom	25/8/14	12:46	72°09.486	130°49.148	983	981		PG
045	BR-3	Moorings	27/8/14	14:49	73°24.290	129°21.382	690	687		PG
046	BR-4	Moorings	28/8/14	14:26	73°13.020	127°03.522	158	147		LT
047	AMD0214-03	PistonCore	1/9/14	15:28	70°33.264	137°32.510	1070	1065		lt
048	BR-1	Moorings	1/9/14	22:30	70°25.649	139°01.531	742	741		PG
049	482	Basic-Biom	2/9/14	1:06	70°31.511	139°22.890	831	821		LT
050	482	Basic-Nut	2/9/14	4:33	70°31.553	139°23.200	819	820		PG
051	BR-2	Moorings	3/9/14	17:19	70°00.028	137°58.800	162	152		PG
052	470-A	Basic	4/9/14	22:09	69°21.971	138°13.955	47	37		LT
053	470	Nuts	6/9/14	12:51	69°25.816	137°59.058	52	41	no chlo max	PG
054	472	Basic-Biom	6/9/14	14:45	69°36.508	138°13.226	129	114		LT
055	472	Basic-Nut	6/9/14	16:40	69°36.502	138°12.049	120	112		PG
056	474	Nut	6/9/14	20:42	69°47.860	138°26.111	175	163		PG
057	476	Nut	6/9/14	23:00	69°58.914	138°39.788	268	260		LT
058	478	Nut	7/9/14	2:26	70°10.051	138°54.581	372	367		PG
059	480	Nut	7/9/14	4:50	70°20.224	139°08.898	570	556		LT
060	1040	Basic-All	10/9/14	14:04	71°14.794	157°10.001	47	39	no chloro max	PG
061	1041	Basic-All	10/9/14	18:04	71°19.707	157°20.006	91	82	Archiv data a partir de 7m	LT
062	1042	Basic-All	10/9/14	21:11	71°24.619	157°29.332	125	117		PG
063	1043	Basic-All	11/9/14	5:31	71°29.802	157°40.092	82	72		LT
064	1044	Basic-All	11/9/14	8:14	71°34.673	157°50.382	65	55		LT
065	1036	Basic-All	12/9/14	1:20	71°43.608	155°24.703	174	167		PG
066	1038	Basic-All	12/9/14	6:08	71°34.409	155°45.407	164	157		LT
067	1045	CTD	12/9/14	15:00	71°38.554	154°54.942	60	52	CTD for mooring	PG
068	1046	CTD	12/9/14	19:07	71°41.892	155°05.137	171	160	CTD for mooring	LT
069	1047	CTD	13/9/14	1:47	71°45.968	155°16.241	213	203	CTD for mooring	PG
070	BCW-13	Moorings	13/9/14	3:59	71°47.155	155°21.574	156	147		LT
071	1034	Full	13/9/14	5:13	71°54.440	154°58.212	414	404	Inclinaison du cable jusqu'à 150m	LT
072	1034	Full-02	13/9/14	10:36	71°54.536	154°57.918	446	442		PG
073	BCC-14	Moorings	13/9/14	21:51	71°43.946	155°10.154	290	282	Just CTD	LT
074	1032	Nut	14/9/14	1:14	72°03.302	154°37.310	1311	1013	Altimer removed for tests	PG
075	1030	Basic-All	14/9/14	4:15	72°12.368	153°56.782	2068	1700	PAR ISUS removed	LT
076	CAP 12T	Moorings	16/9/14	5:53	75°11.851	172°34.241	444	434	Just CTD	LT
077	NORPAC-4	Nut	16/9/14	11:51	75°12.397	169°49.531	302	296	Nobody wants water !!!	PG

Appendix 3 - CTD Logbook for Leg 1 of the 2014 ArcticNet / *Amundsen* Expedition

