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2008 | Expedition Report

CCGS *Amundsen*

LEG 11A
ArcticNet/SOLAS
Canadian Arctic Archipelago
and Baffin Bay

LEG 11B
ArcticNet/IORVL
Labrador fjords

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

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2008 Expedition Report

The 2008 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 Leg 11 of the ArcticNet Expedition onboard the CCGS *Amundsen*. The ArcticNet Nunavut Inuit Health Survey (Legs 2, 10b and 12) and the International Polar Year (IPY) Circumpolar Flaw Lead (CFL) Study (Legs 4 to 10a) were also carried out in 2007 and 2008 onboard the *Amundsen* but are not covered in this report. The 2008 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 Legs 11.

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 2008. 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 and surface ocean components first (Sections 1 and 2), followed by water column properties, which include the mooring program (Section 3), CTD-Rosette operations and physical properties (Sections 4 and 5), as well as a suite of chemical and biological parameters (Sections 6 to 13). Contaminants cycling in seawater and biota are treated in Section 14. The last sections cover seabed mapping (Section 15), ROV operations (Section 16) and finally sediments and benthos sampling (Section 17).

The 2008 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 the 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 2008 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.

In July of 2007, the CCGS *Amundsen* left its homeport of Quebec City for an historical 15-month expedition to the Canadian Arctic to support ArcticNet's marine-based research program (see Phase 1 projects at www.arcticnet.ulaval.ca/Research/Phase 1) and several projects funded by the Canadian International Polar Year (IPY) program. These included the Circumpolar Flaw Lead (CFL) study, a large Canadian-led international effort to understand the role of the CFL in a context of Arctic warming; the Canadian Arctic SOLAS (Surface Ocean-Lower Atmosphere Study) project that examined the variability and changes in

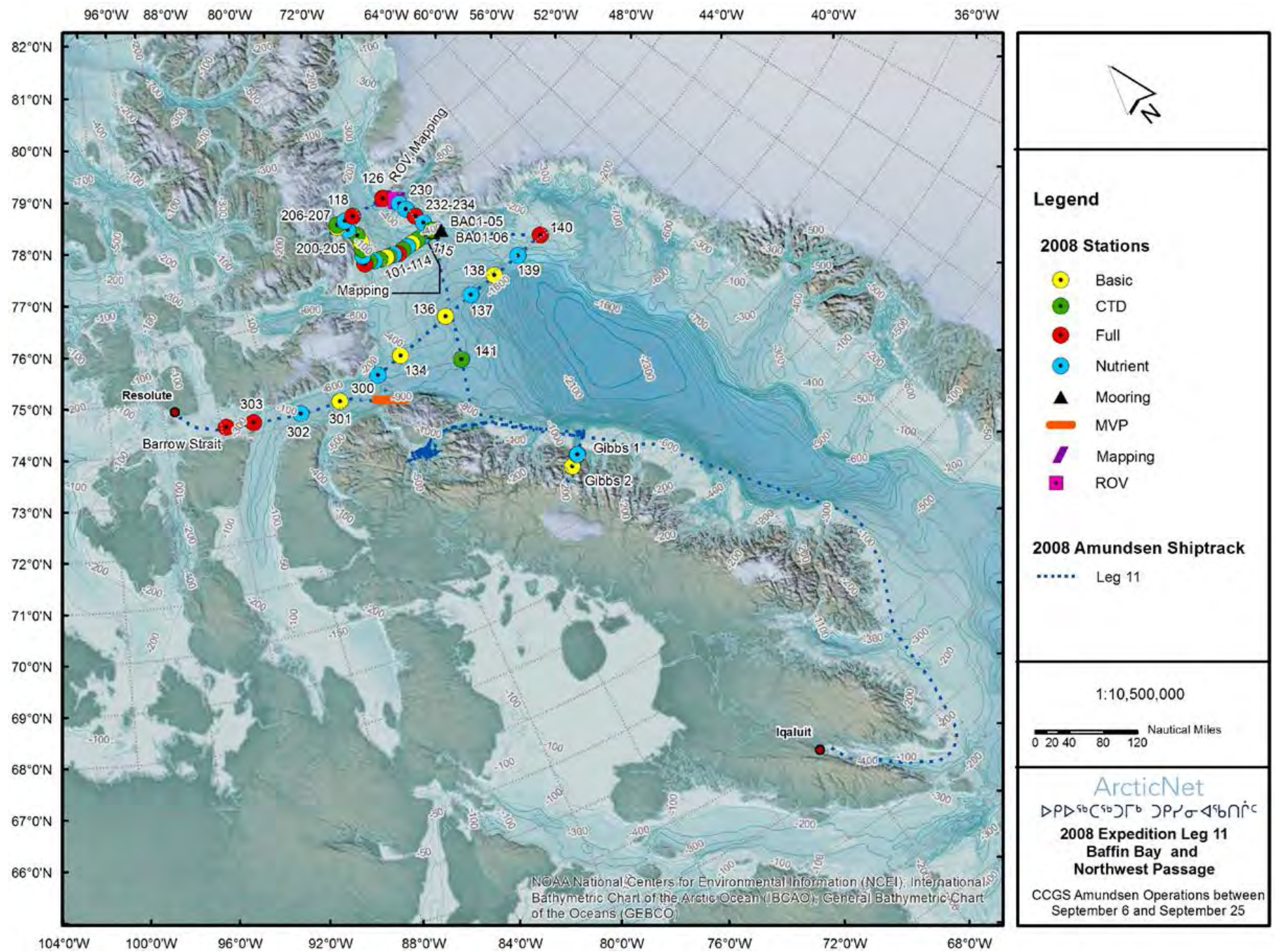

Figure 1.1. Map of Baffin Bay and Lancaster Sound showing the location of stations and the CCGS *Amundsen* cruise track during Leg 11 of the 2008 ArcticNet Expedition.

ocean-atmosphere interactions in response to climate warming in the Canadian Arctic; and the Inuit Health Survey where doctors, nurses, interpreters and scientists used the CCGS *Amundsen* to visit the coastal communities of Nunavut, Inuvialuit (NT) and Nunatsiavut (Labrador) to assess the overall health of Inuit residents, including lifestyle, diet, heart disease, bone density, safety habits, and exposure to environmental contaminants.

The main objective of the 2008 ArcticNet/*Amundsen* Expedition was to carry on with the seabed mapping of the Canadian Arctic particularly in Barrow Strait, Lancaster Sound, Baffin Bay and Davis Strait. ArcticNet's ultimate goal is to collect as much bathymetry and sub-bottom information as possible to identify marine geohazards to hydrocarbon development and improve navigational charting. In addition to work conducted at the mapping stations, shipboard sampling was carried out along the ship track and at designated sampling stations, including meteorological measurements, mooring recovery and the sampling of seawater, sediment, plankton and juvenile fish.

1.2 Regional settings

1.2.1 Canadian Arctic Archipelago (CAA)

The Canadian Arctic Archipelago (CAA) is a vast array of islands and channels that lies between Baffin and Ellesmere Islands in the east and Banks Island in the west. While transiting through the Northwest Passage, the science teams aboard the *Amundsen* extended their time series of atmosphere, ice and ocean data (Figure 1.1). This work 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. Seafloor 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.

1.2.2 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 small passages through the islands of the Canadian Arctic Archipelago (CAA). Arctic water also enters Baffin Bay/Davis Strait via the West Greenland Current, which flows northward along the western coast of Greenland. Melting ice sheets, changing sea ice conditions and changing weather also influence oceanographic conditions in Baffin Bay and Davis Strait.

Located in northern Baffin Bay, between Ellesmere Island and Greenland, the North Water (NOW) Polynya is a large, year-round expanse of open water. North Water is the largest and most productive polynya in the Canadian Arctic and in addition to the tremendous marine bird resources in this area, it is of significance to many species of marine mammals. The NOW Polynya has been the subject of intense ecosystem studies, including the Canadian-led study of the NOW Polynya in 1998. In Baffin Bay, the *Amundsen* served as a research platform to continue the time series of oceanographic measurements in the NOW Polynya and along transects sampled in 2006 across the Bay (Figure 1.1). Oceanographic moorings deployed during the 2006 Expedition were also serviced and redeployed to continue monitoring the meteorological and oceanographic parameters in this region.

1.3 2008 Expedition Plan

1.3.1 General schedule

The CCGS *Amundsen* left Quebec City on 26 July for a 15-month expedition in the Canadian Arctic to conduct a wide range of scientific activities in northern Labrador fjords, Hudson Bay, Baffin Bay, the Canadian Arctic Archipelago and the Beaufort Sea. The ship overwintered in the Beaufort Sea for the Circumpolar Flaw Lead (CFL) study and returned to Quebec City on 16 October 2008.

1.3.2 Leg 11 – ArcticNet/SOLAS - 4 September to 5 October 2008 – Lancaster Sound and Baffin Bay

The penultimate leg of the expedition was divvied up in two parts. On 4 September, the ship raised the anchor and left Resolute Bay to conduct a full suite of sampling operations across Barrow Strait and Lancaster Sound. The survey of an active gas vents area in Barrow Strait was also completed using the ROV. The ship then sailed along five transects in northern Baffin Bay to conduct bathymetric surveys and biophysical samplings, and to retrieve two North Water Polynya moorings. On its way to Iqaluit, the ship stopped by Gibbs Fjord to perform sampling operations and an oil seep survey at the entrance of Scott Inlet. The *Amundsen* finally reached Iqaluit on 28 September for a science personnel rotation. Mainly dedicated to the Nunatsiavut Nuluak project, Leg 11b kicked off on 28 September. However, a search and rescue operation near Bylot Island, combined to transit time, forced the cancellation of scientific operations. The ship reached Nain on 5 October to end the leg.

2 Leg 11a – 4 September to 28 September 2008 – Lancaster Sound and Baffin Bay

Chief Scientist: Martin Fortier[1] (martin.fortier@arcticnet.ulaval.ca)
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2.1 Introduction

Leg 11a staggered from 4 September to 28 September 2008, with operations conducted in Lancaster Sound and Baffin Bay as a part of the ArcticNet marine-based research program.

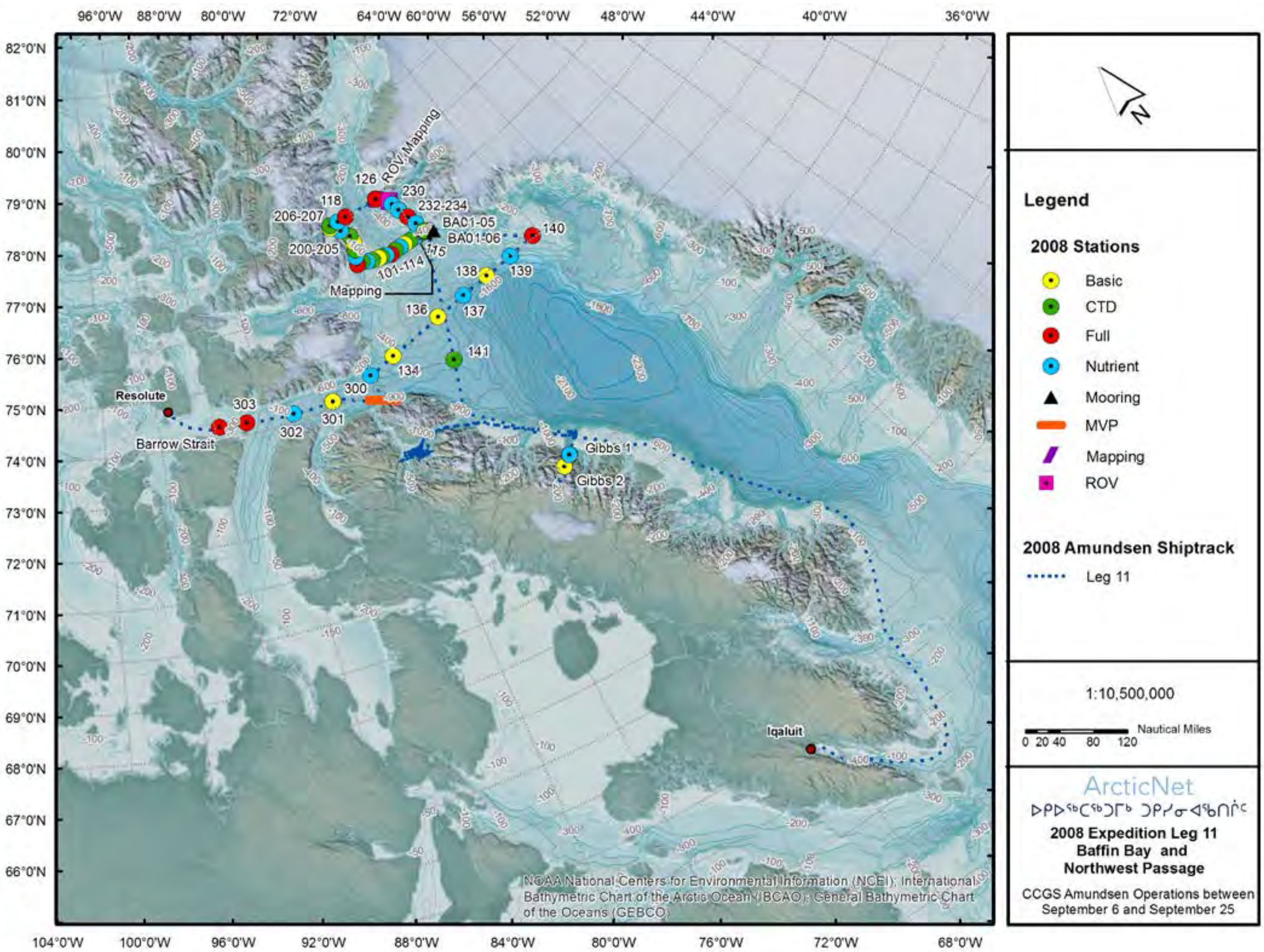

Figure 2.1. Cruise track and stations visited during Leg 11a of the 2008 Amundsen Expedition.

The overall objectives were to:

- Characterize the atmosphere and quantify gas fluxes at the sea-ice seawater-atmosphere interface along the cruise track;

- Conduct oceanographic sampling of the water column for physico-chemical properties and components of the marine food web at designated stations;
- Sample the sediments at designated stations located in Lancaster Sound and northern Baffin Bay;
- Conduct ROV dives in Barrow Strait for pockmarks survey as well as in northern Baffin Bay for mooring recovery and benthic surveys;
- Retrieve two moorings of the North Water Polynya in northern Baffin Bay (BA01-05 and BA01-06);
- Conduct MVP profiling across Lancaster Sound and along Gibbs Fjords (Baffin Island);
- Obtain bathymetry and sub-bottom information using the multibeam sonar system along the cruise track and conduct dedicated surveys in Barrow Strait, Smith Bay and Scott Inlet.

2.1.1 Arctic-SOLAS (Surface Ocean – Lower Atmosphere Study)

The domain of the surface ocean and lower atmosphere is a complex, highly dynamic component of the Earth system. Better understanding of the physics and biogeochemistry of the air–sea interface and the processes that control the exchange of mass and energy across that boundary define the scope of the Surface Ocean-Lower Atmosphere Study (SOLAS) project (see www.solas-int.org for more information).

SOLAS team members were onboard the *Amundsen* during Leg 11a to conduct atmospheric and oceanographic sampling as part of the Canadian International Polar Year (IPY) Arctic-SOLAS program. The project's goal is to study the ocean and atmosphere in concert along an eastern-western transect through the Canadian Arctic Archipelago. The specific objectives for Leg 11a were to:

- Quantify continuously atmospheric trace gases, aerosols and particles involved in atmospheric chemistry and climate, with a focus on the sulfur cycle.
- Quantify key trace gases in the upper water column at designated ArcticNet stations, with a focus on the biological production and cycling of climate active gases dimethyl sulfide (DMS) and nitrous oxide (N_2O).

2.2 Synopsis of operations

This section provides a general synopsis and timeline of operations during Leg 11a. 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 (4 September) to Iqaluit (25 September) and 52 stations were visited with an overall tally of operations and activities as follows:

- 9 CTD casts
- 72 CTD-Rosette casts
- 2 MVP transects

- 35 light and phytoplankton profiles, including Secchi disk, PhytoFlash and PNF.
- 3 VMP profiles
- 48 plankton tows and trawls, including horizontal and vertical net tows, Hydrobios and RMT
- 24 box cores sampling of the sediments
- 6 Agassiz trawls
- 4 dedicated bathymetry / sub-bottom mapping surveys
- 8 ROV dives
- One mooring recovery out of the two attempted

A detailed scientific log for all sampling operations conducted during Leg 11a giving the positions and depths of the visited stations is available in Appendices 1 and 2.

2.2.1 Timeline of operations

Leg 11a started with a full crew change in Resolute on 4 September. The ship then sailed through Barrow Strait to reach the first station on 6 September. A Full station was completed in an area where active gas vents have been located and time was dedicated to bathymetric survey. As to delineate and explore these pockmarks, the ROV was deployed twice, totting up more than 4 hours of survey.

The *Amundsen* continued east into Lancaster Sound to conduct sampling operations at designated stations along the way (Full 303, Nutrient 302 and Basic 301). At Stations 303 and 301, the SCAMP was deployed to obtain water column profiles. However, due to instrument issues, no profiles were recorded at Station 301. A 7.5-h MVP transect was also completed at the entrance of the Sound.

From 9 to 22 September, operations were carried out in northern Baffin Bay along 5 transects. Along the Arctic SOLAS transect, 7 stations were sampled between 9 and 11 September, including Nutrient, Basic and Full stations (300 to 140). At Basic Station 134 and Full Station 140, the SCAMP was deployed to record water column profiles. From 12 to 15 September, operations were completed along an eastern-western transect at 15 stations (115 to 101) divided up as follows: 3 Full, 6 CTD, 2 Basic and 4 Nutrient. At Station 115, the ROV was deployed for 5 hours to locate mooring release BA01-06, without success. Multibeam data was used to assist the ROV during survey.

Between 15 and 17 September, operations were conducted northward at 8 designated stations (201 to 207), inclusive of Nutrient, Basic and CTD stations, and time was specifically dedicated to the mapping of Smith Bay. The fourth transect consisted in 2 Full stations (118, 126), 2 bathymetric surveys totting up 10 hours, and one ROV test dive. The last transect in northern Baffin Bay was completed on 22 September. Operations included sampling at 5 biophysical stations (Nutrient, Full and CTD) and a 7-h bathymetric survey. Three ROV dives were also conducted to recover moorings BA01-05 and BA01-06, which could not be recovered during Leg 3a. An 8-h deployment was first completed to recover

BA01-05 sediment trap. A second dive, totting up 7h, was subsequently conducted to recover the associated mooring. Finally, a 5-h deployment was dedicated to the localisation of BA01-06 releases.

Once transects were completed, the ship headed south towards Iqaluit. A CTD cast was completed (141) along the way, and a Nutrient and a Basic station were sampled in Gibbs Fjord (Baffin Island) on 24 and 25 September. A 4-h MVP transect was completed At Basic station Gibbs-2. At the entrance of Scott Inlet, a 6.5-h bathymetric survey was completed in an area where seabed hydrocarbon seeps are known to occur. The ship then headed towards Iqaluit for a science personnel rotation on 28 September.

Leg 11b kicked off on 28 September. However, a search and rescue operation near Bylot Island, combined to transit time, forced the cancellation of scientific operations. The ship reached Nain on 5 October to end the leg.

2.3 Chief Scientist's comments

Overall, Leg 11a was a great success, with 52 stations completed during the 42-day expedition. Out of the two North Water Polynya moorings recovery initially planned, 1 was fully retrieved.

In addition to surveying tracks between science stations, time was also specifically dedicated to bathymetry and sub-bottom mapping surveys in areas of particular interest, including Barrow Strait, Smith Bay and Scott Inlet. The ROV was also deployed for more than 32 hours during the Leg.

The Chief Scientist and the science participants of Leg 11a express their gratitude to the Commanding Officer Lise Marchand and the officers and crew of the CCGS *Amundsen* for their unrelenting support and comprehension throughout the cruise.

Part II – Project reports

1 Atmospheric aerosols and trace gases (Arctic-SOLAS) – Leg 11

Project leaders: Richard Leaitch[1] (Richard.Leaitch@ec.gc.ca), Jonathan Abbatt[2] (jabbatt@chem.utoronto.ca) and Ann-Lise Norman[3] (alnorman@ucalgary.ca)
Cruise participants Leg 11: Steve Sjostedt[2], Alison Seguin[3] and Ofelia Rempillo[3]
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1.1 Introduction

The primary goal of this study was to follow the sulfur cycle in the atmosphere in collaboration with the other SOLAS groups on board who looked at ocean-atmosphere sulfur exchange. Gas-phase dimethyl sulfide, measured on board with the proton transfer mass spectrometer (PTR-MS), can be oxidized to form sulfur dioxide, also measured on board, which can be further oxidized to sulfuric acid and either nucleate to form new particles or condense onto existing particles. This was monitored using various aerosol size distribution instruments as well as a time-of-flight aerosol mass spectrometer (ToF-AMS). Secondary goals were to measure other trace gases and characterize the aerosol population in a polar marine environment.

1.2 Methodology

1.2.1 Sampling instruments

All of the instruments were located in a controlled temperature structure located behind the bridge of the CCGS *Amundsen*. Approximately 30 feet of ¾ in stainless steel line was run out to the mast ~10 feet above the bridge for aerosol sampling. A ¼ inch Teflon line was run parallel to the aerosol sampling line to measure the trace gases.

1.2.2 Trace gas measurements

An Ionicon PTR-MS was employed to measure multiple volatile organic carbon and sulfur compounds. Some of the species measured were acetaldehyde, acetone, acetic acid, benzene, dimethyl sulfide (DMS), methanol, methacrolein, methyl ethyl ketone, methyl vinyl ketone and toluene. Measurements were obtained continuously on 30-second intervals. Ozone (Thermo Environmental U.V. Photometric Analyzer Model 49) and sulfur dioxide

(Thermo Environmental Pulsed Fluorescence Analyzer Model 43 S) were also measured continuously from the mast sampling site. A Max DOAS, courtesy of Heidelberg, has been measuring BrO since the OASIS campaign as well.

1.2.3 Aerosol measurements

Size distributions of aerosols between 10-500 nm were obtained with a sizing mobility particle sizer (SMPS), total fine particles (> 3 nm) were measured with a condensation particle counter (CPC). All of these samples will be processed back at the University of Calgary for concentration (soluble cation and anion) and sulphur isotope analysis. This will allow for the source appointment of the sulphur compounds (i.e. sea salt, marine biogenic, anthropogenic {mostly from ship stack emissions}).