Cast number	Station ID	Station Type	Date start UTC	Time UTC	Latitude (N)	Longitude (W)	Bottom depth (m)	Cast depth (db)	Comments	Init
078	1085	Basic	16/9/14	20:07	75°03.683	167°08.425	242	236		PG
079	NORPAC-5	Nut	17/9/14	9:34	75°04.277	164°21.913	593	591	no scm, Heave	PG
080	NAP13	Moorings	17/9/14	15:11	74°36.137	161°56.537	1764	1520	no PAR,Isus and alti	LT
081	NAP 12 T	Moorings	18/9/14	1:38	75°00.238	162°00.205	1959	1471	no PAR,Isus and alti	PG
082	1100	Full	18/9/14	4:48	75°04.082	161°15.720	1983	1500	no PAR,Isus and alti	LT
083	1100	Full-2	18/9/14	15:13	75°04.116	161°15.822	1987	1013	with Isus and PAR, no water	PG
084	1105	Nut	19/9/14	0:39	74°47.237	157°34.175	1281	1270	no PAR and ISUS	LT
085	1107	Basic	19/9/14	13:05	74°37.160	155°58.843	3847	1522	no Par, Isus and alti	PG
086	1110	Nut	20/9/14	12:33	74°19.680	148°16.769	3799	1521	no Par, Isus and alti	PG
087	1115	Basic	21/9/14	3:10	73°56.666	147°23.314	3172	1500	no Par, Isus and alti	LT
088	1125	Nut	21/9/14	13:02	73°00.066	144°40.194	3550	1521	no Par, Isus and alti	PG
089	1130	Basic	22/9/14	7:08	72°35.779	141°50.166	3229	1500	no Par, Isus and alti	LT
090	1130	Basic	22/9/14	10:57	72°36.826	141°58.151	3305	1013	Nitrate connected	PG
091	435	Basic	23/9/14	15:32	71°04.688	133°38.119	289	286	no chloro max, swell	PG

Cast number	Station ID	Station Type	Date start UTC	Time UTC	Latitude (N)	Longitude (W)	Bottom depth (m)	Cast depth (db)	Comments	Init
001	pcbc2	Full	30/9/14	19:43	71°05.450	071°50.920	696	697		SB
002	pcbc3	Basic	1/10/14	13:11	70°46.042	072°15.617	444	437		LB
003	Gibbs N	Nutrient	1/10/14	22:58	71°07.378	070°57.670	446	439		LB
004	176	Nutrient	2/10/14	13:13	69°35.527	065°26.024	195	187		LB
005	179a	Nutrient	3/10/14	8:34	67°20.380	062°36.947	110	96.4		LB
006	179	Nutrient	3/10/14	10:22	67°24.974	062°10.826	190	182		SB
007	180	Basic-n	3/10/14	13:55	67°28.666	061°45.314	210	200		SB
008	181	Nutrient	3/10/14	16:41	67°33.199	061°22.589	1127	1130		LB
009	640	Nutrient	7/10/14	17:20	58°55.486	062°09.276	143	135.6		LB
010	645	Nutrient	8/10/14	4:16	56°42.206	059°42.230	119	109		SB
011	650	Nutrient	8/10/14	19:51	53°48.293	055°26.112	204	195		LB

Appendix 4 - List of participants on Leg 1 of the 2014 ArcticNet / *Amundsen* Expedition

Leg	Name	Position	Affiliation	Network Investigator/ supervisor	Embark date	Disembark date
Leg 3	Amitnak, Kaytlyn	Student	Schools on Board	Watts, Michelle	25-Sep-14	06-Oct-14
Leg 1a, Leg1b	Amoréna, Zoé	MSc Student	UQAR	Bélanger, Simon	08-Jul-14	14-Aug-14
Leg 2b	Arkett, Matt	Professional	Canadian Ice Service	Braithwaite, Leah	09-Sep-14	25-Sep-14