1.2.4 DMS measurements

Atmospheric DMS measurements were also made Leg 11. Samples were collected through a Tenax tube using a portable, battery-operated sampler equipped with mass flow controller. Samples were collected on the deck containing the hi-vols. Samples were collected every hour for 24 hours when the ship was transiting and then reduced to every one and a half or two hours during periods where the ship was at station or mapping. All atmospheric DMS samples were analysed on board using a gas chromatograph fitted with a sulphur chemiluminescence detector provided by the Meterological Service of Canada (S. Sharma).

DMS at sea surface was collected by Steve Sjostedt and Michael Scarratt's groups. These measurements will be used to compare atmospheric DMS to that found in the surface water. Correlation between DMS Rosettes and atmospheric sampling was also carried out. Unfortunately, only a few samples were collected due to instrument instability in the water and the diversion of the ship for a search and rescue effort.

1.2.5 Other measurements

CO_2 in the atmosphere was also measured using a LICOR CO_2 analyzer. The difference between CO_2 in the atmosphere and CO_2 in a cylinder of compressed air (yet to be calibrated to international standards) was used to determine the presence of ship stack emissions. At the beginning of Leg 11 however, the gas standard was found empty and thus exact CO_2 concentrations could not be determined. The LICOR was still put to use to give a qualitative representative of when ship stack emissions were influencing sampling.

A sample of ship fuel was taken during Leg 11. This will be analyzed back at the University of Calgary to determine the sulphur isotope of the fuel. This value will assist in determining source apportionment of both SO_2 and aerosol sulphate collected by the high volume sampler.

Relative humidity and temperature sensors were placed at the level 5, on the exterior of the ship, to obtain temperature measurements at two heights so that boundary layer heights could be calculated. Unfortunately, interference from the ship's radio and radar signals rendered these temperature measurements useless during Leg 3. Additional hardware was brought aboard during Leg 11 to counter this effect. Unfortunately, this did not solve the problem, and thus the desired readings were not obtained.

1.3 Preliminary Results

1.3.1 Trace gas measurements

Figure 1.1 and 1.2 represent a limited time series for selected trace gases monitored by the PTR-MS. The measurement period includes the Health Study (Leg 10b) and the "Arctic-SOLAS" transect (Leg 11).

In Figure 1.1, norm59 is representative of acetone. The signal has been normalized to the reagent ion and the background has been subtracted from the signal. Calibrations have also been performed with a gas standard and will be used to calculate mixing ratios upon returning to Toronto. The signal has also had a very limited number of outliers removed; this number will surely increase in later analysis. Norm63, which represents dimethyl sulfide, has undergone the same limited analysis as norm59, as has norm33, representing methanol, in Figure 1.2. Norm45 in Figure 1.2 corresponds to acetaldehyde. This signal has not had the backgrounds removed and should be considered an upper limit.

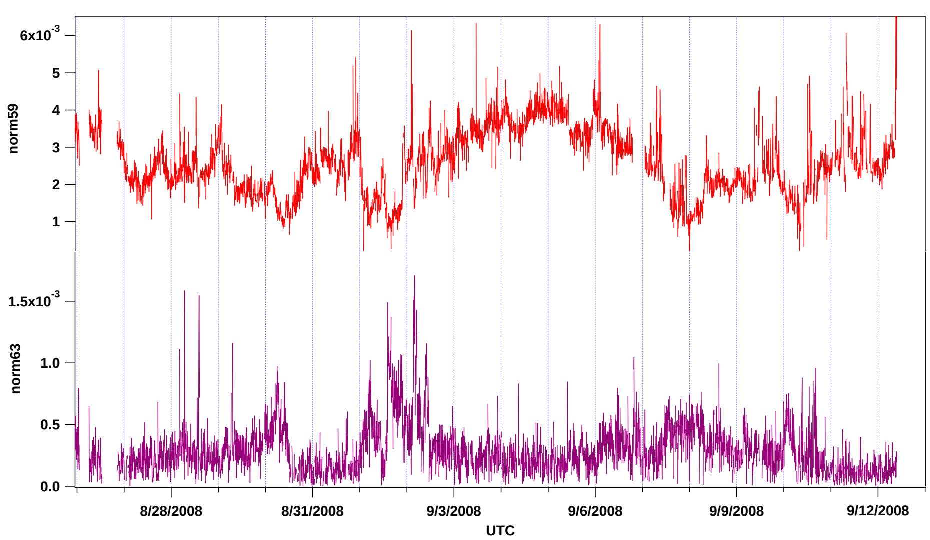

Figure 1.1. Time series of acetone and dimethyl sulphide (respectively upper and lower curves) during Legs 10b and 11.

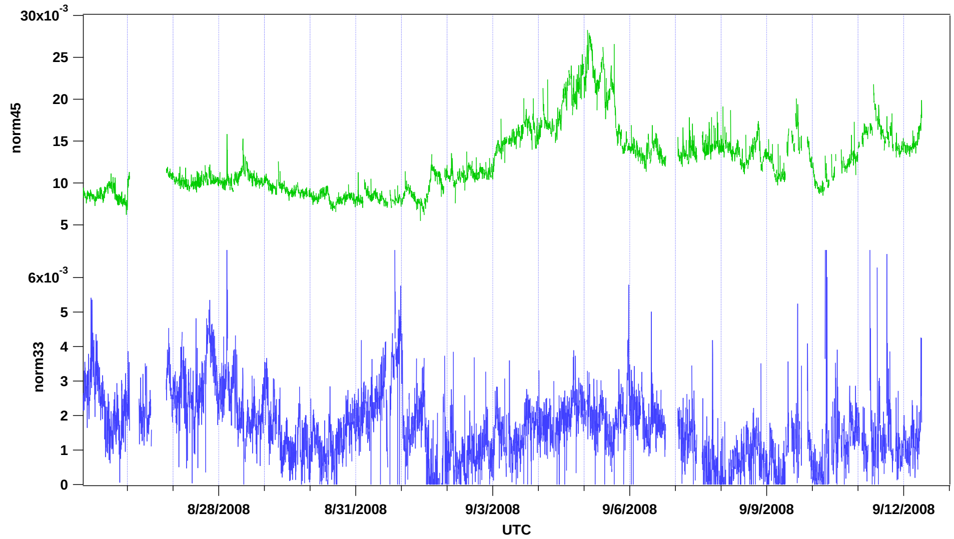

Figure 1.2. Time series for acetaldehyde and methanol (respectively upper and lower curves) during Legs 10b and 11.

1.3.2 Aerosol measurements

The data needs to be quality checked due to frequent fumigation of the inlet lines by smoke stack emissions. Chemical and stable isotope analysis of the aerosol samples will be performed in laboratories at the University of Calgary. Approximately 20 particulate filters and 20 SO_2 were collected for analysis during Leg 11.

The data collected during will require substantial post-processing. This is quite apparent in Figure 1.3. It should be noted that the upper limit that the of the CPC is set at 10^5 particles/cm^3, the actual concentration was probably much higher.

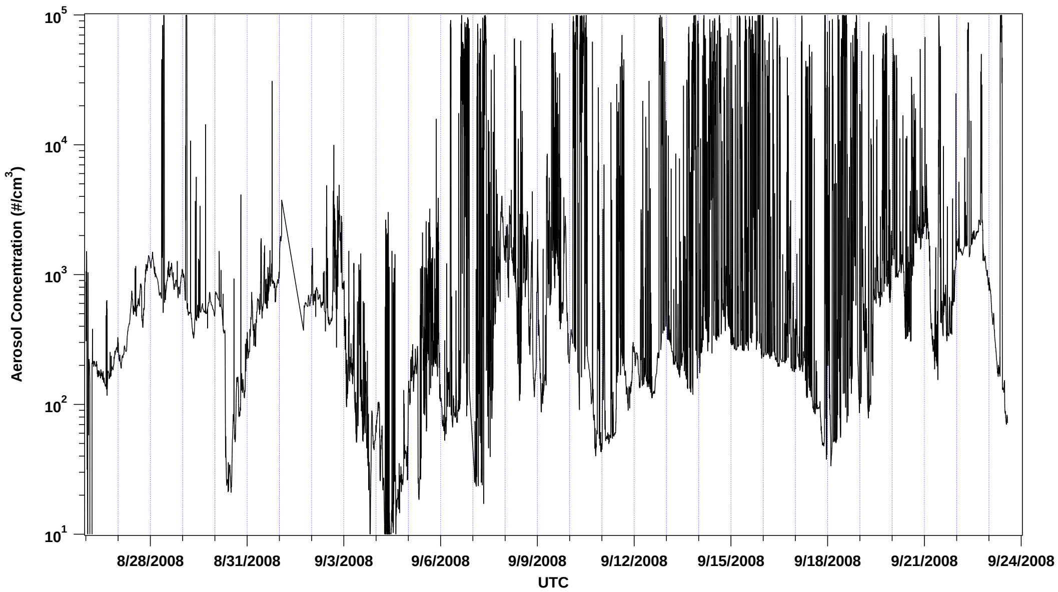

Figure 1.3. Aerosol concentrations obtained from the condensation particle counter (CPC 3025) during Leg 11.

1.3.3 DMS measurements

Atmospheric DMS that was run on the GC-LCD during Leg 11 showed higher concentrations than during Leg 3 (September-November 2007). Concentrations have yet to be calibrated, but in general when there were high wind and breaking waves, higher concentrations were usually seen. Also during the SOLAS track, a gradient from higher concentration in the west to lower concentration in the east was seen. Additional analysis must be completed to be able to report qualitative DMS concentrations, along with confident observation of trends. Over 300 samples have been collected during Leg 11.

1.4 Comments and recommendations

Smokestack pollution is a big concern for atmospheric measurements aboard a ship, as it occasionally causes a loss of data. As long as the winds were coming from a direction other than the stern, the smokestack pollution was not an issue. Having the bow into the wind would have been preferable for us, but even when the wind was coming from port or starboard the impact of the smokestack emission was negligible. Whenever possible, particular attention should be paid to ship's orientation in relation to wind origin during future expeditions.

2 Surface meteorology and flux program – Leg 11

ArcticNet Phase I – Project 3.1: Ocean-Ice-Atmosphere Coupling and Climate Variability. http://www.arcticnet.ulaval.ca/pdf/phase1/31.pdf.

Project leader: Tim Papakyriakou[1] (papakyri@cc.umanitoba.ca)
Cruise participant Leg 11: Brent Else[1]
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2.1 Introduction

The surface meteorology and flux program is designed to record basic meteorological conditions and to study exchanges of momentum, heat and CO_2 across the atmosphere-sea ice-ocean interface. To augment these atmospheric measurements, measurements of sea surface pCO_2 are also made.

2.2 Methodology

2.2.1 Eddy correlation flux system and surface meteorology

The micrometeorological tower located on the front deck of the *Amundsen* (Figure 2.1) provided continuous monitoring of meteorological variables and eddy covariance parameters. The tower consists of slow response sensors that record bulk meteorological conditions (air temperature, humidity, wind speed/direction, surface temperature) and fast response sensors that record the eddy covariance parameters (CO_2/H_2O concentration, 3D wind velocity, 3D ship motion, air temperature) (Table 2.1). In addition, radiation sensors were installed on the roof of the wheelhouse to provide information on incoming longwave, shortwave, photosynethetically active and ultra-violet radiation. All data was logged to Campbell Scientific dataloggers; a model CR5000 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.

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

In order to make sure that the two systems are comparable, careful calibrations were performed on both instruments. The closed path system is based on a LI-7000 gas analyzer, which employs 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).

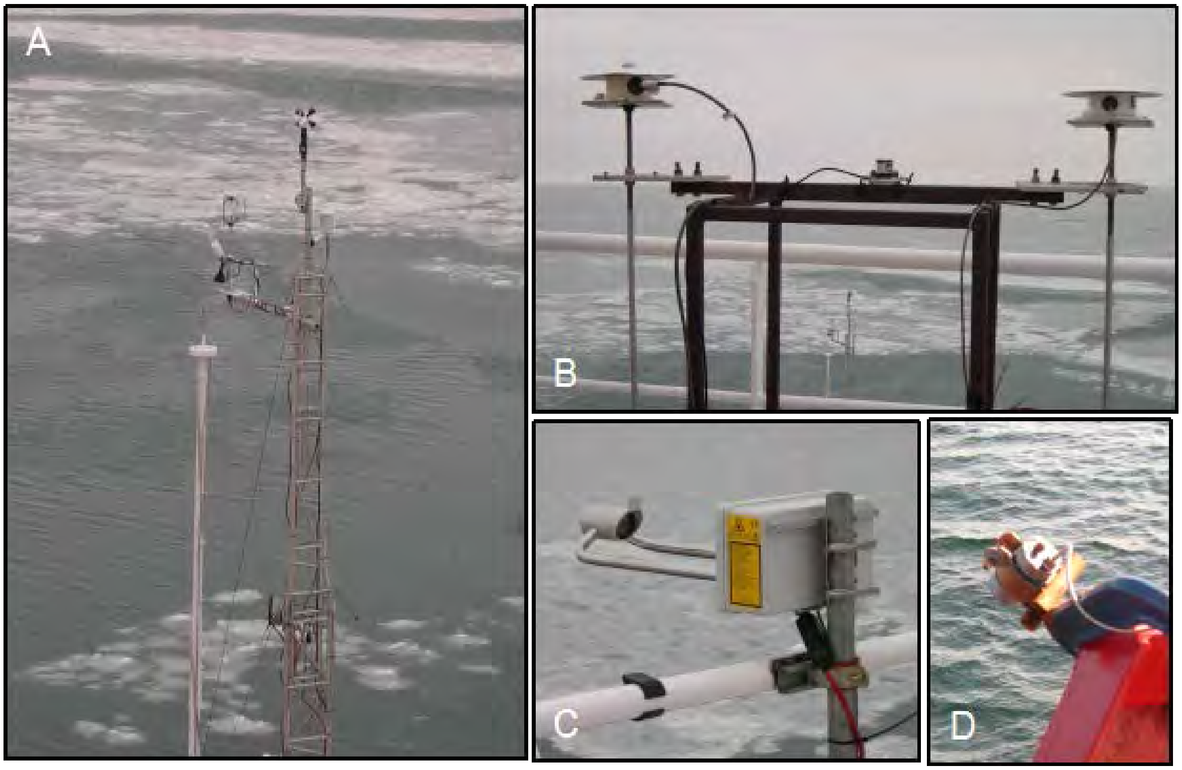

Figure 2.1. Eddy correlation flux and surface meteorology system. a) flux tower on foredeck; b) radiometers on top of wheelhouse; c) laser precipitation monitor on top of wheelhouse; d) infrared temperature transducer on foredeck rail.

Table 2.1. Sensors and associated specifications (manufacturers listed below).

Sensor	Variable	Unit	Height (m)[a]	Scan (s)/ Avg (min)	Specs / Accuracy
Wind monitor (RM Young 05103MA)	Horizontal wind speed and direction (ws and wd[b])	m/s; º	8.45	2 sec/ 1 min	±0.6 m/s ±3º deg
Temperature/relative humidity probe (Vasailla HMP45C212)	Temperature and relative humidity (T and RH)	ºC %	7.53(Leg 1)	2 sec/ 1 min	Humidity ±2% 0-90% @ 20ºC ±3% 90-100% @ 20ºC 0.05% RH/ºC Temperature ± 0.1 ºC
Pyranometer (Eppley, model PSP)	Incoming shortwave radiation (SW_in)	W/m^2	7.0	2 sec/ 1 min	~±5%
Pyrgeometer (Eppley, model PIR)	Incoming longwave radiation (LW_in)	W/m^2	7.0	2 sec/ 1 min	~±10%
PAR/Quantum sensor (LI-190)	Photosynthetic Active Radiation PAR	$\mu mol/m^2$	7.6	2 sec/ 1 min	~±5%
Pressure transducer (RM Young 61205V)	Patm	kPa		2 sec/ 1 min	
Temperature transducer (Everest infrared transducer, model 4000.44	Surface temperature (T_{srfc})	ºC	1.6 m	3 sec/ 1 min	±0.5 ºC accuracy

Sensor	Variable	Unit	Height (m)[a]	Scan (s)/ Avg (min)	Specs / Accuracy
ZL)					
Multi-axis inertial sensor (MotionPak, Systron Donner)	3D acceleration and angular rate (x,y,z) of tower	º/s g	6.48	10 Hz	rate <0.004º/s acc <10 μg
Gas Analyzer (LI-COR LI-7500)	CO_2 concentration (ρCO_2)	μmol/ m³	7.1	10 Hz	RMS noise ±0.1 μmol/mol zero drift 0.1 μmol/mol/ºC gain drift 0.1%/ºC
	H_2O concentration (ρO_2)	mmol/ m³	7.1	10 Hz	RMS noise ±0.14 mmol/mol zero drift 0.3 %/ºC gain drift 0.15%/ºC
Gas Analyzer (LI-COR LI-7000)	CO_2 concentration (ρCO_2)	μmol/ m³	7.1	10 Hz	RMS noise ±0.1 μmol/mol zero drift 0.3 μmol/mol/ºC gain drift 0.2%/ºC
	H_2O concentration (ρO_2)	mmol/ m³	7.1	10 Hz	RMS noise ±0.14 mmol/mol zero drift 0.02 mmol/mol/ºC gain drift 0.4%/ºC
Wind fluctuations (Gill R3 ultra-sonic anemometer)	3-dimensional wind vector (u,v,w) speed of sound (SOS)	m/s	7.1	10 Hz	RMS noise <1% offset <0.01 m/s SOS < 0.5% accuracy
UV Radiometer (Kipp & Zonen, UV-S-AB-T)	UVA, UVB	W/m2	1.5	2/1	~±5%

[a] From deck; [b] Measured winds are apparent, relative to the ship's speed and course over ground.
LI-COR Instruments, Lincoln NE; The Eppley Laboratories, Newport, RI; Systron Donner Intertial Division; Concord, CA; Everest Inrterscience, Inc, Fullerton, CA; Campbell Scientific Canada Ltd, Edmonton, AB; Gill Instruments, Ltd., UK; Vaisala, Inc., Woburn, MA; RM Young Company, Traverse City, MI; Kipp & Zonen, Delft, The Netherlands.

The meteorological tower ran consistently for the duration of the leg, with the exception of brief periods when the tower was taken down for maintenance. However, for some periods of time during the leg certain sensors were inoperable due to atmospheric conditions. The most common problem encountered during this leg was poor wind directions. The extent of data lost due to atmospheric conditions cannot be estimated at this time, and will only be known once post processing is complete.

2.2.2 On-track pCO₂ System

A custom-built *p*CO_2 system was utilized on this leg to measure dissolved CO_2 at the sea surface in near real time. The system (Figure 2.2) was located in the engine room of the *Amundsen*, and drew sample water from the ship's clean water intake. The water passed into a sealed container through a showerhead, 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 a LI-7000 gas analyzer in a closed loop. Thermocouples were used to measure water temperature in the equilibration chamber, and to measure the temperature of the air in the chamber. All data was logged to a Campbell Scientific CR1000 datalogger.

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 desiccant column removes H_2O from the air stream before passing into the sample cell. As with the closed path system, a stream of N_2 is constantly cycled through the reference cell of the LI-7000 to monitor and correct for drift of the instrument.

Figure 2.2. The on-track pCO_2 system located in the engine room of the *Amundsen*. The equilibration chamber is the clear cylinder (left bottom) and the gas analyzer is the box with the digital display.

The *p*CO_2 system ran for the duration of the leg, with only minor interruptions for servicing.

3 Mooring program – Legs 10a and 11

ArcticNet Phase I – Theme 1: Climate Change Impacts in the Canadian High Arctic: a Comparative Study Along the East-West Gradient in Physical and Societal Conditions. http://www.arcticnet.ulaval.ca/pdf/phase1/11.pdf.

Project leader: Yves Gratton[1] (yves_gratton@ete.inrs.ca)
Cruise participants Leg 10a and 11: Luc Michaud[2], Pascal Massot[2], Steve Gagné[2], Sylvain Blondeau[2], Alexandre Forest[2] and Louis Létourneau[2]
Cruise participants (R/V *Knorr*): Jim Ryder[3], Fiammetta Straneo[3], D. Sutherland[3]
[1] *Institut national de la recherche scientifique (INRS) – Eau, terre et environnement (ETE), 490, de la Couronne, Québec, QC, G1K 9A9, Canada.*
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3.1 Introduction

This is the fifth year (2008) of ArcticNet, which 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 in the coastal Canadian Arctic. The ArcticNet program was created in 2004 to assess the effects of ongoing warming and modernization on Canadian Arctic ecosystems, economies and societies. An important part of the ArcticNet program includes the monitoring and study of biological, chemical and physical components of the coastal Canadian Arctic seas.

The Northern Open Water (NOW) is a polynya (area of year-round open water surrounded by sea ice) that lies between Greenland and Canada in northern Baffin Bay. The world's largest Arctic polynya at about 85,000 square kilometres, it creates a warm microclimate that provides a refuge for narwhal, beluga, walrus, and bowhead whales to feed and rest. While thin ice forms in some areas, the polynya is kept open by wind, tides and an ice bridge on its northern edge. Named the "North Water" by 19th century whalers who relied on it for spring passage, this polynya is one of the most biologically productive marine areas in the Arctic Ocean. The Canadian Arctic Archipelago is especially under-sampled. The NOW mooring deployments allowed to build a long-term time series of temperature and salinity contours along 75°N. This will additionally enable the monitoring of freshwater fluxes through Smith Sound.

3.1.1 ArcticNet Moored Marine Observatory Program

ArcticNet's 2008 mooring operations were carried out during Legs 10a (within CFL program in July) and 11. The primary objective of the Beaufort Sea moorings deployed in 2008 was generally towards an improved understanding of the character and causes of variability and change in the Canada Basin. The secondary objective was to improve understanding of the influence of topography on the exchange of waters between the continental shelf and the ocean basin. Beaufort Sea moorings carried sediment traps to measure the carbon flux and associated oceanographic conditions along with ADCP and CTD sensors to investigate the fluid dynamics in relation to detrital transport. Specific objectives of the program were to:

- Recover the seven 2007 ArcticNet moorings (CA04, 5,5-MMP,8, 16,16-MMP, 18) that were deployed in the Beaufort Sea;
- Re-deploy six of these Beaufort Sea moorings (CA04, 05, 05-MMP, 16, 16-MMP, 18);
- Recover the remaining (BA01, 03) North Water Polynya (NOW) moorings in northern Baffin Bay.

3.1.2 WHOI and Canadian Merica-Nord program

UQAR-ArcticNet worked with Woods Hole Oceanographic Institute (WHOI) to deploy a four mooring arrays across the Hudson Strait from onboard the R/V *Knorr* (12th – 29th August 2008). The goal of this project was to observe and quantify the water exchange across the Hudson Strait and, in particular, the inflow of the Arctic freshwater along the northern side of the strait. This is an important question not only because exchanges through the strait have an impact on the both Hudson Bay and the Labrador Sea, but also in the light of the dramatic changes occurring all over the Arctic region. This project followed a three-year project, carried out in collaboration with Canadian colleagues as part of the Canadian MERICA-Nord program, to observe the current flowing out of Hudson Strait along its northern boundary.