Leg 3	Aubé, Jean-Pierre	Media		Archambault, Philippe	25-Sep-14	12-Oct-14
Leg1b, Leg 2a, Leg 2b, Leg 3	Aubry, Cyril	Technician	Université Laval	Fortier, Louis	24-Jul-14	12-Oct-14
Leg 2a, Leg 2b	Babb, David	Research Associate	University of Manitoba	Barber, David	14-Aug-14	25-Sep-14
Leg 3	Barber, Lucette	Professional	Schools on Board	Watts, Michelle	25-Sep-14	06-Oct-14
Leg 3	Bennett, Robbie	Technician	GSC	Campbell, Calvin	25-Sep-14	12-Oct-14
Sea trial	Bhardwaj, Michael	Media	Canada Foundation for Innovatio	CFI	21-Jun-14	26-Jun-14
Leg1b, Leg 2a	Blais, Marjolaine	Technician	UQAR-ISMER	Gosselin, Michel	24-Jul-14	09-Sep-14
Leg 2a	Blasco, Steve	Scientist	NRCan	Blasco, Steve	14-Aug-14	09-Sep-14
Leg 3	Blondeau, Sylvain	Technician	Québec-Océan	Levesque, Keith	25-Sep-14	12-Oct-14
Leg 3	Blouin, Jean-Francois	Professional	Schools on Board	Watts, Michelle	25-Sep-14	06-Oct-14
Leg 1a, Leg1b	Boudreau, Catherine	Student	Université Laval	Fortier, Louis	08-Jul-14	14-Aug-14
Leg 3	Bourdages, Line	PhD Student	McGill University	Tremblay, Bruno	25-Sep-14	12-Oct-14
Leg 1a, Leg 2b, Leg 3	Brouard, Étienne	PhD Student	Université Laval	Lajeunesse, Patrick	08-Jul-14	24-Jul-14
Leg 1a, Leg1b	Burgers, Tonya	MSc Student	University of Manitoba	Papakyriakou, Tim	08-Jul-14	14-Aug-14
Leg1b, Leg 2a, Leg 2b	Burt, Alexis	Research Associate	University of Manitoba	Stern, Gary	24-Jul-14	25-Sep-14
Leg 3	Campbell, Karley	PhD Student	University of Manitoba	Gosselin, Michel	25-Sep-14	12-Oct-14
Leg 1a, Leg 2a, Leg 2b	Candlish, Lauren	Research Associate	University of Manitoba	Barber, David	14-Aug-14	25-Sep-14
Leg 3	Chacon-Vega, Stephanie	Student	Schools on Board	Watts, Michelle	25-Sep-14	06-Oct-14
Leg 1a, Leg1b	Chagnon-Lafortune, Aurélie	Undergraduate	UQAR	Nozais, Christian	08-Jul-14	14-Aug-14
Leg 2a, Leg 2b, Leg 3	Chamberlain, Gord	Research Assistant	University of Manitoba	Stern, Gary	14-Aug-14	12-Oct-14
Leg 1a, Leg1b	Charette, Joannie	MSc Student	UQAR-ISMER	Gosselin, Michel	08-Jul-14	14-Aug-14
Leg 2b	Cooper, Lee	Scientist	University of Maryland	Grebmeier, Jacqueline	09-Sep-14	25-Sep-14
Leg 1a, Leg1b	Côté, Jean-Sébastien	MSc Student	Université Laval	Tremblay, Jean-Éric	08-Jul-14	14-Aug-14
Leg 2a, Leg 2b	Coupel, Pierre	Post Doctoral Fellow	Universtié Laval	Tremblay, Jean-Éric	14-Aug-14	25-Sep-14
Leg 1a, Leg1b, Leg 3	Courchesne, Isabelle	MSc Student	Université Laval	Tremblay, Jean-Éric	08-Jul-14	14-Aug-14
Leg 1b	Crawford, Anna	PhD Student	Carleton University	Mueller, Derek	24-Jul-14	14-Aug-14
Leg 2a	Curtiss, Greg	Professional	Golder	Lowings, Malcolm	14-Aug-14	09-Sep-14
Leg 1a	de Moura Neves, Barbara	Scientist	Memorial University	Edinger, Evan	08-Jul-14	17-Jul-14
Leg 3	de Paula Ribeiro da Fonseca, Flavia	MSc Student	University of Manitoba	Stern, Gary / Zou Zou Ku	25-Sep-14	06-Oct-14
Leg 3	Deering, Robert	MSc Student	Memorial University	Bell, Trevor/Forbes, Don	25-Sep-14	12-Oct-14
Leg 1a, Leg1b	Del Marro, Virginie	Technician	ArcticNet	Levesque, Keith	08-Jul-14	14-Aug-14
Leg 2a	Deschamps, Charles-Edouard	MSc Student	UQAR	Montero-Serrano, Jean-C	14-Aug-14	09-Sep-14

Appendix 4 - List of participants on Leg 1 of the 2014 ArcticNet / *Amundsen* Expedition

Leg	Name	Position	Affiliation	Network Investigator/ supervisor	Embark date	Disembark date
Leg 3	Desroches, Stephen	Student	Schools on Board	Watts, Michelle	25-Sep-14	06-Oct-14
Leg 1a	Edinger, Evan	Scientist	Memorial University	Edinger, Evan	08-Jul-14	17-Jul-14
Leg 2a	Elias, James	Professional	ArcticNet/Golder	Lowings, Malcolm	14-Aug-14	09-Sep-14
Leg 1a, Leg1b	Falardeau-Côté, Marianne	Research Assistant	Université Laval	Fortier, Louis	08-Jul-14	14-Aug-14
Leg 1b	Falardeau, Jade	MSc Student	UQAM	Massé, Guillaume	24-Jul-14	14-Aug-14
Leg 3	Forbes, Don	Scientist	Memorial University	Bell, Trevor/Forbes, Don	25-Sep-14	12-Oct-14
Leg 2a	Forest, Alexandre	Professional	Golder	Lowings, Malcolm	14-Aug-14	09-Sep-14
Leg 2b	Fortier, Louis	Scientist	Université Laval	Fortier, Louis	09-Sep-14	25-Sep-14
Leg 2a, Leg 2b, Leg 3	Friscourt, Noémie	MSc Student	UQAR	Nozais, Christian	14-Aug-14	12-Oct-14
Leg 1a, Leg1b	Gagnon, Jonathan	Technician	Université Laval	Tremblay, Jean-Éric	08-Jul-14	14-Aug-14
Leg 1b	Galindo, Virginie	PhD Student	Université Laval	Levasseur, Maurice	24-Jul-14	14-Aug-14
Leg 1a, Leg1b, Leg 2a, Leg 2b, Leg 3	Geng, Lantao	PhD Student	ISMER/UQAR	Xie, Huixiang	08-Jul-14	12-Oct-14
Leg 2a, Leg 2b	Geoffroy, Maxime	PhD Student	Universtié Laval	Fortier, Louis	14-Aug-14	25-Sep-14
Leg 1a	Ghahremaninezhad, Roghayeh	PhD Student	Netcare/U of Calgary	Abbatt, Jon	08-Jul-14	24-Jul-14
Leg 1a	Gosselin, Michel	Scientist	UQAR-ISMER	Gosselin, Michel	08-Jul-14	24-Jul-14
Leg 1a, Leg1b	Gourdal, Margaux	PhD Student	Université Laval	Levasseur, Maurice	08-Jul-14	14-Aug-14
Leg1b, Leg 2a	Grant, Cindy	Research Associate	UQAR	Archambault, Philippe	24-Jul-14	09-Sep-14
Leg 2b	Grebmeier, Jacqueline	Scientist	University of Maryland	Grebmeier, Jacqueline	09-Sep-14	25-Sep-14