The primary objective of the Hudson Strait MERICA-Nod moorings was to measure temperature, salinity, and velocity at a number of depths, as well as sea ice thickness and velocity. Three moorings were deployed in the northern part of the section – so as to cover the inflow, currently under-observed. One single mooring was deployed across the outflow since, based on observations made during the previous 3-year project; the structure of this outflow is known and can be reconstructed from a single mooring. There was no intention of recovering the 2007 Hudson Bay moorings in 2008; this was slated for 2009.

3.1.3 NABOS program

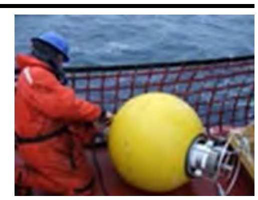
In addition to the Beaufort Sea and Hudson Strait moorings were six mooring recovery attempts from the Laptev and East-Siberian Seas, with the Nansen Amundsen Basin Observations System (NABOS) program. The main goal of the NABOS project is to provide a quantitative assessment of circulation and water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

3.2 Methodology

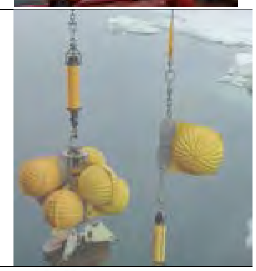
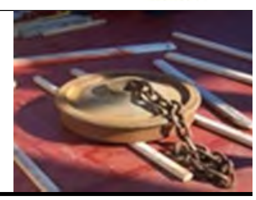
3.2.1 Mooring design and instrumentation

A list of oceanographic mooring equipment deployed on the ArcticNet moorings can be found in Table 3.1.

Table 3.1. Description of oceanographic equipment on moorings.

Instrument	Description	Image
Ice Profiling Sonar (IPS)	The ASL Environmental Sciences IPS (model 4/5) was used to measure size and thickness of ice keels and ice velocities. Deployment depth 50-60m with synthetic buoy.	
SBE37 Conductivity Temperature and Depth (CTD) Data Logger	RBRduo/concerto data loggers were used to record conductivity, temperature and depth information. *picture from Seabird website : http://www.seabird.com/sites/default/files/product_images/37sitakeapartlowres.JPG	
Nortek Aquadopp® Acoustic Doppler Current Profiler (ADCP)	Nortek Aquadopp® current profilers were used to measure the surrounding water current velocity in a single volume and were deployed at various depths, accompanied by an RBRduo/concerto (multi-channel/sensor) CTD data logger. *Picture from Nortek online datasheet (http://www.nortek-as.com/lib/brochures/Aquadopp%2006%20b.pdf)	
RBRduo/concerto Conductivity Temperature and Depth (CTD) Data Logger	RBRduo/concerto data loggers were used to record conductivity, temperature and depth information, which was then used to compute the speed of sound for a specific position (required for IPS data processing). These multi-channel data loggers contained additional turbidity (Tu) and dissolved oxygen (DO) sensors. *picture from RBR online datasheet (http://www.rbr-global.com/images/stories/datasheets/ct-and-ctd-loggers.pdf)	

Instrument	Description	Image
AURAL-M2 Sound Recorder	The AURAL-M2 (Autonomous Underwater Recorder for Acoustic Listening-Model 2) is a continuous underwater sound recording device with one year data storage. Deployment Depth 60-70m. *picture from Multi-Electronique website (http://www.multi-electronique.com/pages/auralm2en.htm)	
Satlantic *In situ* ulrtaviolet spectrophotometric (ISUS) V2/3 Nitrate Sensor	ISUS was deployed to collect an annual time-series of high-resolution (0.5 – 2000 µM) nitrate concentration data. Deployment Depths 60m and 80m. *picture from Satlantic Website (http://satlantic.com/sites/default/files/images/satlantic-isus.jpg)	
Nortek Continental® 470 kHz Current Profiler	Nortek Continental® current profilers were used to measure the water current velocity towards the surface with an increased range (100m) with a 1m resolution and were accompanied by an RBRduo/concerto (multi-channel/sensor) CTD data logger. Deployment Depth 90m	
Marine Subsea Float	13" Vinyl Floats were attached to the JFE_ALEC Infinity-CLW	
JFE_ALEC Infinity-CLW ACLW2-USB	The Infinity-CLW is an autonomously deployable data logger for long-term chlorophyll and turbidity measurements. *picture from JFE_ALEC website (http://www.jfe-advantech.co.jp/eng/ocean/infinity/img/infinity-clw.jpg)	
JFE_ALEC Compact-LW ALW-CMP	The COMPACT-LW is an autonomous deployable data logger for PAR (Photosynthetic Available Radiation: 400 to 700nm) measurements. *picture from JFE_ALEC website (http://www.jfe-advantech.co.jp/eng/ocean/compact/img/compact-lw.jpg)	
Technicap Sediment Trap PPS 3/3-24s	Model PPS 3/3-24s is a cylindro-conical trap which was used to sequentially collect 24 sediment samples to record the annual cycle in vertical carbon flux. Deployment Depths 100m and 200m. *pictures from VENUS project website (http://venus.uvic.ca/discover-venus/what-is-venus/instruments/technicap-sediment-trap-pps-43-24s/)	
SeaBird SBE26plus	The SBE26plus was used to record the wave and tide cycles, temperature and conductivity for this mooring location. The SBE26plus was deployed	

Instrument	Description	Image
Wave and Tide Recorder	with the Benthos acoustic release device. Deployment Depth 200m. *picture from Seabird website (http://www.seabird.com/products/spec_sheets/26plusdata.htm)	
Benthos 17" Floats	204-SRM-17 Super ribbed mooring flange hard hat housing and 17" glass spheres were used as flotation along the mooring line.	
EdgeTech / ORE Offshore 30" Float	EdgeTech/ORE Offshore 30" Float was installed along the mooring line to increase floatation *picture from EdgeTech website (http://www.edgetech.com/)	
Teledyne - Benthos Acoustic Release Device	Tandem (875-A-TR) Teledyne-Benthos model 866-A transponding acoustic releases were used as the primary recovery device. *picture from Benthos Website (http://www.benthos.com/userfiles/Acoustic%20Releases/866_A.jpg)	
Train Wheels	Two or four (large mooring payload) 800 lbs steel train wheels were used as mooring weights.	

The ArcticNet moorings were generally designed to be of taut-line configuration consisting of (Figure 3.1):

- Top float with ice profiler (IPS);
- JFE-ALEC CT or SBE37 - Conductivity, Temperature and Depth (CTD) probe to record water characteristics;
- Hydrophone – bioacoustics (AURAL);
- RCM 11/ RBR with Aquadopp or AquaPro - Conductivity, Temperature and Depth (CTD) probe with single-point current meter;
- ISUS V3 Nitrate sensor – nitrate sensor;
- Sediment trap (Technicap 24cups – bi-weekly sampling rate) to trap descending sediment for particle flux analysis and accumulation rates;
- RDI or Nortek Continental current profilers;

- In-line floatation (30” ORE float, 17” BENTHOS floats) to balance the weight/ float balance throughout the mooring line;
- Sediment trap (Technicap 24 cups – bi-weekly sampling rate) to trap descending sediment for particle flux analysis and accumulation rates, (deeper water moorings);
- RCM 11 / Aquadopp or AquaPro with RBR - Conductivity, Temperature and Depth (CTD) probe with single-point current meter;
- In-line floatation (17” BENTHOS floats) to balance the weight/ float balance throughout the mooring line;
- Tandem mooring releases (Oceano 861AR and BENTHOS 865A);
- An anchor (one to four train wheels).

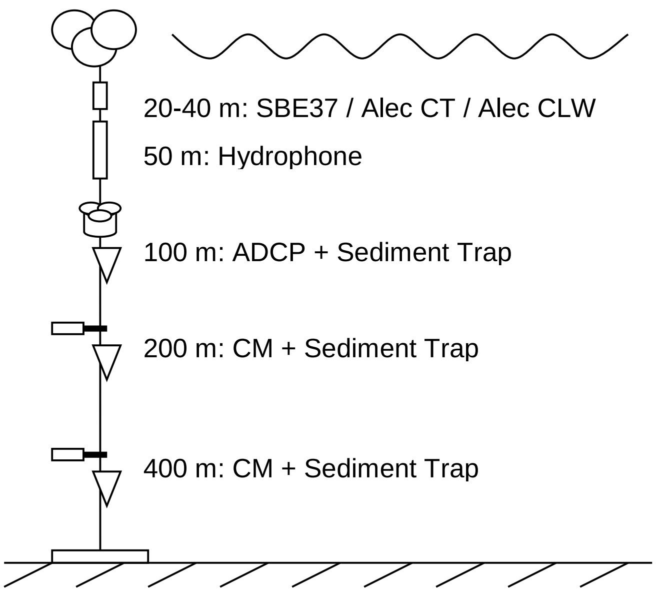


Figure 3.1. Illustration of a typical mooring line. The first instrument deployed close to the surface is a conductivity-temperature probe. Different models from RBR, Sea-Bird, Alec or Nortek companies were used. Sediment traps were always attached 5 to 10 meters below a current meter. Acoustic Doppler Current Profilers (ADCPs) were deployed at 100 meters so they could provide current data from 100 meters and upwards and simpler Current Meters (CMs) were used at 200 m and 400 meters.

3.2.2 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.

Compass calibration information is not available for ancillary expeditions (MERICA and NABOS). Please contact MERICA (Yves Gratton) and NABOS (Sylvain Blondeau – Québec Ocean) for more information concerning these expeditions.

Beaufort Sea

All mooring instruments deployed in the Beaufort Sea in 2008 were calibrated by their respective companies prior to the expeditions.

All of the instruments needed for the Beaufort Sea mooring sites were calibrated close to the respective deployment sites and were reported as having been properly calibrated (INRS – TechReport 2008-2009; Boivert et al. 2010).

The current meter compasses (Aquadopp, Continental (CNL), WorkHorse – Sentinel (WHS) and RCM11) were calibrated in Sachs Harbor on 27July 2008 by the ArcticNet technical staff (Table 3.2, Figure 3.2).

Table 3.2. 2008 Beaufort Sea (BS) compass calibrations for the 2008 ArcticNet mooring deployments.

Instrument	SN	Region	Pre-Calibration site	Pre-calibration date	Pre-calibration status
AQD	2703	BS	Sachs Harbour, NT	2008	good
AQD	2745	BS	Sachs Harbour, NT	2008	good
AQD	2772	BS	Sachs Harbour, NT	2008	good
CNL	6084	BS	Sachs Harbour, NT	2008	good
RCM11	272	BS	Sachs Harbour, NT	2008	good
WHS	6079	BS	Sachs Harbour, NT	2008	good
CNL	6087	BS	Sachs Harbour, NT	2008	good
AQD	2758	BS	Sachs Harbour, NT	2008	good
AQD	2780	BS	Sachs Harbour, NT	2008	good
CNL	6077	BS	Sachs Harbour, NT	2008	good
AQD	2712	BS	Sachs Harbour, NT	2008	good
AQD	2763	BS	Sachs Harbour, NT	2008	good
AQD	2756	BS	Sachs Harbour, NT	2008	good

Figure 3.2. 2008 ArcticNet Beaufort Sea mooring equipment compass calibration site.

3.2.3 ADCP compass calibration procedure

The 2008 calibration procedure was not previously recorded but the author believes that the procedure would have followed the steps below.

The ADCP calibrations were conducted with a tilt and rotate jig using a tripod with a spinning top fixture, where the ADCP was installed. A Garmin hand-held GPS unit was used to establish a distinct true North sight line from the tripod to a landmark, and the successive instrument direction readings are obtained by rotating the unit relative to this true North direction, in 10 / 15 degree increments. The calibration procedures followed standard manufacturer protocols for each instrument.

At the calibration site, the ADCP was set on the tripod. The heads (beams) on the ADCP are numbered 1= East, 2= West, 3= North, 4= South. Each ADCP was aligned on the tripod so the notch at beam-3 (north) points at the landmark located by GPS to be true North from the tripod. The communication cable hangs down from the bottom connector on the side opposite that.

The RDI utility program “BBtalk” is run on the laptop-PC connected to a diesel generator: pressing ‘Enter’ wakes up the instrument. Enter command ‘AX’ to check the internal compass table with the instrument vertical, and then lean the instrument 10º to 20º from the vertical axis (wooden wedges were propped under one side). Enter command ‘AF’, and then rotate the unit around the vertical axis while tilted. Press ‘F3’ on the PC to record entries to a file named ‘WH-####-cal.txt’ where #### is the unit’s serial number. Repeat the rotation with different tilt angle as prompted by the program. Now rotate the turntable back to 0º (notch points to true north) and enter ‘PC2’ to display the data stream to screen. When the displayed heading value is stable (after about 5-10 seconds), press ‘Enter’ and rotate the unit 10º to the next mark on the turntable. Enter ‘PC2’, wait for stable heading and press ‘Enter’ again. Repeat at successive marks around the turntable until last measurement at 360º is back at 0º (=360º). Press ‘F3’ to stop logging to the file.

3.2.4 CTD sensor calibration

Calibration of the CTD sensors used in the Beaufort Sea (RCM 11; Seabird37; RBR XR420 and JFE-ALEC CTs) was either done at the factory (2006, 2007) or at the University Laval (2007, 2008).

The temperature calibration performed by the Alec Company in 2007 was done for a temperature range of + 3ºC to + 31ºC. Considering that the water temperature in the Arctic Ocean is generally below 0ºC, this calibration was inappropriate. Therefore, the data recorded by the Alec CLW, deployed in 2007 and 2008, must be handled with care.

3.2.5 Aanderaa RCM (Recording Current Meter) calibration

The CTD sensor testing / calibration procedure was never documented by the 2005 mooring teams; however, the author believes they would have followed a procedure similar to the one written below (IOS 2003 calibration procedural notes).

The water-current simulation Test Unit (Aanderaa A-3731) was placed over the Doppler current sensors (type DCS-3900), with transducer surfaces moistened for best acoustic contact. Deck Unit Aanderaa A-3127 was connected to the port on top of the RCM11 and to the laptop-PC, and the Hyperterm terminal program was used to look at (and during actual compass calibrations, to capture to file) the ascii output from it. The Test Unit was rotated 90 degrees to verify that the acoustic sensors functioned properly and changed the simulated "direction" by about that amount. The instrument was inclined to check the built-in tilt sensor.

3.2.6 Mooring operations – Beaufort Sea

Mooring operations were performed at all times, day and night, many times in rough weather, and surrounded by ice.

<u>Mooring recovery</u>

Expedition year 2008 was a good year for mooring recoveries in the Beaufort Sea. During the 2008 ArcticNet mission (sometime referred to as 0805) onboard the *Amundsen,* six moorings were deployed (including 2 MMP moorings) and six out of seven moorings were recovered in the southern Beaufort Sea (Figure 3.3), including two McLane Mooring Profilers (MMP) (Figure 3.4). Mooring CA18-07 was not recovered in 2008; however, it was re-deployed in 2008. There was no recount of mooring operations (field report) for the Beaufort Sea in 2008 and the information on why mooring CA18-07 was not able to be recovered is unknown.

The MMP is a moving profiler sliding up and down along the mooring line and recording temperature, salinity, pressure and fluorescence data. These two moorings were deployed next to moorings CA05 and CA16 and were named accordingly CA05MMP and CA16MMP. This was the second year (2008) for the Beaufort Sea MMP moorings and they were paired with other moorings that contained a full suite of oceanographic equipment (sediment traps, current meters, CTDs), this way the CTD data on the MMP moorings could be verified with the adjoining mooring and increase the resolution of the water column data.

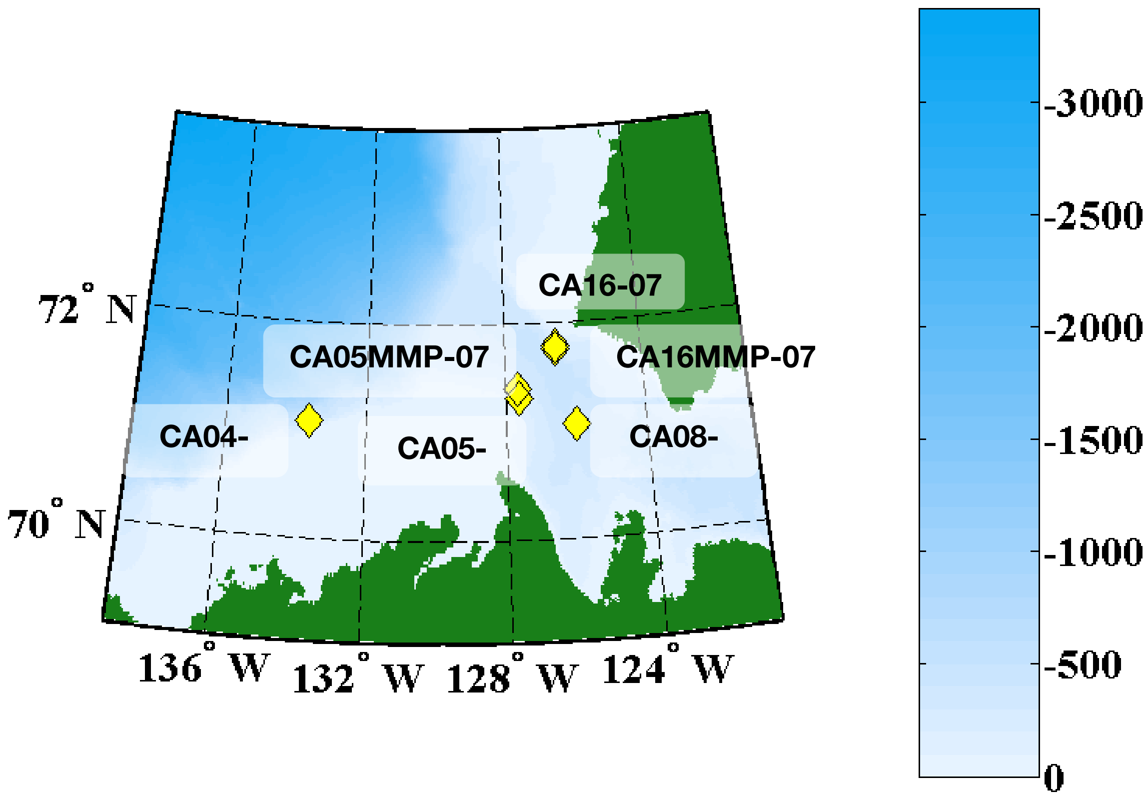


Figure 3.3. 2008 ArcticNet mooring recovery operations in the Beaufort Sea.

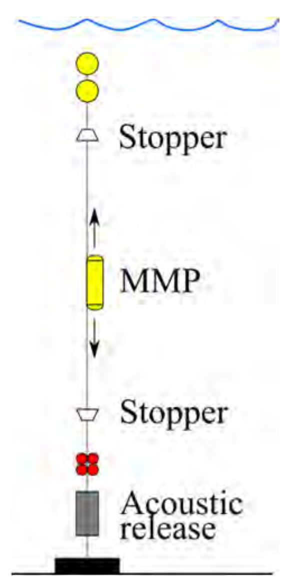


Figure 3.4. General 2008 MMP ArcticNet mooring setup / orientation.

Mooring deployment

Six moorings were deployed in the Beaufort Sea in 2008 (CA04, CA05, CA05-MMP, CA16, CA16-MMP, CA18)(Figure 3.5, Table 3.3).

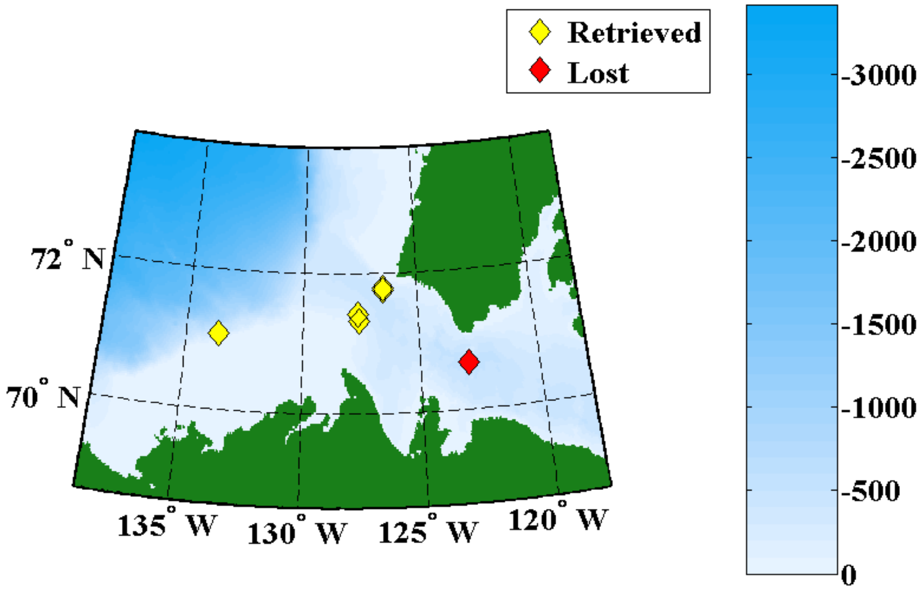


Figure 3.5. 2008 ArcticNet mooring deployment operations in the Beaufort Sea.

Table 3.3. 2008 ArcticNet Beaufort Sea mooring operations. Bold indicates 2008 deployments.

Mooring ID	Program	Deployment	Recovery	Latitude (N)	Longitude (W)	Depth (m)
CA04-07	ArcticNet	2007	2008	71°04.872	133°38.112	306
CA05-07	ArcticNet	2007	2008	71°18.816	127°36.138	202
CA05-MMP-07	ArcticNet	2007	2008	71°24.198	127°38.112	233
CA08-05	ArcticNet	2007	2008	71°03.234	126°01.362	395
CA16-07	ArcticNet	2007	2008	71°47.424	126°29.574	309
CA16-MMP-07	ArcticNet	2007	2008	71°45.204	126°30.330	356
CA18-07	ArcticNet	2007	2008	70°39.966	122°59.460	542
CA04-08	**ArcticNet**	**2008**	**LOST**	**71°04.884**	**133°37.776**	**307**
CA05-08	**ArcticNet**	**2008**	**2009**	**71°18.744**	**127°34.944**	**204**
CA05-MMP-08	**ArcticNet**	**2008**	**2009**	**71°24.696**	**127°38.676**	**235**
CA16-08	**ArcticNet**	**2008**	**2009**	**71°47.208**	**126°29.814**	**314**
CA16-MMP-08	**ArcticNet**	**2008**	**2009**	**71°45.150**	**126°30.486**	**353**
CA18-08	**ArcticNet**	**2008**	**LOST**	**70°39.894**	**122°59.652**	**540**

ArcticNet moorings nomenclature: the first two characters represent the region (CA: Beaufort Sea; BA: Baffin Bay and AN: Hudson Bay); the adjoining two digits are the mooring number and the digits after the hyphen (if present) indicate the deployment year.

3.2.7 Mooring operations – Baffin Bay (NOW)

In Baffin Bay, the 2008 Expedition focused exclusively on a recovery operation. Expedition (0806), called Leg 11, started in Resolute Bay, sailed across the Northern Baffin Bay and ended on September 28th after the ship was called for a Search and Rescue mission.

The mooring team was not able to communicate with the mooring BA01-06 releasers again (Figure 3.6) and the ROV was deployed to retrieve AN01-05 and AN01-06 (near each other). The ROV team managed to find the lower half of AN01-05; unfortunately, AN01-06 was not recovered due to water ingress into the TMS pressure housing thru a poorly assembled (by the manufacturer) vacuum port (see ROV performance comments below).

Mooring BA03-06 was covered by ice, again, and no attempt to recover the mooring was made (Table 3.4).

Table 3.4. 2008 ArcticNet mooring operations in Baffin Bay with 2006-2008 recovery results.

Mooring ID	Program	Deployment	Recovery	Latitude (N)	Longitude (W)	Depth (m)
BA01-05	NOW	2005	2006 (Top); 2008 (bottom)	76°19.620	071°11.904	649
BA01-06	NOW	2006	LOST	76°19.692	071°13.626	670
BA03-06	NOW	2006	LOST	76°23.154	077°24.624	358

ArcticNet moorings nomenclature: the first two characters represent the region (CA: Beaufort Sea; BA: Baffin Bay and AN: Hudson Bay); the adjoining two digits are the mooring number and the digits after the hyphen (if present) indicate the deployment year.

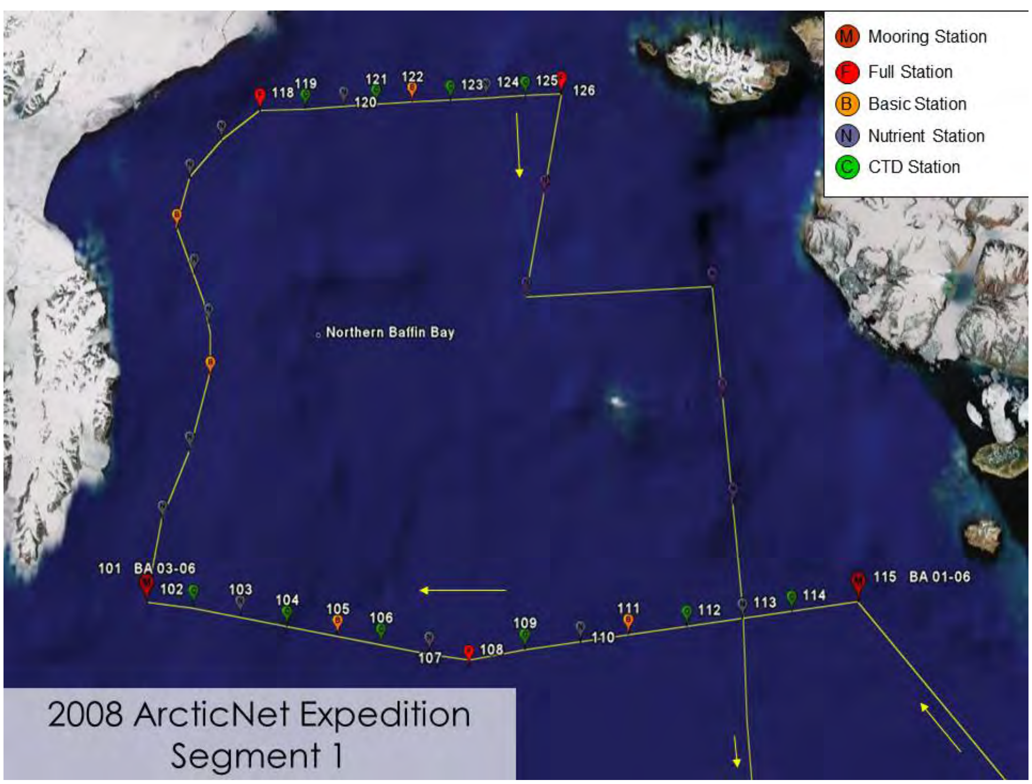


Figure 3.6. 2008 ArcticNet expedition plan with year 2005-2006 mooring sites indicated.

ROV system performance/problems

During the cruise, the system presented several problems that needed to be remedied. The most difficult problem was the intermittent loss of communication, sonar, and colour camera video at depth. This problem did not present itself at the surface and the team was unable to find a definite source of the problem until getting the ROV back in the water. Numerous possibilities were explored. In the end, it was determined that damage to the optic fibre strands in the tether was the source of the problem. The tether was re-terminated after removing 7m of cable from service. It was also found that the fibres were extremely fragile when spliced. The cause of this fragility is a question that requires further investigation and will continue to be a problem until the tether is replaced.

Water ingress into the TMS pressure housing thru a poorly assembled (by the manufacturer) vacuum port ended a dive, which probably would have recovered the releases at BA01-06. The presence of water in the pressure housing caused significant damage and many hours of repair. It is one of several issues, which will be discussed with the ROV manufacturer – Sub Atlantic.

Other mechanical failures included faulty assembly of the starboard vertical thrusters, which caused them to leak water and begin to wear severely. The Pan and Tilt was also disassembled for cleaning, which required a considerable amount of time.

The navigation system also worked very poorly at depth. This system can be improved with calibration. The mounting of the transducer on the ship's hull instead of the cable guide pole would also help a great deal. The poor performance of the navigation system contributed largely to the difficulty finding known targets on the sea floor and thus the loss of significant lengths of operation time. Calibration and hull mounting should be accomplished before the next offshore operation.

3.2.8 Mooring operations – Hudson Strait

In 2008, a set of four moorings (Figure 3.8) was deployed in calm seas across Hudson Strait in collaboration with Woods Hole Oceanographic Institute (WHOI) and ArcticNet-UQAR (Figure 3.9). Measurements in Hudson Strait are focused along a section, across the strait, which runs from Big Island (Baffin Island side) towards Wakeham Bay (Quebec). The section is approximately 110 km long. The mooring operations were all conducted by WHOI onboard the *Knorr* from 19 to 27 August 2008 (Figure 3.7).

In addition to the mooring deployments, hydrographic data at twelve stations across the strait (four of which coincided with locations where the moorings were anchored) was collected. These data serve the dual purpose of obtaining a snapshot of conditions across the strait and to aid in the calibration of the moorings' instrumentation.

Shipboard meteorological, acoustic Doppler current profiler, sea surface salinity and temperature data were collected while transiting.

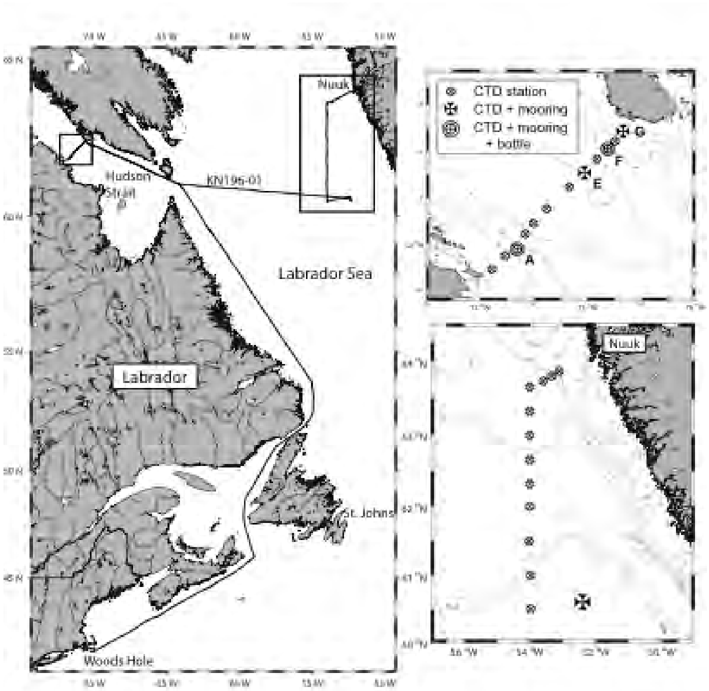


Figure 3.7. 2008 R/V *Knorr* cruise track from WHOI to Nuuk, Greenland. Left panel shows the Irminger Ring Mooring Location (US State Dept. cruise 2009-054).

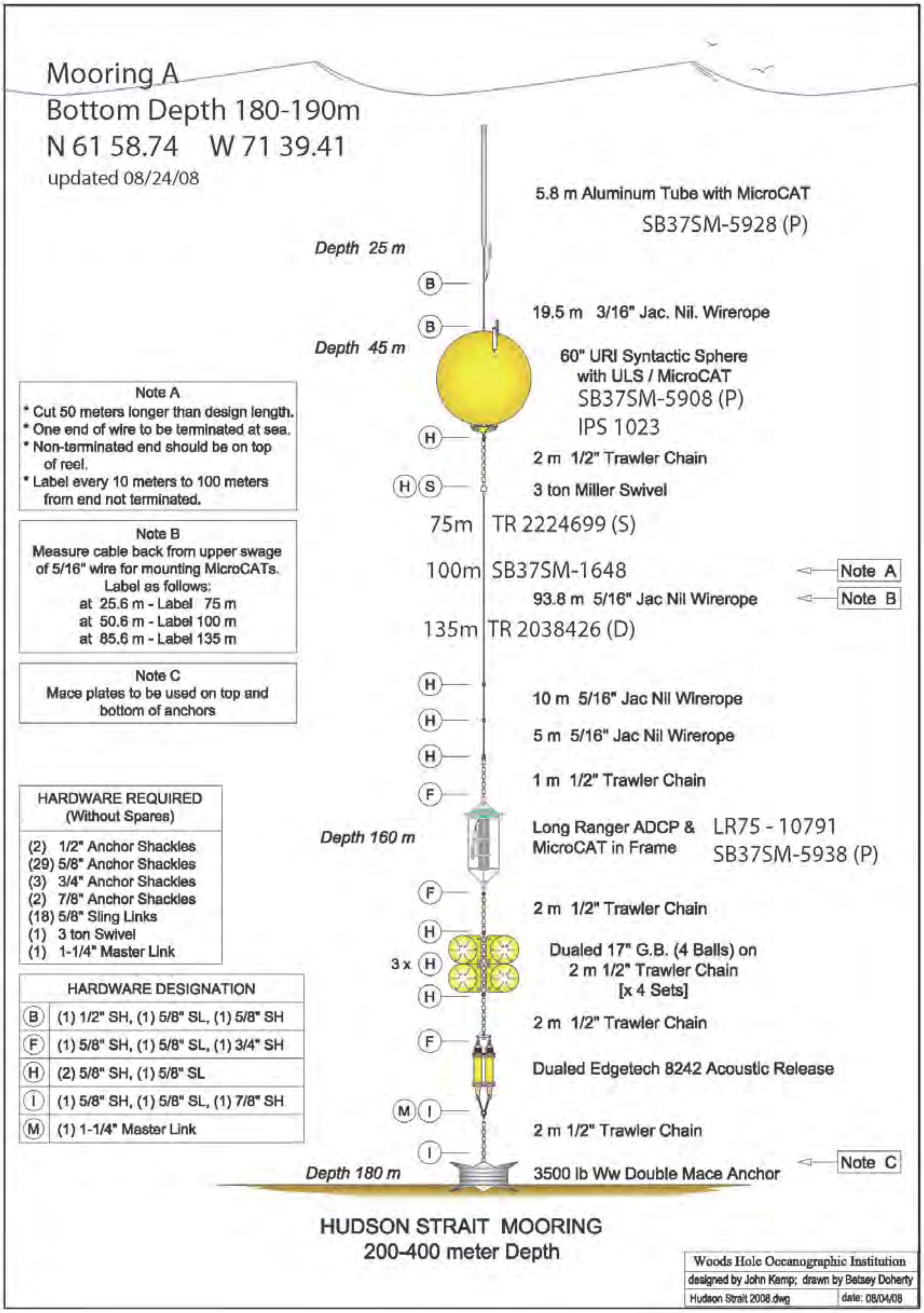


Figure 3.8. Mooring design A deployed in Hudson Strait.

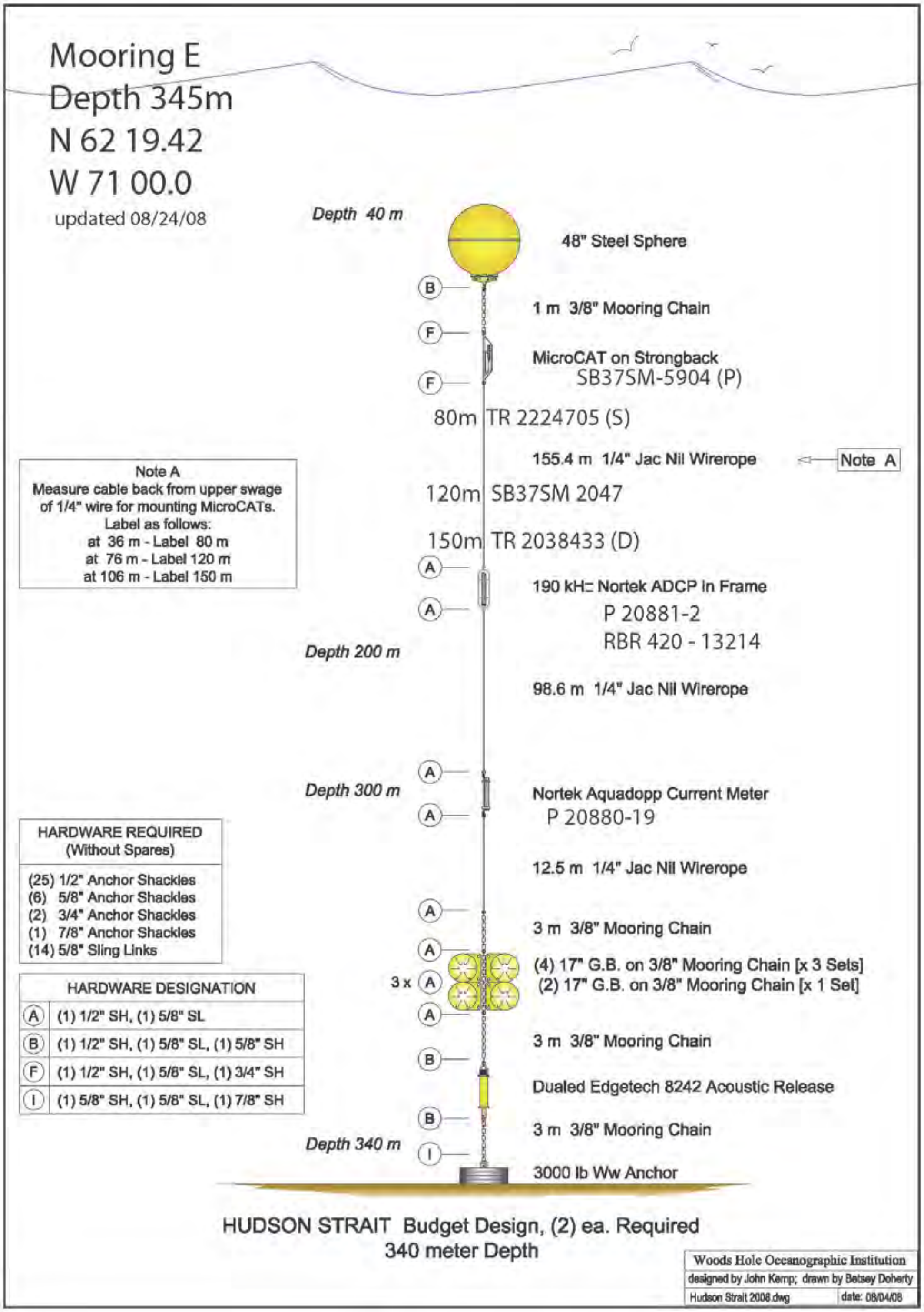


Figure 3.9. Mooring design E deployed in Hudson Strait.

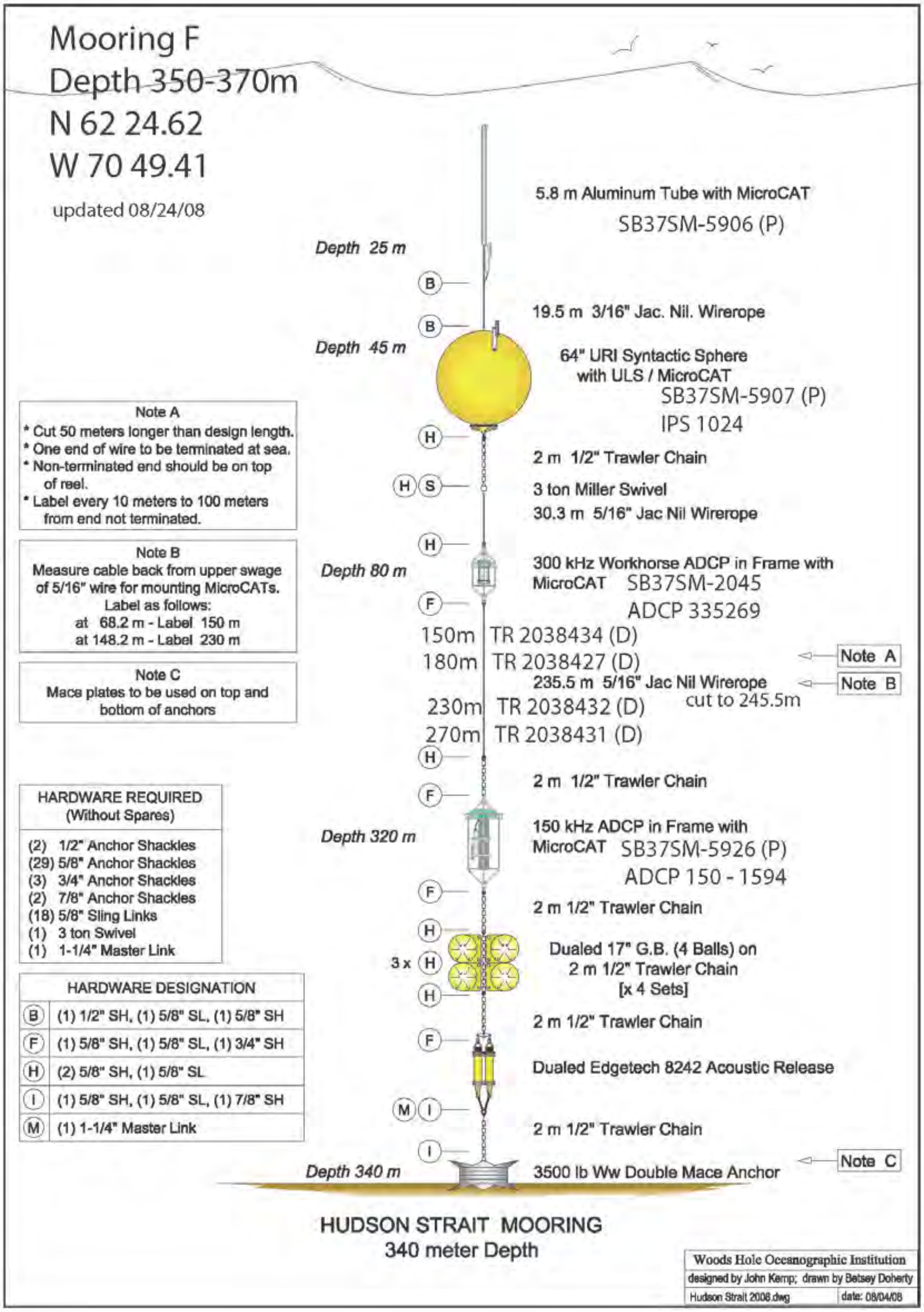


Figure 3.10. Mooring design F deployed in Hudson Strait.

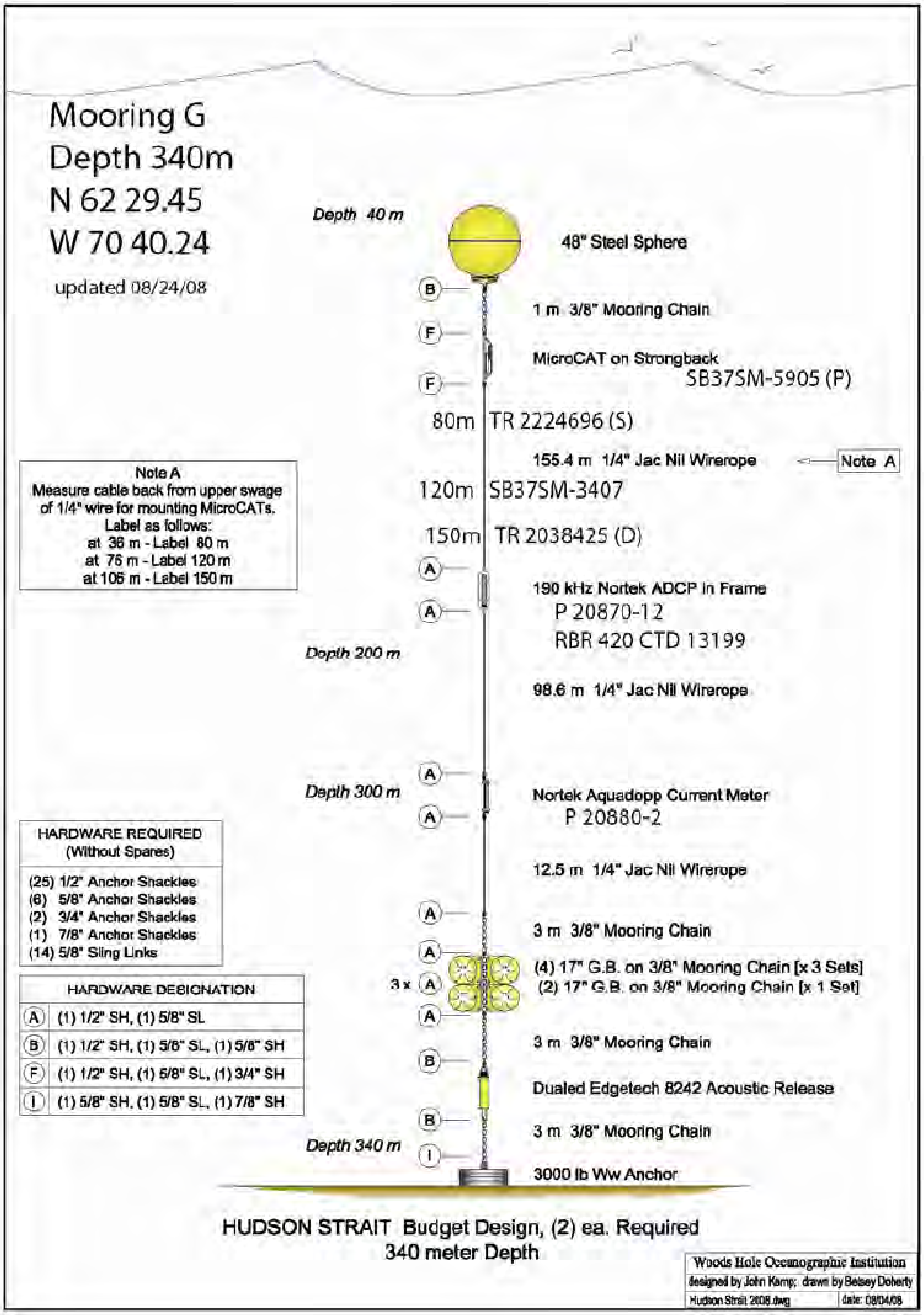


Figure 3.11. Mooring design G deployed in Hudson Strait.