Leg 2a, Leg 2b, Leg 3	Grigor, Jordan	PhD Student	Université Laval	Fortier, Louis	14-Aug-14	12-Oct-14
Leg 2a, Leg 2b	Guillot, Pascal	Professional	Québec-Océan	Levesque, Keith	14-Aug-14	25-Sep-14
Leg 1b	Houssais, Marie-Noelle	Professional	CNRS	Babin, Marcel	24-Jul-14	14-Aug-14
Leg 1a, Leg1b	Irish, Vickie	PhD Student	UBC	Miller, Lisa	08-Jul-14	14-Aug-14
Leg 2b	Ito, Keizo	MSc Student	Hokkaido Univ.	Kikuchi, Takashi	09-Sep-14	25-Sep-14
Leg 2b	Iwahara, Yuka	PhD Student	Hokkaido Univ.	Kikuchi, Takashi	09-Sep-14	25-Sep-14
Leg 2a	Jaegle, Matthieu	Undergraduate	UQAR	Montero-Serrano, Jean-C	14-Aug-14	09-Sep-14
Leg 3	James, Hannah	Student	Schools on Board	Watts, Michelle	25-Sep-14	06-Oct-14
Leg 2a	Jarret, Kate	Research Assistant	NRCan	Blasco, Steve	14-Aug-14	09-Sep-14
Leg 1b	Joli, Nathalie	PhD Student	Université Laval	Lovejoy, Connie	24-Jul-14	14-Aug-14
Leg 2a, Leg 2b, Leg 3	Joyal, Gabriel	MSc Student	Université Laval	Lajeunesse, Patrick	14-Aug-14	12-Oct-14
Leg 3	Kaufman, Benjamin	Student	Schools on Board	Watts, Michelle	25-Sep-14	06-Oct-14
Leg 2b	Kikuchi, Takashi	Scientist	JAMSTEC	Kikuchi, Takashi	09-Sep-14	25-Sep-14
Leg 2a	King, Ned	Scientist	NRCan	Blasco, Steve	14-Aug-14	09-Sep-14
Leg 2a, Leg 2b	Kirillov, Sergei	Student	University of Manitoba	Dmintrenko, Igor/Barber,	14-Aug-14	25-Sep-14
Leg 2b, Leg 3	Komatsu, Kensuke	PhD Student	University of Manitoba	Barber, David/Ogi, Masay	09-Sep-14	12-Oct-14

Appendix 4 - List of participants on Leg 1 of the 2014 ArcticNet / *Amundsen* Expedition

Leg	Name	Position	Affiliation	Network Investigator/ supervisor	Embark date	Disembark date
Leg 2a	Lakeman, Tom	Post Doctoral Fellow	Dalhousie University	Blasco, Steve	14-Aug-14	09-Sep-14
Leg 2b	Lalande, Catherine	Research Associate	Université Laval	Fortier, Louis	09-Sep-14	25-Sep-14
Leg 1a, Leg1b	Laliberté, Julien	MSc Student	UQAR	Bélanger, Simon	08-Jul-14	14-Aug-14
Leg 1a, Leg1b	LeBlanc, Mathieu	Undergraduate	Université Laval	Fortier, Louis	08-Jul-14	14-Aug-14
Leg 1b	Lee, Alex	Research Associate	Netcare/ U of Toronto	Abbatt, Jon	24-Jul-14	14-Aug-14
Leg 1a	Levasseur, Maurice	Scientist	Université Laval	Levasseur, Maurice	08-Jul-14	24-Jul-14
Sea trial	Levesque, Keith	Professional	ArcticNet	Fortier, Martin	21-Jun-14	26-Jun-14
Leg 1b	Limoges, Audrey	PhD Student	UQAM	Massé, Guillaume	24-Jul-14	14-Aug-14
Leg 1a, Leg1b	Linkowski, Thomas	Technician	ArcticNet	Levesque, Keith	08-Jul-14	14-Aug-14