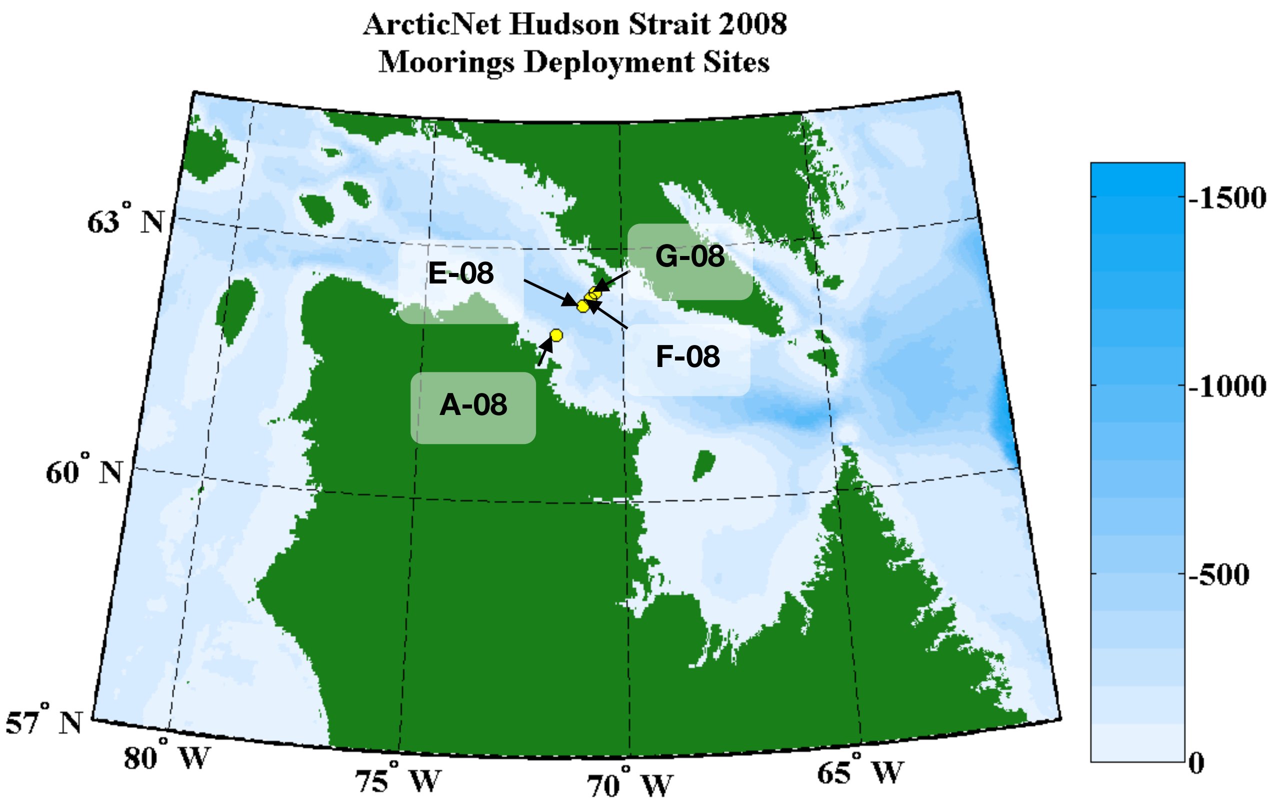


Figure 3.12. ArcticNet – MERICA – WHOI moorings deployed in Hudson Strait during summer 2008.

3.2.9 Mooring operations – Summary

A summary of all mooring operations done in 2008 is presented in the table below.

Table 3.5. 2008 ArcticNet Associated Mooring Operations

Mooring_ID	Program	Deployment	Recovery	Latitude (N)	Longitude (W)	Depth (m)
BA01-05	NOW	2005	2006 & 2008 (lower part with ROV)	76°19.620	071°11.904	649
CA04-07	ArcticNet-CFL	2007	2008	71°04.872	133°38.112	306
CA05-07	ArcticNet-CFL	2007	2008	71°18.816	127°36.138	202
CA05-MMP-07	ArcticNet-CFL	2007	2008	71°24.198	127°38.112	233
CA08-07	ArcticNet-CFL	2007	2008	71°03.234	126°01.362	395
CA16-07	ArcticNet-CFL	2007	2008	71°47.424	126°29.574	309
CA16-MMP-07	ArcticNet-CFL	2007	2008	71°45.204	126°30.330	356
CA18-07	ArcticNet-CFL	2007	LOST	70°39.966	122°59.460	542
M1-07	NABOS-ArcticNet	2007	2008	79°45.408	159°20.004	1464
M2-07	NABOS-ArcticNet	2007	LOST	79°55.002	142°21.000	1250
M3 -07	NABOS-ArcticNet	2007	LOST	79°56.112	142°19.320	1351
M7-07	NABOS-ArcticNet	2007	LOST	81°39.642	131°11.100	2461
M8-07	NABOS-ArcticNet	2007	LOST	80°47.028	138°47.256	2048
M9-07	NABOS-ArcticNet	2007	2008	80°20.928	161°15.840	2690

Mooring_ID	Program	Deployment	Recovery	Latitude (N)	Longitude (W)	Depth (m)
CA04-08	ArcticNet	2008	LOST	71°04.884	133°37.776	307
CA05-08	ArcticNet	2008	2009	71°18.744	127°34.944	204
CA05-MMP-08	ArcticNet	2008	2009	71°24.696	127°38.676	235
CA16-08	ArcticNet	2008	2009	71°47.208	126°29.814	314
CA16-MMP-08	ArcticNet	2008	2009	71°45.150	126°30.486	353
CA18-08	ArcticNet	2008	LOST	70°39.894	122°59.652	540
M9-08	NABOS-ArcticNet	2008	LOST	80°23.214	161°34.080	2718
HS_A-08	ArcticNet-MERICA- WHOI	2008	2009	61°58.740	071°39.410	190
HS_E-08	ArcticNet-MERICA- WHOI	2008	2009	62°19.420	071°00.000	345
HS_F-08	ArcticNet-MERICA- WHOI	2008	2009	62°24.620	070°49.410	360
HS_G-08	ArcticNet-MERICA- WHOI	2008	2009	62°29.450	070°40.240	340

3.2.10 Mooring recovery procedure

A CTD instrument was lowered at each mooring site (prior to recovery) to obtain a profile of the water column near the mooring while it still was in place. It was done to determine the possible sensor drift over time of the moored instruments, or to obtain accurate data on the acoustic properties of the water. A detailed deployment procedure was never formally documented, but roughly followed this procedure for the *Amundsen*:

- The ship was stopped about 1-2 cables from the deployment location.
- A CTD cast was done usually before recovery (or after deployment) of the mooring
- Transducer ranges were taken on the acoustic releases from several positions around the mooring site to verify approximate location & distance from the ship.
- When greater accuracy was needed (due to poor visibility or nearby ice) then triangulation was done by taking three range fixes from points surrounding the target location: ranges and locations were logged and a program was run to determine the most likely location of the mooring.
- The ship was then re-positioned sufficiently down-drift from this location and another range is taken before sending the release code.
- If the area over the target was clear then the Release code was transmitted, its confirmation reported, and the release time logged.
- When the mooring surfaced, the time and its location (distance & direction from ship position) were logged.
- The boat was launched and hooked onto the top float when all floatation components had reached the surface.
- The boat then pulled this alongside the ship and hooked it onto the A-frame winch hook.
- As the A-frame hook lifted sections of mooring on deck, the time was logged when each instrument came out of the water.

3.2.11 Mooring deployment procedure

- Instruments programmed and mounted onto respective frames / floats.
- Verify Mooring releases function properly.
- Assemble the mooring Top-down on the foredeck 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).
- Payout 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 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.
- 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 and also archived at ArcticNet (Figure 3.10).
- The fore deck is cleaned of debris and remaining mooring equipment / cages are secured on the foredeck.

CA05 MMP-08	Opération	Date	Profondeur de la station (m)	Press.Atm. mbar	Échelle de Beaufort	Temp. oC	Vit. Vents Nœud/Dir.	Position (de MatLab): 71°24.6948N 127°38.6778W
	Déploiement	26/Jul/08	235	1019.61	1	4.5	3,8k/028	Couvert nuageux: Clear
	Récupération							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	183.4	51.6	6:12				
Kevlar 3/8	1.5	182.4	52.6					
ORE SS-30	1.0	180.9	54.1	6:12				
Wire jacketed	0.0	179.9	55.1	6:13		12138-06		Bumper à 58m.
MMP	0.0	179.9	55.1	6:17				Profile entre 155m et 65m.
Wire jacketed	165.0	179.9	55.1	6:20				Bumper à 205m.
4*Benthos (17˝)	2.0	14.1	220.9					Pinger LinkQuest: 10
Kevlar 3/8	5.0	12.1	222.9					
2*Acoustic releases	2.2	7.0	228.0	6:26				#41447 Re= 8.00 , #41449 Re= 9.00
BENTHOS	0.0	4.8	230.2					Tr:12 En:B Rel: D Tr:12 En:B Rel: G
Chain 1/2	0.7	4.8	230.2					Profil CTD après déploiement:
Poly rope 3/4	3.0	4.1	230.9					0805030
Chain 1/2	0.6	1.1	233.9					Profil CTD avant récupération:
2*Wheel 1600 Lbs	0.5	0.5	234.5	6:33				
Bottom		0.0	235.0					

	Lat(deg) Lat(min)	Lon(deg) Lon(min)	Distance (m)
Ship's position	71o 24,404	127o 38,451	
Zodiac's position	71o 24,439	127o 38,420	
range1	71o 24,191	127o 37,693	674
range2	71o 24,794	127o 37,895	867
range3	71o 24,354	127o 39,830	965

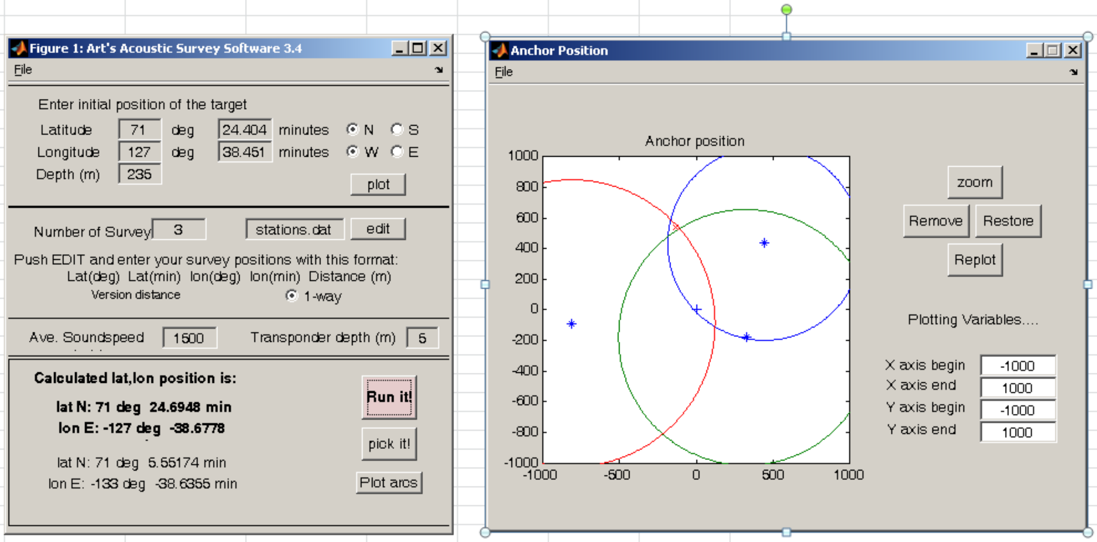


Figure 3.13. Example of information recorded in the field deployment workbook.

3.2.12 Triangulation of mooring position procedure

The triangulation of the mooring positions was not documented, but would most likely consist of the vessel proceeding to 3 triangulation points ~100m around the target location (position were anchor was released) and verification of acoustic release communications through ranging / 'pinging', allowing for the anchor position to be calculated (Figure 3.11). Triangulation onboard the R/V *Knorr* was not done for the MERICA-Nord moorings.

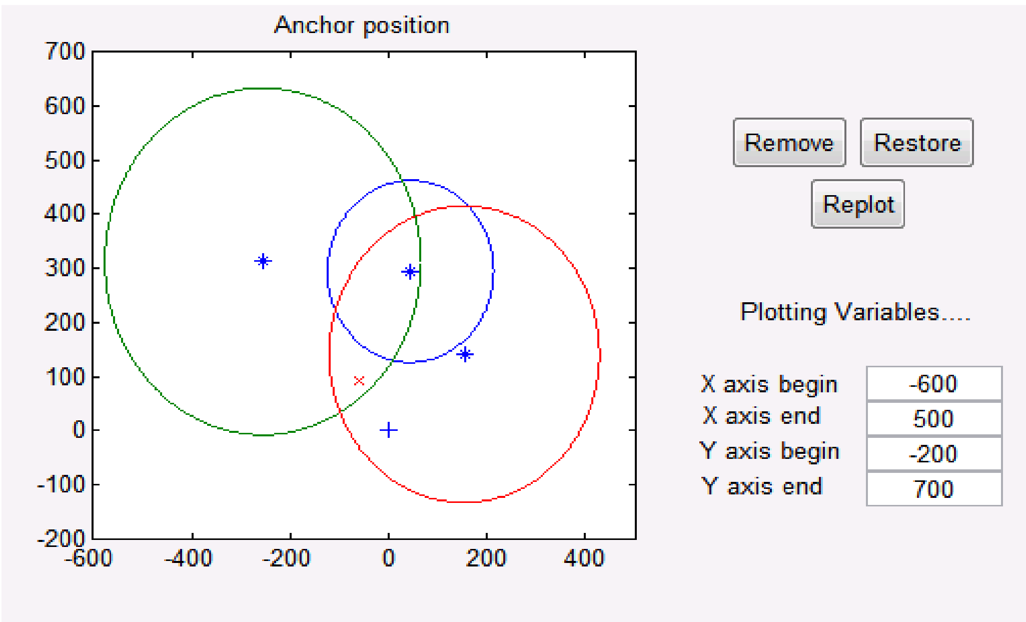


Figure 3.14. Example of triangulation plot using Art's Acoustic Survey Matlab Script.

3.2.13 Mooring deployment instrumentation setup

Figure 3.12 and 3.13 contain information identifying how each ArcticNet mooring instrument was programmed for its deployment / re-deployment. It has the added benefit of having the information on data quality from each instrument (recovered in 2009).

Mooring	Water depth	Position	Instrument	Serial No	Instr. Depth (m)	Date of first reliable data	Date of last reliable data	T (°C)	Cond (mS/cm)	Press (dbar)	Spd (m/s)	Dir (true)	Turb (FTU)	Oxy (% or µmol)	Chl	Luminosity (µmol/m²s)	Quality Control Comments
CA04-07	306	71° 04.87' N 133° 38.11' W	RBR-XR	10421	34	2007-10-18 01:30	2008-07-29 03:55										
			Aquadopp	2752	34	NO DATA RECORDED											
			RBR-XR	13210	92	2007-10-18 01:24	2008-07-29 04:02										Problems with pressure sensor
			Continental	6075	79	2007-10-18 01:40	2008-07-29 03:40										
			SBE 37	1697	213	2007-10-18 01:40	2008-07-29 03:50										
			Aquadopp	2747	213	NO DATA RECORDED											
			RBR-XR	13209	285	NO DATA RECORDED											
			Aquadopp	2688	285	2007-10-18 02:00	2008-06-26 00:30										Several data points are missing
CA05-07	200	71° 18.82' N 127° 36.14' W	ACLW	877	34	2007-10-23 00:00	2008-07-25 00:00										
			RBR-XR	10424	35	2007-10-23 00:00	2008-07-25 01:00										
			ALW	71	35	2007-10-23 00:00	2008-07-25 00:00										
			ACLW	883	46	2007-10-23 00:00	2008-07-25 00:00										
			ACTW	151	46	2007-10-23 00:00	2008-07-25 00:00										
			RBR-XR	10420	89	2007-10-23 00:00	2008-02-19 22:30										Several data points are missing; Offset correction applied to salinity data
			Continental	6088	88	2007-10-23 01:00	2008-07-25 00:40										
			RCM11	285	178	2007-10-22 21:29	2008-01-10 00:29										Several data points are missing
			SBE26	371	192	NO DATA RECORDED											

Figure 3.15. Summary of the instruments moored in 2007 and recovered in 2008 or later, for the benefit of the ArcticNet program.

Mooring	Water depth	Position	Instrument	Serial No	Instr. Depth (m)	Date of first reliable data	Date of last reliable data	T (°C)	Cond (mS/cm)	Press (dbar)	Spd (m/s)	Dir (true)	Turb (FTU)	Oxy (% or µmol)	Chl	Luminosity (µmol/m²s)	Quality Control Comments
CA05 MMP-07	234	71° 24.20' N 127° 38.11' W	MMP	12138-05	35-200	NO DATA RECORDED											
CA08-07	397	71° 03.23' N 126° 01.36' W	ACLW	886	24	2007-10-31 06:00	2008-07-27 00:00										
			ALW	67	29	2007-10-31 06:00	2008-07-27 00:00										
			ACTW	146	40	2007-10-31 06:00	2008-07-27 00:00										
			ACLW	885	40	2007-10-31 06:00	2008-07-27 00:00										
			ALW	72	40	2007-10-31 06:00	2008-07-27 00:00										
			RBR-XR	13203	79	2007-10-31 06:00	2008-07-27 00:47										Offset correction applied to salinity data
			Continental	6081	79	2007-10-31 06:00	2008-07-28 00:40										
			Aquadopp	2754	222	2007-10-31 06:00	2008-07-27 00:00										
			SBE 37	1695	222	2007-10-31 06:00	2008-07-27 00:40										Problems with pressure sensor
			RBR-XR	13206	377	2007-10-31 06:00	2008-07-27 00:47										Offset correction applied to salinity data
			Aquadopp	2793	383	2007-10-31 06:00	2008-07-27 00:00										
CA16-07	309	71° 47.42' N 126° 29.58' W	ACTW	150	26	NO DATA RECORDED											
			ACTW	149	41	2007-10-21 01:00	2008-07-22 18:00										Conductivity data are not reliable after 2008-07-04 21:00
			RBR-XR	10422	87	2007-10-21 01:00	2008-07-22 19:05										
			Continental	6085	85	2007-10-21 01:00	2008-07-22 19:00										
			Aquadopp	2778	222	2007-10-21 01:00	2008-07-15 01:00										Some data points are missing
			RBR-XR	13205	222	BROKEN											
			RBR-XR	13211	291	2007-10-21 01:00	2008-07-22 19:05										Problems with pressure sensor; Offset correction applied to salinity data
			Aquadopp	2746	291	2007-10-21 01:00	2008-07-22 19:00										
CA16 MMP-07	356	71° 45.21' N 126° 30.33' W	MMP	12138-03	40-300	NO DATA RECORDED											
AN01-07	106	59° 58.64' N 91° 56.63' W	RCM11	280	23	No reliable data											
			ACTW	148	77	2007-08-16 08:00	2008-09-19 10:59										
			WH-ADCP	333	77	NO DATA RECORDED											

Figure 3.16. Moorings deployed in October 2007 and recovered in July 2008, during CFL expeditions. AN01-07 was recovered in Summer 2009.

3.3 Comments and recommendations

The future involvement of dynamic positioning (concerning ROV operations) will improve the ship handling and the safety and ease of ROV operations. Further training of ROV operators and technicians is still required to operate the ROV in a secure and efficient manner. It is very difficult to gain useful and detailed knowledge with the limited number of dives this ROV does in a year. Other training aids, such as a simulator or offshore experience with a different ROV, will help the development of skills and expertise for the personnel involved.

We would like to thank the ships' crew of the *Amundsen* and the Quebec-Oceans mooring teams for working together. This cooperation between mooring team members and ships' crew made it possible that the mission was a success. We would also like to thank the R/V Knorr and WHOI (with the help of Yves Gratton and UQAR) for their interest and cooperation in forging a positive relation concerning mooring operations, in the Hudson Strait, with ArcticNet.

4 Water column structure and ocean circulation (CTD-Rosette, MVP and ADCP operations) – Leg 11

ArcticNet Phase I – Theme 1: Climate Change Impacts in the Canadian High Arctic: a Comparative Study Along the East-West Gradient in Physical and Societal Conditions. http://www.arcticnet.ulaval.ca/pdf/phase1/11.pdf.

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4.1 Introduction

The general objective was to describe the water masses and general oceanic circulation in Baffin Bay as part of ArcticNet's marine-based program.

4.2 Methodology

4.2.1 Instrumentation

Physical parameters were recorded using a ship mounted RD Instruments Ocean Surveyor ADCP, a Brooke Moving Vessel Profiler (MVP) 300 and a Rosette frame equipped with 24 bottles of 12 L and an array of sensors described in Table 4.1.

Table 4.1. Description of the instruments and sensors used on the Rosette.

Instrument	Manufacturer	Type	Properties	Serial number	Max depth (m)
CTD	SeaBird	SBE-911	Sampling rate: 24Hz		6800
Temperature	SeaBird	SBE 3plus	Range: -5°C to +35°C Accuracy: 0.001	4204	
Conductivity	SeaBird	SBE 4C	Range: 0 to 7 S/m Accuracy: 0.0003	2696	
Pressure	Paroscientific	410K-105	Accuracy: 0.015% of full range	90584	
Oxygen	SeaBird	SBE-43	Range: 120% of saturation Accuracy: 2% of saturation	0427	7000
pH	SeaBird	SBE-18	Range: 0 to 14 Accuracy: pH 0.01	0452 switched to 0444 on cast 024 of Leg 3	1200
Nitrates	Satlantic	MBARI	Range: 0.5 to 200 μM	132 switched to	1000

Instrument	Manufacturer	Type	Properties	Serial number	Max depth (m)
		ISUS	Accuracy: ± 2 μM	134 on cast 143 of Leg 3	
PAR	Biospherical	QCP2300	Range : 1.4×10^{-5} to 0.5 μE/(cm^2·sec)	4664	
SPAR	Biospherical	QCP2200	Range : 1.4×10^{-5} to 0.5 μE/(cm^2·sec)	20147	
Fluorometer	Sea Point		Range : 0.02-150 μg/l	2465	
Transmissometer	WetLab	C-Star	Range: 0-5 V	CST-558DR	
Altimeter	Benthos	PSA-916	Range: 0-100 m	1044 switched to 1061 on cast 028	6000

4.2.2 Probe calibration

pH: Tests were done at the beginning of Leg 11 using two buffers: at pH 4 and pH 7. Results were not satisfying, as buffer 4.01 gave results between 7.51 and 7.28 and buffer 7.00 gave a result of 7.38. Because seawater is usually around pH=8, pH data are expected to be overestimated.

Salinity: Samples were taken for calibration on many casts with small bottles of 200 mL. Samples were analyzed onboard with a GuildLine Autosal (model 8400B). Results were not always satisfactory when compared with the SCAMP profile and it was concluded that there was an offset on the Rosette salinity data and that this dataset will need to be corrected accordingly. The difference in between the salinity probe recordings and the samples was around 0.09.

Oxygen: Oxygen calibration was performed onboard using Winkler's method and a Mettler Toledo titration machine. Reagent blanks were performed twice during the leg, and results showed that the reagents were good (m<4). Oxygen samples were taken on four casts during the leg with satisfactory results. Each time, five depths of different oxygen concentration were chosen and sampled three times. The results were satisfying; the slope of comparison between the sensor and the samples varied from 0.97 to 0.99. A small correction will need to be done on the data.

4.2.3 Sampling sites

During Leg 11, CTD casts were conducted in Lancaster Sound and Baffin Bay (Figure 4.1).

The MVP was used twice during the leg. One transect was completed across Lancaster Sound and one along Gibbs fjord.

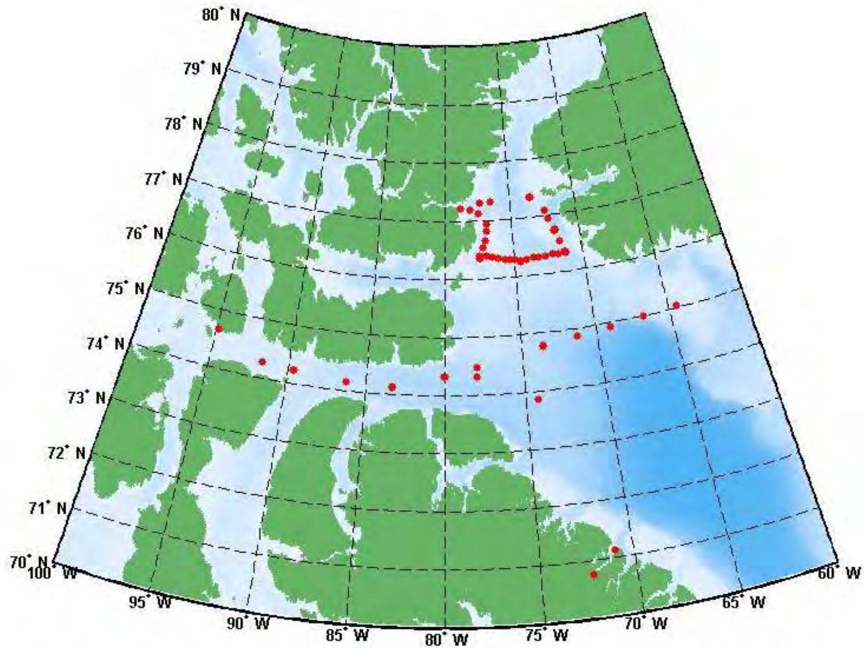

Figure 4.1. CTD-Rosette cast locations in Lancaster Sound and Baffin Bay during Leg 11.

4.2.4 Water samples

Water was collected from the Rosette by the different science teams. Here are examples of usual depths of bottle closure:

Nutrients (J.-É. Tremblay): Salinity of 33.1, chlorophyll maximum, 10, 20, 30, 40, 50, 60, 80, 100, 125, 150, 175, 200, 250, 300 and every 100 m up to the bottom.

Nitrogen (J.-É. Tremblay): Surface and chlorophyll maximum.

DIC (L. Miller's team): Salinity of 33.1, 5, 10, 20, 30, 40, 50, 60, 80, 100, 125, 150, 175, 200, 250, 300 and every 100 m up to the bottom.

Mercury (G. Stern): Salinity of 33.1, 5, 10, 20, 30, 40, 50, 60, 80, 100, 125, 150, 175, 200, 250, 300 m and every 100 m up to the bottom.

DOC/DON (C. Michel): Salinity of 33.1, 5, 10, 20, 30, 40, 50, 60, 80, 100, 125, 150, 175, 200, 250, 300 m and every 100 m up to the bottom.

DNA (C. Lovejoy): Surface, chlorophyll maximum, minimum of oxygen, bottom and any special feature in the profile.

Primary production (M. Gosselin): 100%, 50%, 30%, 15%, 5%, 1%, 0.2% of light, chlorophyll maximum, 75, 100 and 200m.

N_2O (M. Scarrat): 5, 20, 30, 50, 100, 250, 500 m, bottom.

N_2O incubation (M. Scarratt): Chlorophyll maximum, 140m, 60m and bottom or just chlorophyll maximum.
DMS (M. Levasseur): 100%, 50%, 5%, 0.2% of light and chlorophyll maximum.

DMS incubation (M. Levasseur): Surface.

Microbial productivity (R. Rivkin): 100%, 50%, 15%, 5%, 1%, 0.2% of light, chlorophyll maximum and 200m.

Microbial productivity incubation (R. Rivkin): 50% of light.

Contaminants (G. Stern): 5, 10, 25, 50, 150, 200, 400, 700 m and bottom.

4.2.5 Data availability

All information on CTD-Rosette casts is summarized in the CTD Logbook (Appendix 3) and include cast and station numbers, date and time of sampling in UTC, latitude and longitude, bottom and cast depths, as well as any comment relating to the cast. A Rosette sheet was also created for every cast and included the same information than the CTD Logbook plus the bottle distribution among the sampling teams. The weather information was recorded in every Rosette sheet as well as in the meteorological logbook. For every cast, data recorded at the moment of bottle closure were averaged and logged in the 'bottle files'. These averages recorded parameters in a 10-seconds time span, from 3 seconds before bottle closure to 7 seconds after it. The bottle files also included information about bottle position, time and date, pressure, temperature, salinity, transmissivity, chlorophyll, oxygen, irradiance and pH measurements.

Between 4 September and 28 September 2008:

- 83 CTD casts were performed with the Rosette;
- Transects across Lancaster Sound and along Gibbs fjord were done by the MVP;
- ADCP data was partly collected, as it could not determine the middle range of the water column currents for an unknown reason.

4.3 Preliminary results

4.3.1 CTD-Rosette transects

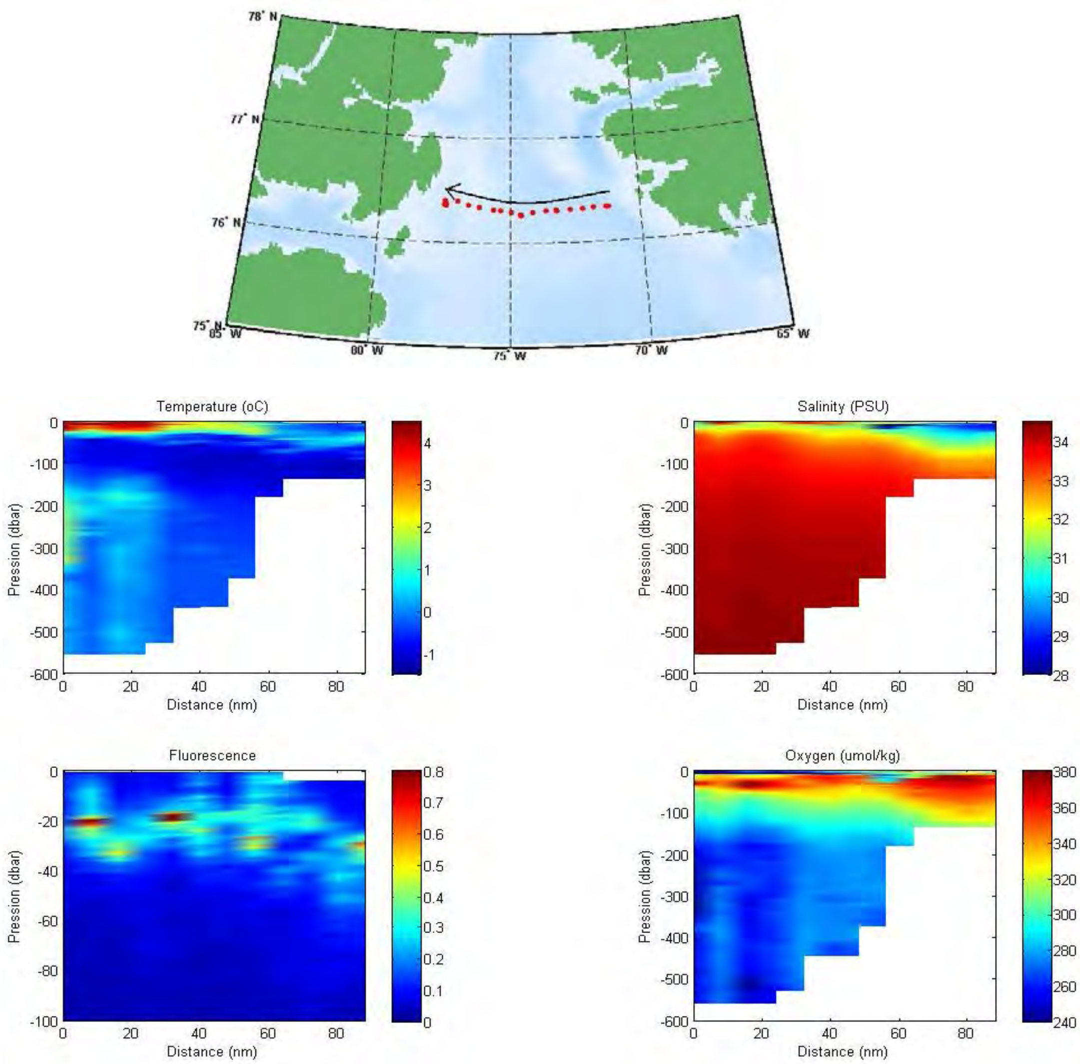

Figure 4.2. CTD-Rosette transect from east to west of Baffin Bay over Stations 115 to 101.

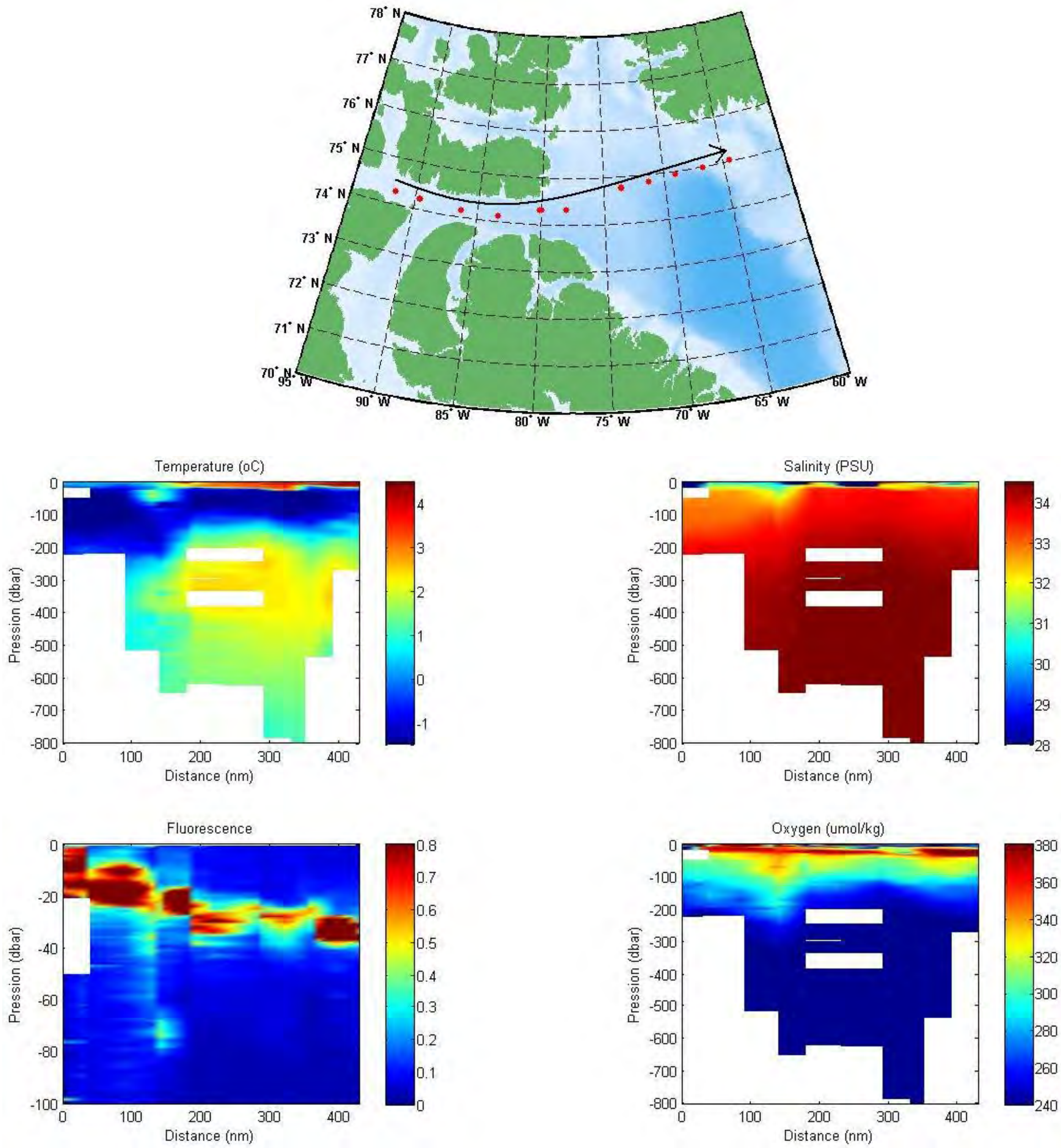

Figure 4.3. CTD-Rosette transect from west to east along Lancaster Sound and across Baffin Bay over Stations Barrow Strait, as well as 303 to 140.

4.3.2 MVP transects

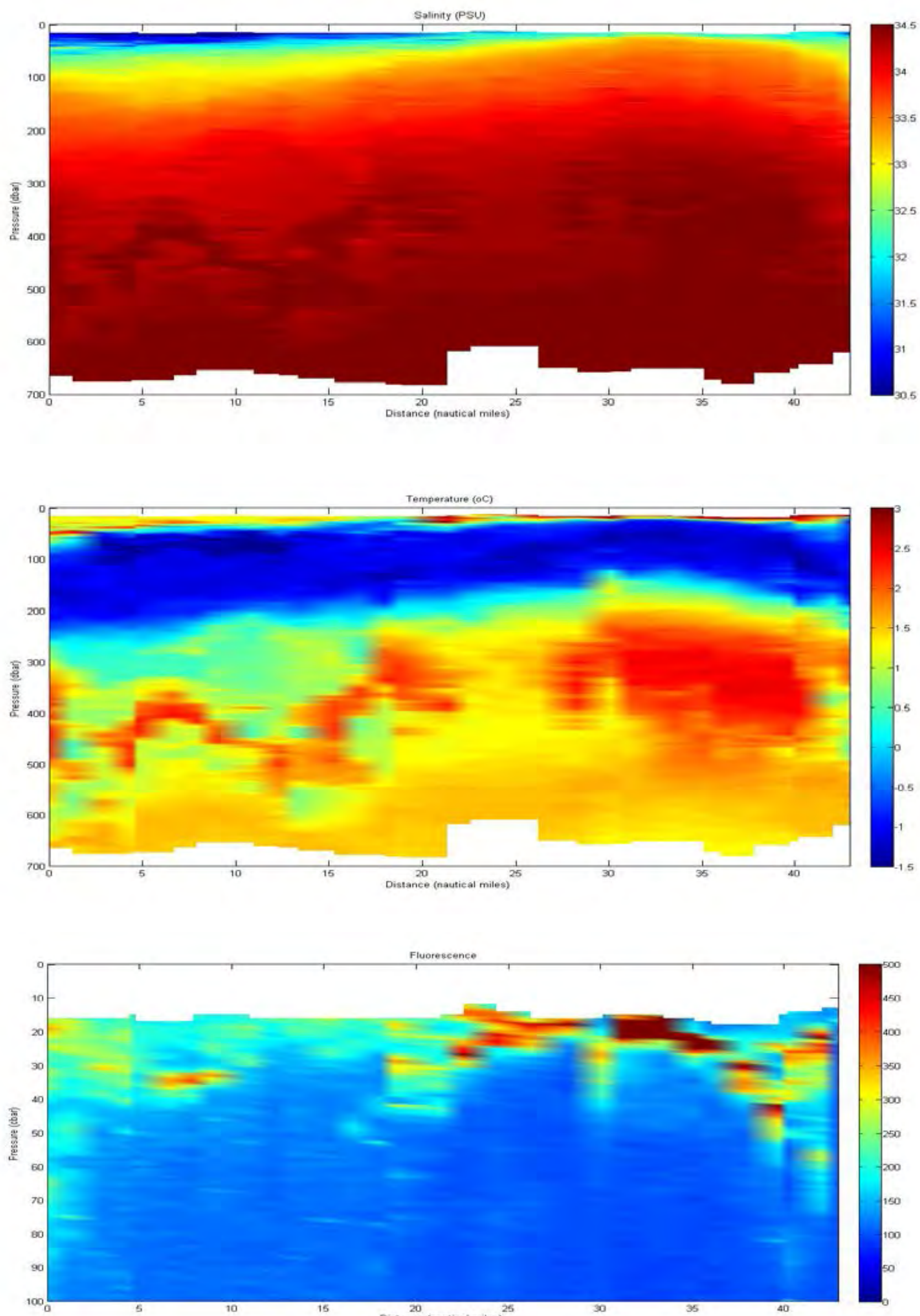

Figure 4.4. Recorded salinity (upper graph), temperature (middle graph) and fluorescence (lower graph) across Lancaster Sound, from South to North.

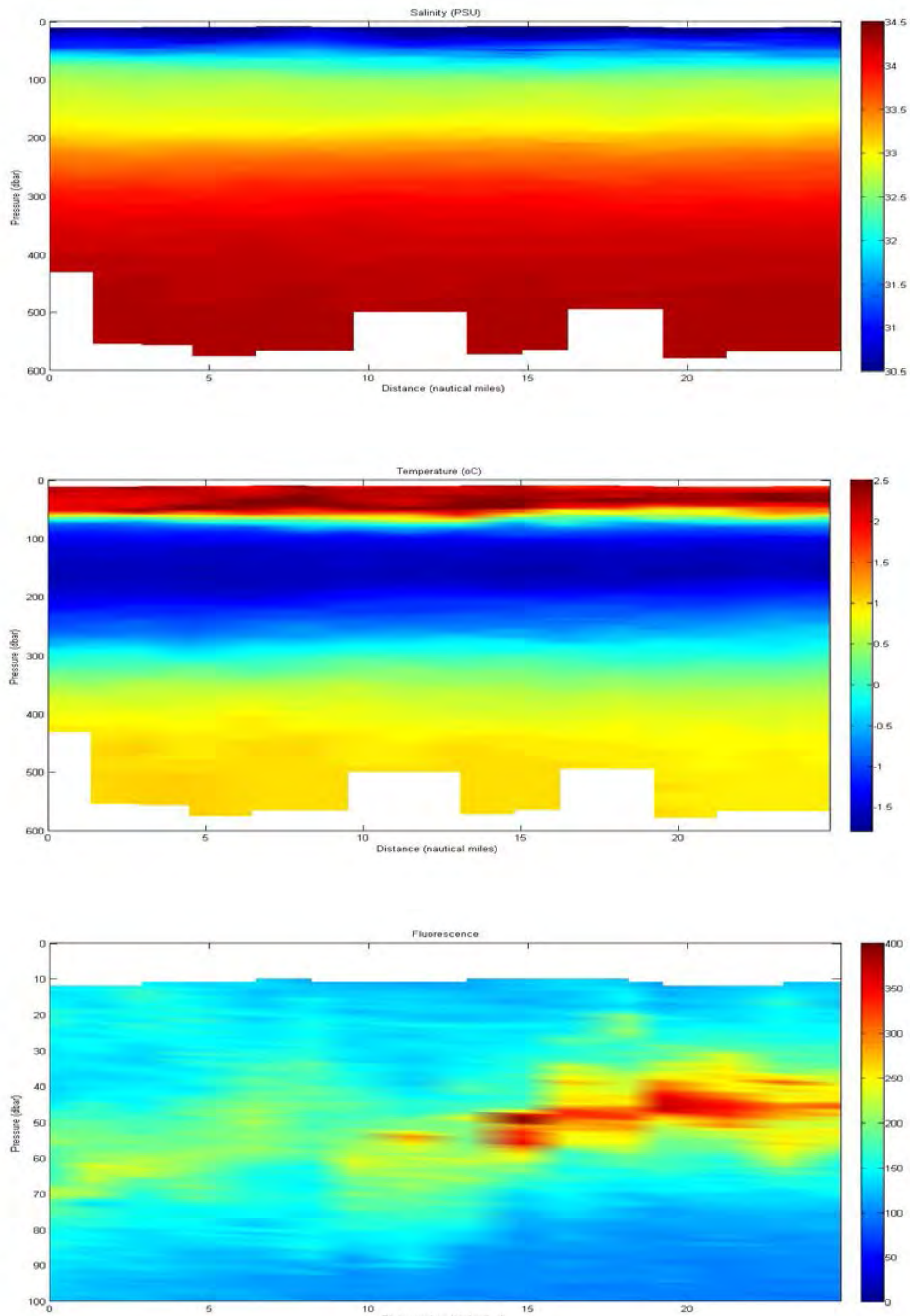

Figure 4.5. Recorded salinity (upper graph), temperature (middle graph) and fluorescence (lower graph) across Gibbs fjord, from outside to inside.