Leg 1a, Leg1b	Lizotte, Martine	Research Associate	Université Laval	Levasseur, Maurice	08-Jul-14	14-Aug-14
Leg 1a	Lockhart, Peter	Professional	CSSF	Levesque, Keith	08-Jul-14	17-Jul-14
Leg 1b	Lovejoy, Connie	Scientist	Université Laval	Lovejoy, Connie	24-Jul-14	14-Aug-14
Leg 2a	MacKillop, Kevin	Research Assistant	NRCan	Blasco, Steve	14-Aug-14	09-Sep-14
Leg 2b, Leg 3	Maftei, Mark	Professional	Environment Canada	Gjerdrum, Carina	09-Sep-14	12-Oct-14
Leg 3	Maksagak, Alysha	Student	Schools on Board	Watts, Michelle	25-Sep-14	06-Oct-14
Sea trial	Marchand, Claire	Technician	TAKUVIK	Fortier, Louis	21-Jun-14	26-Jun-14
Leg 1b	Marec, Claudie	Research Associate	Takuvik	Babin, Marcel	24-Jul-14	14-Aug-14
Leg 1b	Massé, Guillaume	Scientist	Université Laval	Massé, Guillaume	24-Jul-14	14-Aug-14
Leg 2b	Matsuno, Kohei	Scientist	NIPR/Hokkaido Univ.	Kikuchi, Takashi	09-Sep-14	25-Sep-14
Sea trial	Ménard, Nadia	Professional	Parcs Canada	Ménard, Nadia	22-Jun-14	25-Jun-14
Leg 2a, Leg 2b	Meredyk, Shawn	Professional	ArcticNet	Levesque, Keith	14-Aug-14	25-Sep-14
Leg 2a, Leg 2b	Michaud, Luc	Professional	ArcticNet	Levesque, Keith	14-Aug-14	25-Sep-14
Leg 2b	Mizobata, Kohei	Research Assistant	TUMSAT	Kikuchi, Takashi	09-Sep-14	25-Sep-14
Leg 2a, Leg 2b	Mol, Jacoba	MSc Student	Dalhousie University	Papakyriakou, Tim	14-Aug-14	25-Sep-14
Leg 1a, Leg 2a, Leg 2b	Morisset, Simon	Professional	ArcticNet	Levesque, Keith	14-Aug-14	25-Sep-14
Leg 1a, Leg1b	Mungall, Emma	MSc Student	Netcare/ U of Toronto	Abbatt, Jon	08-Jul-14	14-Aug-14
Leg 1a	Murdock, Ian	Professional	CSSF	Levesque, Keith	08-Jul-14	17-Jul-14
Leg 1a	Murphy, Jennifer	Scientist	Netcare/University of Toronto	Abbatt, Jon	08-Jul-14	24-Jul-14
Leg 3	Murphy, Robert	Technician	GSC	Campbell, Calvin	25-Sep-14	12-Oct-14
Leg 1a, Leg1b	Nistad, Jean-Guy	Technician	University of Hamburg	Lajeunesse, Patrick	08-Jul-14	14-Aug-14
Leg 1b	Noel, Amy	MSc Student	University of Calgary	Stern, Gary / Hubert, Cas	24-Jul-14	14-Aug-14
Leg 1a	Nozais, Christian	Scientist	UQAR	Nozais, Christian	08-Jul-14	24-Jul-14
Leg 2b, Leg 3	Ogi, Masayo	Scientist	University of Manitoba	Barber, David	09-Sep-14	12-Oct-14
Leg 2b	Onodera, Jonaotaro	Scientist	JAMSTEC	Kikuchi, Takashi	09-Sep-14	25-Sep-14
Leg 1a	Papakyriakou, Tim	Scientist	University of Manitoba	Papakyriakou, Tim	08-Jul-14	24-Jul-14

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Leg	Name	Position	Affiliation	Network Investigator/ supervisor	Embark date	Disembark date
Leg 2b, Leg 3	Paquette, Laurence	MSc Student	UQAR	Archambault, Philippe	09-Sep-14	12-Oct-14