4.4 Comments and recommendations

Sensors: During the leg, there were some serious communication issues with the sensors and the carrousel of the Rosette until Cast 020. After all the cables and connections had been cleaned up, it seemed to be working again, except for the pH sensor that stopped working by Cast 016 and never worked again. Many bottles did not close occasionally or closed only out of water, most frequently bottles 11 and 24.

Deck material (winch, A-frame, etc.): No problems were reported during the leg.

5 Turbulence measurements (SCAMP) – Leg 11

ArcticNet Phase I – Theme 1: Climate Change Impacts in the Canadian High Arctic: a Comparative Study Along the East-West Gradient in Physical and Societal Conditions. http://www.arcticnet.ulaval.ca/pdf/phase1/11.pdf.

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5.1 Introduction

Turbulence is usually defined as the irregular, random component of fluid motion. In the seas and oceans, this phenomenon is closely associated with sheared flow induced by the breaking internal waves. The resulting 'eddies' generated by this flow induce strain that enhance the production of overturns at smaller and smaller scales to viscosity. This energy cascade (primarily directed toward smaller scales) promotes scalar mixing and the ending of turbulence. When this process occurs in the upper ocean layer (< 100 – 150 m), it promotes pollutants dispersion, the growth of marine organisms (especially plankton) and the transfer of momentum, heat and gases across the surface.

To date, few studies have tried to understand and quantify turbulent processes in the Arctic Ocean and most have dealt with the special case of Barrow Strait (Melling et al. 1984, Crawford et al. 1999, Marsden et al. 1994), a region known to be highly active in terms of vertical transport and mixing. Other projects such as the *Coordinated Eastern Arctic Experiment* (CEAREX) conducted east of Greenland (Padman and Dillon 1991) and the *Lead Experiment* (LAEDEX) conducted north of Alaska (McPhee and Stanton 1996) had also focused on the physical characteristics of turbulence in these Arctic regions. These studies have brought some answers on turbulent processes such as the role of diurnal tides and high frequency internal waves, but did not clarify the problem for other locations in the Arctic. The general objectives of this study were to:

- Outline a general pattern of active turbulence in the High Arctic and Baffin Bay;
- Identify the main physical processes responsible of the observed mixing;
- Specify the role of turbulence in terms of biological production.

5.2 Methodology

5.2.1 Description of profiling instrument (SCAMP)

Turbulence acts first on the velocity field as the propagating waves create line vortices, which continuously advect each other in complex ways. Those complex structures are relatively stable, and the mixing then mainly occurs in regions of intense strain created between nearby vortices. The large resulting velocity gradients at small scales (1 mm to 1 cm) can be detected by an airfoil shear probe, a piezo-ceramic bender that generates an electrical charge in response to cross-axial forces. The signal collected by this probe (u') and the deducted shear (du'/dz) can be used to estimate the rate of loss of kinetic energy in turbulent events ($\varepsilon \propto (\partial u'/\partial z)^2$, expressed in W kg^{-1} or m^2 s^{-3}. This parameter ranges from 10^{-10} W kg^{-1} in the deeper parts of the oceans to 10^{-1} W kg^{-1} in the more active regions.

As vortices are created, the scalar fields (i.e. temperature) are compressed by the strain created between the turbulent structures of the flow. The scalar variance is then driven to smaller scales via eddies as the energy cascade progresses. As soon as they are formed, thermal anomalies blend into the background by molecular diffusivity at a rate χ the rate of loss of thermal variance (°C^{-2} s^{-1}), which constitutes the far end of turbulence or the smaller possible tracks of overturns.

This turbulent mark can be detected by the Self-Contained Autonomous Profiler (SCAMP), a profiler designed to directly estimate the thermal variance produced by diapycnal mixing. This instrument was equipped with two fast response thermistors to measure the temperature gradient at every 0.01 s. Since it falls through the water column at a rate of 0.1 m s^{-1}, the resulting precision is of 1 mm, which is sufficient to resolve the complete scalar spectrum and estimate $\chi \propto (\partial T'/\partial z)^2$. The SCAMP is also fitted with PAR, accurate T, accurate C and pressure sensors, and a fluorometer. The SCAMP was used as a complementary instrument in profiling sequence mode.

5.2.2 Sampling stations

During the leg, SCAMP profiles were taken from the Zodiac at 3 stations (Table 5.1). Profiles were not recorded at Station 301 due to problems with the instrument.

Table 5.1. Stations where SCAMP profiles were completed during Leg 11.

Station	Date (UTC)	Time (UTC)	# Profiles	Profiling depth (m)
303	07 sep 2008	17h42	3	100
301	08 sep 2008	18h42	0	100
134	09 sep 2008	09h30	3	100
140	11 sep 2008	16h32	2	100

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6 Barium sampling – Leg 11

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6.1 Introduction

In the Canadian Arctic, barium (Ba) is mainly released from the North American continent and can therefore be used as a tracer for terrestrial freshwater input. Together with ^{18}O, a tracer for freshwater input from precipitation and ice melt, all freshwater sources to the Arctic can be quantified.

6.2 Methodology

Samples for barium were taken from the Rosette parallel to samples for ^{18}O, at approximate depths of 5, 10, 20, 50, 70, 100, 140, 200 and 300 m (Table 6.1). 15 ml Nalgene bottles were rinsed three times, then filled and spiked with 15 µl concentrated HCl. Sample bottles were sealed with parafilm and taken for later analysis using isotope dilution mass spectrometry.

Table 6.1. Stations sampled for barium during Leg 11.

Station	Latitude (N)	Longitude (W)	CTD Cast	Date
303	74°14.387	089°38.484	0806004	07/09/08
301	74°07.405	083°20.687	0806010	08/09/08
134	74°28.812	078°00.241	0806017	09/09/08
140	75°02.153	064°28.770	0806026	11/09/08
115	76°20.021	071°18.688	0806028	12/09/08
108	76°15.828	074°36.112	0806042	14/09/08
101	76°22.294	077°26.668	0806050	15/09/08
233	76°43.950	071°51.935	0806074	20/09/08
Gibbs2	70°46.063	072°16.519	0806082	25/09/08
Gibbs1	71°07.307	070°57.880	0806083	25/09/08

7 Carbon system analysis – Leg 11

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7.1 Introduction

The ocean's exchange of carbon dioxide (CO_2) 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 in the surface waters. Of the seven relevant carbon system parameters, a minimum of two is needed to calculate the others and fully describe inorganic carbon chemistry, over-determination of the system being beneficial.

7.2 Methodology

Roughly 325 samples were analyzed for dissolved inorganic carbon (DIC) and total alkalinity (TA) (Table 7.1). During the leg, 500 ml water samples were collected from the Rosette using a plastic tube, ensuring the sample was free of bubbles, at several depths for determination of DIC and TA. Samples were usually first to be taken from the Niskin bottles, or preceded only by dissolved oxygen, nitrous oxide (N_2O), and carbon monoxide (CO) at individual casts and depths.

Samples were analyzed immediately, using a VINDTA 3C (Versatile Instrument for the Determination of Titration Alkalinity) by Marianda. Total alkalinity was determined by titrating a volumetrically accurate sub-sample of seawater using hydrochloric acid (HCl) as a titrant. In the case of dissolved inorganic carbon, a volumetrically determined sub-sample of sweater was acidified with 8.5% H_3PO_4 to convert all inorganic carbon into gaseous CO_2. The CO_2 is then stripped out of the sample using ultra-pure nitrogen gas, and transferred into the titration cell where total inorganic carbon is detected using the coulometric method (Johnson et al. 1993).

Table 7.1. Stations sampled for DIC and TA during Leg 11.

Station	Latitude (N)	Longitude (W)	CTD Cast	Date
303	74°14.387	089°38.484	0806004	07/09/08
301	74°07.405	083°20.687	0806010	08/09/08
134	74°28.812	078°00.241	0806017	09/09/08
136	74°46.492	073°37.108	0806018	10/09/08

Station	Latitude (N)	Longitude (W)	CTD Cast	Date
138	74°56.189	069°04.132	0806023	11/09/08
140	75°02.153	064°28.770	0806026	11/09/08
115	76°20.021	071°18.688	0806028	12/09/08
108	76°15.828	074°36.112	0806042	14/09/08
101	76°22.294	077°26.668	0806050	15/09/08
202	76°48.926	076°54.251	0806055	16/09/08
205	77°12.560	078°49.091	0806061	17/09/08
126	77°20.573	073°26.220	0806066	18/09/08
230	77°06.004	072°25.740	0806071	19/09/08
233	76°43.950	071°51.935	0806074	20/09/08
234	76°32.390	071°32.154	0806077	20/09/08
Gibbs2	70°46.063	072°16.519	0806082	25/09/08
Gibbs1	71°07.307	070°57.880	0806083	25/09/08

Reference

Johnson K.M., Wills K.D., Butler D.B., Johnson W.K. and Wong C. S. (1993) Coulometric total carbon dioxide analysis for marine studies: maximizing the performance of an automated gas extraction system and coulometric detector. Marine Chemistry 44: 167-187.

8 Carbon and nutrients fluxes – Leg 11

ArcticNet Phase I – Project 1.4: Marine Productivity & Sustained Exploitation of Emerging Fisheries. http://www.arcticnet.ulaval.ca/pdf/phase1/14.pdf

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8.1 Introduction

The Arctic climate displays high inter-annual variability and decadal oscillations that modulate growth conditions for marine primary producers. Much deeper perturbations recently became evident in conjunction with globally rising CO_2 levels and temperatures (ACIA 2004, Comiso 2003). The thickness and extent of Arctic sea-ice decrease rapidly (Johannessen et al. 1999, Rothrock et al. 1999) and the ice-free season is extending both in the Arctic (Laxon et al. 2003) and subarctic (Stabeno & Overland 2001). Models predict further reductions in ice cover (ACIA 2004). These changes entail a greater penetration of light into surface waters, which is expected to bolster phytoplankton production (Rysgaard et al. 1999), food web productivity and CO_2 drawdown by the ocean. At present, phytoplankton production varies by two orders of magnitude across the Canadian Arctic, but the forcing mechanisms are poorly understood and quantified. In the Canadian Archipelago, the productivity of phytoplankton is likely to be limited by light or the supply of allochtonous nitrogen, depending on ice conditions. The supply of allochtonous nitrogen is influenced by climate-driven processes, mainly the large-scale circulation, river discharge, upwelling and regional mixing processes. Over most of the western Arctic, and especially the Beaufort Sea, the concentrations of inorganic nitrogen (i.e. nitrate, nitrite and ammonia) at surface remain low throughout the year and the phytoplankton possibly depend on local recycling and the dissolved organic nitrogen (DON; e.g. urea, amino acids and primary amines) supplied by rivers. A large portion of the phytoplankton biomass is typically located within subsurface chlorophyll maxima (SCM). SCM productivity is possibly in balance with the episodic supply of nitrate across the halocline and/or the supply of ammonium and nitrate by local recycling and nitrification, respectively. Despite the importance of SCM for the food web and CO_2 fluxes, little is known about their structure, turnover and susceptibility to environmental variability and change.

The main goals of this project were to:

- Establish the horizontal and vertical distributions of phytoplankton nutrients and the influence of different processes (e.g. mixing, upwelling and biological processes) on these distributions;
- Characterize the detailed vertical structure of chlorophyll-*a* with respect to irradiance, nutrient supply and physical structure;
- Experimentally assess causal relationships between the assimilation of different nitrogen sources by phytoplankton and the availability of light;

- Determine the utilisation of different sources of inorganic and organic nitrogen by phytoplankton and bacteria;
- Determinate the rates of nitrification and the regeneration of ammonium at SCM.

Ancillary objectives were to calibrate the *SeaPoint* fluorometer and *ISUS* nitrate probe attached to the Rosette.

8.2 Methodology

Samples for inorganic nutrients (ammonium, nitrite, nitrate, orthophosphate and orthosilicic acid) were taken at all Rosette stations (Table 8.1) to establish detailed vertical profiles. Additional samples for dissolved organic nitrogen (DON) and urea were taken at stations where incubations were performed. Ammonium was determined immediately after collection using modifications of the manual fluorometric method (e.g. Holmes et al. 1999). Urea samples were stored frozen and DON samples were preserved with acid and stored in the dark at 4°C for post-cruise determination. The concentrations of nitrate, nitrite, orthophosphate and orthosilicic acid were determined on fresh samples using an Autoanalyzer 3 (Bran+Luebbe) with colorimetric methods adapted from Grasshof (1999).

Samples for the natural abundance of ^{15}N and ^{13}C in particulate organic matter were taken at 5 m and in the chlorophyll maximum at stations where incubations were performed (Table 8.1). Volumes ranging from 12 to 20 liters were filtered onto 47 mm pre-combusted GF/F filters with a peristaltic pump and the filters were desiccated at 60°C in a drying oven. These data will be used for nitrogen uptake calculations and to assess the nitrogen status of phytoplankton communities.

The relationship between light and the uptake of C and N by phytoplankton (light-gradient incubation in Table 8.1) from the chlorophyll maximum and from surface was assessed using dual labelling with stable isotopes of C and N in four light-gradient modules (10 light intensities). Temperature was maintained at *in situ* levels with a chilling circulator. Ten samples for each nitrogen source were spiked (10 with ^{15}N-nitrate and ^{13}C-bicarbonate, 10 with ^{15}N-ammonium and ^{13}C-bicarbonate, 10 with $^{13}C/^{15}N$-urea and 10 with $^{13}C/^{15}N$-glycine). Incubations were terminated by filtration onto 24-mm pre-combusted glass fiber filters. All filters were desiccated at 60°C and stored dry for post-cruise determination of isotopic enrichment and the measurement of both particulate organic carbon and nitrogen.

The rate of assimilation of the same four nitrogen sources by phytoplankton and bacteria from surface and chlorophyll maximum depth were also assessed with natural irradiance, using on-deck incubators covered with filters to simulate natural light conditions at those depths. Incubations were terminated by filtrations onto 0.8µm and 0,2µm silver filter. The filtrates of the samples incubated with ^{15}N-ammonium and ^{13}C-bicarbonate were acidified and frozen for post-cruise analysis of regeneration of ammonium using the method of

Holmes (1998) and for measurement of the nitrification rate by the extraction of ^{15}N-nitrite with the method of Olsen (1981).

Presence of dinitrogen fixation in surface water was verified by using the method described by Montoya et al. (1996) with on-deck incubators. Incubations were terminated by filtration onto 3 µm and 0,2 µm silver filter. All filters were desiccated at 60°C and stored dry for post-cruise determination of isotopic enrichment and the measurement of both particulate organic carbon and nitrogen.

The effects of incubation treatments (variable nutrient additions, temperature and light conditions) on the photosynthetic characteristics of phytoplankton were assessed by Pulse Amplitude Modulated fluorometry (PAM; Heinz-Walz). Calibration of the Rosette fluorometer was achieved by comparing the instrument's output with extracted chlorophyll *a* and PAM data. The Phytoflash system was powered by a CTD (SBE-19) and deployed in self-contained mode from the front deck.

Table 8.1. List of sampling stations and measurements for nutrients cycling during Leg 11.

Station	Cast	Nutrients	Ammonium	Urea	Amino acids	Chlorophyll extract	PAM	Natural Abundance	Phytoflash	CTD	Light Gradient	Nitrogen assimilation	Nitrification	Nitrogen fixation
303	04;08	X	X	X	X	X	X	X	X	X	X	X	X	X
302	9	X												
301	10	X	X	X		X		X	X	X				
300	13	X												
134	14	X	X	X		X		X						
136	18	X				X								
137	21	X		X										
138	22;23	X	X	X	X	X	X	X	X	X	X	X	X	X
139	24	X												
140	26	X	X	X		X	X	X						
115	28;30	X	X	X	X	X	X	X	X	X	X	X	X	X
113	33	X												
111	36	X	X	X		X		X						
110	37	X												
108	41;42	X	X	X	X	X	X	X	X	X	X	X	X	X
107	43	X												
105	45	X	X	X		X								
103	47	X												
101	50;51	X	X	X	X	X	X	X	X	X	X		X	X
200	53	X												
202	55	X		X		X		X						
204	59	X												
205	61	X	X	X		X		X						

207	63	X												
126	66;68	X	X	X	X	X	X	X	X	X	X	X	X	X
230	71	X												
232	72	X												
233	74;76	X	X	X	X	X	X	X			X	X	X	X
234	77	X												
141	79	X												
Gibbs fjord 1	83	X						X						
Gibbs fjord 2	81;82	X	X	X	X	X	X	X			X	X	X	X

8.3 Preliminary results

No preliminary results were available at the end of the leg.

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9 DMS(P) cycling and nitrous oxide (N_2O) (Arctic-SOLAS) – Leg 11

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9.1 Introduction

Dimethylsulfide (DMS) is the major volatile sulfur compound produced by marine phytoplankton and bacteria. It forms a significant link in the natural sulfur cycle, transporting the element from the ocean to the land via the atmosphere. In the atmosphere, DMS is oxidized to sulphate, which is an important component of cloud condensation nuclei. Thus the marine microbial loop exerts an important influence on atmospheric chemistry and climate by modifying patterns of cloudiness, albedo and acid precipitation. The objectives of this study were to characterize the distribution and cycling rates of DMS and its precursor compound DMSP (dimethylsulfoniopropionate) across the Canadian Arctic.

Nitrous oxide (N_2O) is a greenhouse gas produced as a by-product of normal microbial nitrogen cycling (both nitrification and denitrification). In the atmosphere, it acts as a strong greenhouse gas, third in importance after CO_2 and methane. Normal atmospheric concentrations are approximately 300 ppm, and normal seawater concentrations are near 8 nmol L^{-1} at the surface. The objective of this study was to measure N_2O concentrations in seawater profiles across the Canadian Arctic and to conduct incubation studies to determine N_2O production rates at representative sample stations. The incubations included measurements of net production rates, as well as tests to determine the influence of nutrient additions (nitrate, ammonium) and the effect of allylthiourea (a nitrification inhibitor) on the production rates. This allowed an estimation of the relative importance of nitrification and denitrification to N_2O production in these waters.

9.2 Methodology

9.2.1 DMS(P) cycling

DMS and DMSP profiles were measures at 15 stations, and process incubations were conducted at 11 of those stations using a ^{35}S isotopic tracer technique (Table 9.1). This method involved incubation with radiolabelled DMSP to estimate DMSP consumption and DMS production rates, as well as incorporation of sulfur into other biomolecules.

Incubations were conducted in both light and dark bottles wherever possible. Additional samples prepared using radiolabelled DMSP and CARD-FISH techniques will permit the sulfur-metabolizing fraction of the microbiota to be identified. At 4 stations, incubations were also conducted in quartz bottles to estimate DMS photo-oxidation, but the results were too variable to be useful. Instead, collaboration with Aubry (Xie team) was established to calculate photo-oxidation rates based on our DMS profiles using laboratory photo-oxidation experiments to be conducted in Mont-Joli after the cruise.

In collaboration with Hale and Keats (Rivkin team), estimates of the impact of microzooplankton grazing on particulate DMSP were made during deck incubations at 5 stations.

Continuous sampling of DMS was also attempeted using the TSG pump to correlate seawater DMS measurements with those made in the air by the SOLAS atmospheric sampling group (Sjosted, Seguin, Rempillo). Unfortunately, this effort was aborted due to instrument instability and the diversion to the ship to search and rescue duty.

9.2.2 Nitrous oxide (N_2O)

During the leg, 18 profile samples were collected and incubations were conducted at 11 of those stations (Table 9.1). Samples were poisoned with $HgCl_2$ and returned to Quebec on the ship for later analysis by gas chromatography.

Table 9.1. Stations sampled for DMS(P) cycling and N_2O concentrations during Leg 11.

Station	DMS(P) Profile	35S incubation - dark	35S incubation - light	CARD-FISH	MAR	DMS Photo-oxidation	DMSP grazing	N20 profile	N2O incubation
303 (Full)	X	X	X	X	X	X		X	X
301 (Basic)	X	X		X				X	
134 (Basic)	X	X	X	X	X	X	X	X	X
136 (Basic)	X							X	
138 (Basic)								X	X
140 (Basic)	X	X	X	X	X		X	X	
115 (Full)	X					X		X	X
111 (Basic)	X							X	
108 (Full)	X	X	X	X	X			X	X
101 (Basic)							X	X	
101 (Full)	X							X	X
202 (Basic)	X	X	X	X		X		X	
205 (Basic)								X	
118 (aborted)	X	X	X	X	X		X		
126 (Full)	X	X	X	X	X	X		X	X
233 (Full)	X	X		X			X	X	X

Station	DMS(P) Profile	35S incubation - dark	35S incubation - light	CARD-FISH	MAR	DMS Photo-oxidation	DMSP grazing	N20 profile	N2O incubation
141 (Basic)	X	X	X	X	X			X	X
Gibbs Fjord 2	X	X		X	X			X	X
Gibbs Fjord 1								X	

10 DMS and CO photochemistry – Leg 11

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10.1 Introduction

The objectives of the project were to:

- Determine the seasonal evolution of the microbial CO uptake kinetics;
- Study carbon monoxide and DMS photochemistry in Arctic seawater.

10.2 Methodology

Time-course incubations of microbial CO uptake were conducted at twelve stations (Table 10.1) to elucidate how CO uptake kinetics changes with CO concentration and with season. Samples were taken at 2 or 4 depths, depending on available incubation material.

Three stations were sampled for CO and DMS photochemistry study. 10L bag of water were collected at 2 depths on each of these stations. Water was filtered on 0.2µm filter cartridge to be brought back to Rimouski for photochemistry experiments.

Table 10.1. Data collected aboard the ship during Leg 11.

Station	Date	Depths for incubation	DMS	Microbial CO uptake
303	07-Sept-08	0 (bucket), 5m, 10m, 20m	x	x
301	08-Sept-08	0 (bucket); 5m		x
134	09-Sept-08	0 (bucket); 5m		x
140	11-Sept-08	0 (bucket); 5m, 10m, 23m	x	x
111	13-Sept-08	0 (bucket); 5m		x
108	14-Sept-08	0 (bucket); 5m, 7m, 17m		x
101	15-Sept-08	0 (bucket); 5m		x
205	16-Sept-08	0 (bucket); 5m		x
126	18-Sept-08	0 (bucket); 6m, 11m, 20m	x	x
233	19-Sept-08	0 (bucket); 5m, 10m, 20m		x
141	23-Sept-08	0 (bucket); 5m, 10m, 19m		x
Gibbs 2	24-Sept-08	0 (bucket); 6m, 10m, 20m		x

11 Microbial diversity and foodwebs – Leg 11

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11.1 Introduction

11.1.1 Microbial foodwebs

A central hypothesis of the Arctic SOLAS project was that changes in water transport in the Lancaster Sound/Baffin Bay region in response to climate change could modify the sea-air fluxes of biogenic climate active gases in this region. The study area was selected to allow sampling of contrasting Pacific and Atlantic water masses, with gradients in ice cover, surface mixed layer depth, and nutrient composition and concentrations: factors that are all known to affect food web structure and biogenic gas production.