Leg 2a	Parenteau, Marie	Technician	UQAR-ISMER	Gosselin, Michel	14-Aug-14	09-Sep-14
Leg 2a	Patton, Eric	Technician	NRCan	Blasco, Steve	14-Aug-14	09-Sep-14
Leg 3	Pivot, Laurence	Media	L'Express	ArcticNet	25-Sep-14	06-Oct-14
Leg 2a	Poole, Justen	Student	Environment Canada	Jantunen, Liisa/Stern, Ga	14-Aug-14	09-Sep-14
Leg 3	Rapaport, Gilles	Media	L'Express	ArcticNet	25-Sep-14	06-Oct-14
Leg 1b	Rochon, André	Scientist	UQAR	Rochon, André	24-Jul-14	14-Aug-14
Leg 3	Sampson, Beth	Professional	Schools on Board	Watts, Michelle	25-Sep-14	06-Oct-14
Leg 2b	Schallenberg, Christina	PhD Student	University of Victoria	Cullen, Jay/Tremblay Jea	09-Sep-14	25-Sep-14
Leg 2a	Schiffrine, Nicolas	PhD Student	Universtié Laval	Tremblay, Jean-Éric	14-Aug-14	09-Sep-14
Leg 2a	Schmid, Moritz	PhD Student	Universtié Laval	Fortier, Louis	14-Aug-14	09-Sep-14
Leg 2b	Semeniuk, Ivan	Media	Globe and Mail	ArcticNet	09-Sep-14	25-Sep-14
Leg 2a	Shin, Cecilia	Technician	Environment Canada	Jantunen, Liisa/Stern, Ga	14-Aug-14	09-Sep-14
Leg 1b	Stark, Heather	Research Associate	University of Manitoba	Barber, David	24-Jul-14	14-Aug-14
Leg 3	Stel, Jaxon	Student	Schools on Board	Watts, Michelle	25-Sep-14	06-Oct-14
Leg 1a, Leg1b	Taalba, Abderrahmane	PhD Student	ISMER/UQAR	Xie, Huixiang	08-Jul-14	14-Aug-14
Sea trial	Thornhill, David	Professional	CHS	Schlagintweit, George	21-Jun-14	26-Jun-14
Leg 1a, Leg1b, Leg 2a	Thornhill, David	Professional	CHS	Schlagintweit, George	08-Jul-14	09-Sep-14
Leg 2a, Leg 2b	Tisné, Lou	Technician	ArcticNet	Levesque, Keith	14-Aug-14	25-Sep-14
Leg 1b	Tremblay, Jean-Éric	Scientist	Université Laval	Tremblay, Jean-Éric	24-Jul-14	14-Aug-14
Leg 2b	Uno, Hirokatsu	Technician	Marine Works Japan	Kikuchi, Takashi	09-Sep-14	25-Sep-14
Leg 3	Watts, Michelle	Professional	Schools on Board	Watts, Michelle	25-Sep-14	06-Oct-14
Leg 1b	Weckstrom, Kaarina	Scientist	Geological Survey, Denmark	Massé, Guillaume	24-Jul-14	14-Aug-14
Leg 1a, Leg1b	Wentworth, Greg	PhD Student	Netcare/ U of Toronto	Abbatt, Jon	08-Jul-14	14-Aug-14
Leg 1a	Wentzell, Jeremy	Research Associate	Netcare/ Env Canada	Abbatt, Jon	08-Jul-14	24-Jul-14
Leg 3	White, Jennifer	Student	Schools on Board	Watts, Michelle	25-Sep-14	06-Oct-14
Leg 3	Yang, Juliana	Student	Schools on Board	Watts, Michelle	25-Sep-14	06-Oct-14
Leg 3	Zhang, Nina	Student	Schools on Board	Watts, Michelle	25-Sep-14	06-Oct-14
Leg 2a	Zottenberg, Katelyn	Professional	ArcticNet/Golder	Lowings, Malcolm	14-Aug-14	09-Sep-14