As microbial foodwebs play a crucial role in the cycling of energy and materials in the ocean, the key objectives were to determine depth profiles of the following variables:

- Abundance and biomass of heterotrophic bacteria (including high and low DNA content), and eukaryotic picoplankton and nanoplankton;
- Abundance and biomass of microzooplankton and nanoflagellates ;
- Bacterial community composition and substrate utilisation (^{3}H-Leucine and ^{3}H-Glucose);
- Heterotrophic bacterial production rates.

11.1.2 Microbial diversity

Microbial diversity in these waters is of particular interest. Molecular analyses work hand in hand with microscopy to identify species, functional groups, and taxa from all three domains of life. The goal of this cruise was mainly to collect the samples. Subsequent analyses are labour intensive, and will take place in the lab on shore.

11.2 Methodology

11.2.1 Microbial foodwebs

Water was collected from the Rosette at 100%, 50%, 30%, 15%, 5%, 1% and 0.2% light depths, at 200 m, and at the chlorophyll max. Abundance and biomass of heterotrophic bacteria and eukaryotic picoplankton and nanoplankton were determined by flow cytometry

(Marie et al. 1999, Li and Dickie 2001) and image analysis of acridine orange stained cells (Hobbie et al. 1977, Loferer-Krößbacher et al. 1998), while abundance and biomass of microzooplankton and nanoflagellates were determined by light and fluorescence microscopy. The bacterial community composition and substrate utilisation was assessed using Fluorescence *in situ* Hybridisation (FISH) and Microautoradiography (MAR-FISH) (Pernthaler et al. 2001) and heterotrophic bacterial production rates were determined by ^{14}C-Leucine uptake (Chin-Leo and Kirchman 1988).

Incubation experiments

Incubation experiments were conducted at the 50% light depth at 6-7 stations (Table 11.1) to determine the factors controlling the growth and loss rates of bacterioplankton:

1. Rates of microzooplankton herbivory (determined by HPLC and flow cytometry) and bacterivory (determined by flow cytometry) using a modified dilution assay (Landry and Hassett 1982, Rivkin et al. 1999). Seawater was collected from the 50% light depth and filtered through a 202 μm Nitex mesh to remove larger grazers before being diluted with particle-free filtrate (0.2 μm filtered seawater) to the following target dilutions (< 202 μm: < 0.2 μm filtered water): 1.0, 0.9, 0.75, 0.5, 0.4, 0.3, 0.2 and 0.1. Samples were incubated in 4-L polycarbonate bottles, in on-deck incubators at ambient temperatures and ~55% of incident irradiance, for 48 h. In collaboration with Scarratt and Michaud (Scarratt/Levasseur team), estimates were made of the impact of grazing on particulate DMSP during 5 of the microzooplankton grazing experiments.

2. Nutrient regulation of bacterial growth (determined by flow cytometry) and community composition (determined by FISH) in nutrient amendment experiments. Seawater was collected at the 50% light depth and modified seawater (MSW) dilution cultures were made with 1 part 1.0 μm filtered seawater to 4 parts 0.2 μm filtered seawater (Rivkin and Anderson 1997), and incubated in 500 ml polycarbonate bottles in the dark and at ambient temperature. Triplicate MSW cultures were either unamended (i.e. control) or amended with additions of organic carbon (glucose), and inorganic nitrogen (NH_4Cl) and phosphorous (Na_2HPO_4), each to a final concentration of 10 μM, in a full factorial matrix.

Additional collaborations and sampling

In collaboration with the Tremblay and Scarratt/Levasseur teams, bacterial abundance was determined, as well as production rates at the surface and chlorophyll maximum on 7 additional casts, corresponding to incubations measuring nitrification rates and production rates of N_2O.

Table 11.1. Number of depths where samples were collected for flow cytometry (FCM), bacterial biomass (BB), bacterial production (BP), bacterial community composition (FISH) and substrate uptake (MAR-FISH), and microzooplankton and nanoflagellate abundance and biomass (Protists) at each station. Microzooplankton grazing experiments (MZG) and nutrient amendment experiments (NA) were conducted at the 50% light depth, where indicated (X).

Station ID	FCM	BB	BP	FISH	MAR-FISH	Protists	MZG	NA
303	7	7	7	4	3	4	X	X
301	7	7	5	4		4		
134	8	8	8	4	3	4	X	X
136	8	8	5	4		4		
140	8	8	8	4	3	4	X	X
115	8	8	8	4		4		
111	8	8	6	4		4		
108	8	8	8	4	3	4	X	X
105	7	7	5	4		4		
101	8	8	8	4	3	4	X	X
202	8	8	5	4		4		
118	8	8	8	4	3	4		
126	8	8	8	4	3	4	X	X
233	8	8	6	4		4		
141	8	8	6	4		4		
Gibbs 2	8	8	6	4		4	X	
Gibbs 1	8	8	6	4		4		

11.2.2 Microbial diversity

A full suite of samples, including DNA, RNA, FISH, chlorophyll, and samples for fluorescent and conventional light microscopy were taken from each Full station, as well as two additional Basic stations (134 and 138) on the SOLAS transect (Table 11.2). Most samples were collected from eight depths, with the exception of RNA, which because of limitations of equipment could never be sampled from more than four depths. Depths were selected based on the CTD profile of the cast and included the surface, bottom, chlorophyll max, and other depths of interest such as the nitricline, O_2 minimum, or different water masses.

At Station 115, an additional four depths were sampled from a second Rosette to capture the diurnal variation in this area. The Full Rosette took place 17 h after the “short” Rosette.

DNA and RNA

Three peristaltic pumps with four heads each made it possible to collect DNA samples from eight depths and RNA samples from four depths at each station sampled. Up to 6 L of water was filtered through a double filtration system to separate the <3 µm and >3 µm size fractions, and these filters were stored in an appropriate buffer and frozen at -80 ºC.

Fluorescent *in situ* Hybridization (FISH)

Samples for FISH were collected from eight depths at each station sampled, preserved with filtered 37 % formaldehyde, and filtered on board in duplicate for bacteria (0.2 μm pore size) and eukaryotes (0.8 μm pore size).

Chlorophyll

Samples for chlorophyll *a* in the total fraction and <3 μm size fraction were filtered from eight depths at each station sampled. These samples were frozen for transport back to Quebec where they will be extracted and quantified.

Fluorescent Microscopy Samples

Samples for fluorescent microscopy were collected from eight depths at each station sampled and preserved with 10 % glutaraldehyde. Samples from Stations 303, 134, 138 and Cast 27 of Station 115 were stained with DAPI, filtered on board, and made into slides for the enumeration of bacteria and eukaryotes. Because stocks of DAPI ran out, only the slides for eukaryote abundance were made for Cast 30 of Station 115, and no slides were made after this point. Instead, samples were preserved in 50 ml centrifuge tubes for transport back to Quebec.

Conventional Light Microscopy Samples

Samples for conventional light microscopy were collected from eight depths at each station sampled and preserved by the addition of a few millilitres of Lugol's acid. Once ashore, these samples will be sedimented in Utermöhl chamber and examined using an inverted microscope for more precise species identification.

Table 11.2. Number of depths sampled at each cast and station, and categorized by sample type.

Station	Cast	DNA	RNA	Chlorophyll	FISH		Fluorescent microscopy		Lugol's
					bact.	euk.	bact.	euk.	
303	8	8	4	7	7	7	7	7	7
134	16	8	4	8	8	8	8	8	7
138	22	7	4	6	7	7	7	7	6
115	27	4	4	4	4	4	4	4	4
115	30	8	4	8	8	8	0	8*	8
108	41	8	4	8	8	8	8*	8*	8
101	51	8	4	8	8	8	8*	8*	8
126	68	8	4	8	8	8	8*	8*	8
233	76	8	4	8	8	8	8*	8*	8
141	79	4	4	4	0	4	4*	4*	4
Gibbs 2	81	8	4	8	8	8	8	8	0

*Starred depths for fluorescent microscopy were sampled, but processing is incomplete.

11.3 Preliminary results

Extra time owing to search and rescue operations made it possible to begin examination of microscope slides and analysis of fluorescent samples. A sample figure is appended (Figure 11.1).

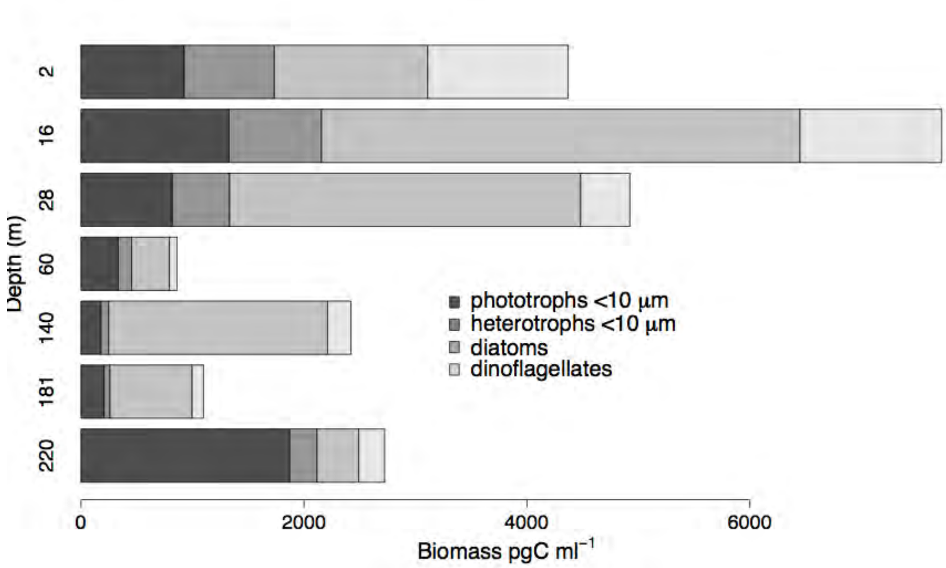

Figure 11.1. Profile of eukaryote biomass in the water column at Station 303, Lancaster Sound (74°14.266 N, 089°39.469 W), on 9 September 2008.

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12 Phytoplankton and primary production – Leg 11

ArcticNet Phase I – Project 1.4: Marine Productivity & Sustained Exploitation of Emerging Fisheries. http://www.arcticnet.ulaval.ca/pdf/phase1/14.pdf
ArcticNet Phase I – Project 3.3 Climate Variability / Change and Marine Ecosystem Resources in Hudson Bay. http://www.arcticnet.ulaval.ca/pdf/phase1/33.pdf

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12.1 Introduction

The general research objectives of this study were to determine:

- Temporal variability of phytoplankton production, biomass and abundance;
- Role of environmental variables on the phytoplankton dynamics.

In the Canadian High Arctic, the ArcticNet transect began in the Canadian Archipelago and included an important transition region, from Lancaster Sound to Baffin Bay. This project aimed to characterize phytoplankton production and biomass between different oceanographic regions (including the Beaufort Sea with the CFL project) in terms of algal species composition and abundance and to establish the relationships between the environmental variables and the changes occurring in the abundance, the species composition and the primary production of the Arctic planktonic microflora. The following hypotheses were tested:

- Beaufort Sea, strongly stratified and poor in nutrients, is characterized by a weak primary production and dominated by small phytoplankton;
- Baffin Bay is weakly stratified and rich in nutrients, promoting highly productive large phytoplankton;
- Inter-annual variability of phytoplankton production and biomass is linked to the sea-ice extent and predominant wind direction.

12.2 Methodology

Phytoplankton is the basement of the marine food chain and depends on the amount of light or PAR (Photosynthetic Active Radiation) and nutrients availability. Euphotic zone depth was established according to the light attenuation in the water column measured using a Secchi disc (Holmes 1970). Light profiles were conducted with a Natural Fluorescence Profiler (PNF 300) and the atmosphere irradiance with a Li-Cor 2 pi. Water samples were collected with *Niskin®* bottles mounted on a CTD rosette (*Seabird 911 plus®*). Seven optical depths were sampled (100%, 50%, 30%, 15%, 5%, 1% and 0.2% of the surface irradiance). Three to 4 aphotic depths (75, 100, 200 and 400 m) and the depth of the maximum chlorophyll *a* (chl *a*) were sampled whenever they were available. Nutrients availability was analyzed by Jean-Éric Tremblay's team.

Samples were filtered for size-fractionated chl *a* (>0.7 µm, >5 µm and >20 µm), particulate organic carbon and nitrogen (POC/PON), dissolved organic carbon and total organic carbon (DOC/TOC), high performance liquid chromatography pigment analysis (HPLC), taxonomic cell identification (cells fixed in Lugol Acid and Formalin will be counted with inverted microscopy), abundance and size class of pico/nanoalgae and bacteria with flow cytometry.

Size fractioned (>0.7 µm and >5 µm) primary production was completed to estimate daily primary production at 7 photic depths (100%, 50%, 30%, 15%, 5%, 1%, and 0.2% of the surface irradiance, maximum chlorophyll switch with the nearest value of irradiance percent) following JGOFS protocol for simulated *in situ* incubation. A radioactive tracer (^{14}C) was used to determine the phytoplankton carbon uptake rate. An incubator installed on the foredeck was used to recreate the depth-related variability of the light with different filters wrapping Plexiglas tubes. The major issue was the temperature of the incubator, which was fluctuating a lot and was always 5 degrees Celsius above the surface temperature of the High Canadian Arctic water. The main purpose of this incubator was to create the same environmental conditions found in the water column for *in situ* experiments.

Table 12.1. Standing stock sampling: number of depths sampled for each variable during Leg 11.

Station	Date (jj/mm/aa)	DOC/TOC	Chl a	POC/N	HPLC	Cells	Bacteria	Pico- and nano-plankton
303	07/09/08	4	10	4	2	3	6	6
301	08/09/08	4	10	4	2	3	6	6
134	09/09/08	4	10	4	2	3	6	6
136	10/09/08	4	11	4	2	3	6	6
140	11/09/08	4	10	4	2	3	6	6
115	12/09/08	4	10	4	2	3	6	6
111	13/09/08	4	10	4	2	3	6	6
108	14/09/08	4	10	4	2	3	6	6
101	15/09/08	4	11	4	2	3	6	6
202	16/09/08	4	11	4	2	3	6	6
205	16/09/08	4	11	4	2	3	6	6
118	17/09/08	4	11	4	2	3	6	6
126	18/09/08	4	11	4	2	3	6	6
233	19/09/08	4	11	4	2	3	6	6
141	23/09/08	4	11	4	2	3	6	6
Gibbs 2	24/09/08	4	11	4	2	3	6	6

DOC/TOC: Knap et al. 1996; Chl *a*, POC/N and Cells: Parsons et al. 1984; HPLC: Zapata et al. 2000; Bacteria and Pico- and Nano-plankton: Marie et al. 2005.

Table 12.2. Rate measurements: number of depths at which experiments were conducted during Leg 11.

Station	Date (jj/mm/aa)	Primary production		
		TOC	POC (>0.7 µm and >5µm)	DOC (<0,2µm)
303	07/09/08	7	7	7
134	09/09/08	7	7	7
115	12/09/08	7	7	7
108	14/09/08	7	7	7
101	15/09/08	7	7	7
126	18/09/08	7	7	7
233	19/09/08	7	7	7
Gibbs 2	24/09/08	7	7	7

12.3 Comments and recommendations

This project was supported by a Network of Center of Excellence Grant (ArcticNet), and Discovery Grant from the Natural Sciences and Engineering Research Council (NSERC) of Canada. We are grateful to the Canadian Coast Guard captain, Lise Marchand, officers and crew of the *CCGS Amundsen* for their skilful support during the 2008 Leg 11 of ArcticNet. We acknowledge the invaluable support of the chief scientist, Martin Fortier, during the expedition as well as several of the scientific staff who provided some assistance in the conduct of our sampling program.

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13 Zooplankton and ichthyoplankton – Leg 11

ArcticNet Phase I – Project 1.4: Marine Productivity & Sustained Exploitation of Emerging Fisheries. http://www.arcticnet.ulaval.ca/pdf/phase1/14.pdf
ArcticNet Phase I – Project 1.5 Changes in Dietary Pattern and Impacts on Chronic Diseases Emergence. http://www.arcticnet.ulaval.ca/pdf/phase1/15.pdf.
ArcticNet Phase I – Project 3.3 Climate Variability / Change and Marine Ecosystem Resources in Hudson Bay. http://www.arcticnet.ulaval.ca/pdf/phase1/33.pdf.
ArcticNet Phase I – Project 3.7 Nunatsiavut Nuluak: Baseline Inventory and Comparative Assessment of Three Northern Labrador Fiord-based Marine Ecosystems. http://www.arcticnet.ulaval.ca/pdf/phase1/37.pdf.

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13.1 Introduction

The general objective of the project is related to the overarching goal of ArcticNet 'Marine productivity and sustained exploitation of emerging fisheries', which is to assess the impact of sea-ice cover reduction and increasing sea temperatures on biological productivity, fisheries resources and marine mammal populations of the coastal Canadian Arctic. This assessment aims to document and anticipate the present and future biodiversity/availability of marine renewable resources, and to propose management strategies for a sustainable exploitation. Aboard the *CCGS Amundsen*, key indices of the ecosystem maturity were collected at the end of the biological production season and automated instruments that recorded all year-long the vertical flux of biogenic matter and marine mammal distribution were recovered.

The main field objectives of this project were to:

- Assess zooplankton / fish abundance and diversity by using various plankton nets;
- Track zooplankton / fish biomass and distribution with the EK60 Echosounder;
- Turnover the automated sediment traps and hydrophones deployed on the moorings.

In addition, zooplankton samples collected will also serve other ArcticNet-CFL subprojects such as the cycling of contaminants (G. Stern). As well, part of the samples collected will be used in a study to identify the sources and pathways of omega-3 in the Arctic marine food chain (J. Michaud, E. Dewaily and L. Fortier) to assess the importance of omega-3 fatty acid in the traditional diet of Inuit communities. The respiration rates of the zooplankton community will be quantified at chosen stations (G. Darnis and L. Fortier) and zooplankton samples will be collected for genetic studies at Woods Hole Oceanographic Institution (V. Starczak) and at UQAR (F. Dufresne and A. Radulovici). Last, Arctic cod laboratory analysis will be added in the pre-existing dataset to validate a biological individual-based model of larval survival and growth (S. Thanassekos and L. Fortier).

13.2 Methodology

In total, zooplankton and fish sampling was conducted at 17 stations (Table 13.1). Acoustic EK60 monitoring was done continuously during the whole cruise. One automated sediment trap deployed in 2005 was recovered at station BA-01 and all the 24 samples were collected. Table 13.1 summarizes the sampling activities at each of the 17 stations.

Table 13.1. Summary of stations visited and samples collected during Leg 11.

					Type	Fishing gear					Measurements								
												Dry weight					R-ETS		
Region	Station	Date (UTC)	Latitude (N)	Longitude (W)	Basic (B) or Full (F)	VTOW (4 x 1 m^2)	Hydrobios	Rosette	OTOW (2 X 1m^2)	RMT	Taxonomy	Profile	Population	Ind. dry weight	Lipids	Respiration profile	Population	Individuals	Contaminants
Barrow	303	7-9	74° 14.06	-89° 40.36	F	x	x	x	x	x	x		x	x	x		x	x	x
Lancaster	301	8-9	74° 07.17	-83° 20.72	B	x			x		x			x					x
N- Baffin Bay	134	9-9	74° 28.00	-78° 59.97	B		x		x	x	x							x	x
N- Baffin Bay	136	10-9	74° 45.39	-73° 45.88	B	x			x		x		x	x			x		x
N- Baffin Bay	138	11-9	74° 56.21	-69° 04.15	B		x		x		x	x				x			x
N- Baffin Bay	140	11-9	75° 01.93	-64° 28.74	B	x			x		x								x
NOW	115	12-9	76° 19.68	-71° 15.95	F	x	x	x	x	x	x	x				x			x
NOW	111	13-9	76° 18.40	-73° 12.91	B	x			x		x			x					x
NOW	108	14-9	76° 15.41	-74° 34.80	F	x	x*		x	x	x	x	x	x		x			x
NOW	105	15-9	76° 06.95	-75° 39.47	B	x			x		x								x
NOW	101	15-9	76° 21.90	-77° 27.70	B	x	x				x	x	x	x			x	x	x
NOW	202	16-9	76° 47.71	-76° 57.15	B	x			x		x								x
NOW	205	16-9	77° 13.27	-78° 52.49	B	x			x		x			x					x
NOW	118	17-9	77° 18.62	-76° 38.66	B		x		x		x								x
NOW	126	18-9	77° 20.08	-73° 24.26	F	x	x*	x	x	x	x	x*		x	x	x		x	x
NOW	233	19-9	76° 43.90	-71° 48.21	F	x	x		2x		x	x	x	x	x	x	x	x	x
Fjords	Gibbs-2	24-9	70° 45.40	-72° 20.38	B	x			x		x		x	x	x		x	x	x
						14	10	3	17	5									
				Total						49									

* Day and night profile

13.2.1 Zooplankton and fish sampling

<u>Vertical tows</u>

4x1-m² Square (Monster Net, Figure 13.1a): Frame rigged with four square 1m^2 opening nets (3 x 200, 2 x 500 µm mesh), out-rigged with a 10 cm diameter net (50 µm) and equipped with flowmeters (2 GOs and 2 TSKs). These nets were used for integrated water column sampling. When deploying, down and up winch speeds were both 30m/min. The content of one 200 µm (TSK-QT) and the 50 µm mesh-net were preserved in formaldehyde for taxonomy (Fortier). The content of the three other nets were sorted for contaminants, lipids, genetics, and respiration studies (Table 13.1). This gear was systematically deployed at all Basic and Full stations, with the exception of the deep Stations 134 and 138 where the quadruple net tows were replaced by Hydrobios casts.

Technical problems occurred during deployment of the 4x1-m^2 square net at Stations 115 and Gibbs 2. On the two occasions the frame and the wire got entangled and the gear did not filter any water on the tow up. At Station 115, this prevented the collection of vertically integrated zooplankton samples. Fortunately, there was enough time to make a second successful deployment at Station Gibbs 2. At the Full Station 118, the deployment was cancelled because of a combination of ice, wind and current conditions that prevented safe sampling. The objective was to return to this site to resume sampling when conditions would improve, but this could not be done.

Hydrobios: Multi plankton sampler (Figure 13.1b) equipped with nine 200 µm-mesh nets (opening 0.5 m^2). This was allowing for depth specific sampling of the water column. The Hydrobios is also equipped with a CTD to record water column properties while collecting biological samples. When deploying, winch speed down was 40 m/min, while speed up was 30m/min to collect samples in good conditions for ETS essays and biomass measurements.

The Hydrobios was routinely deployed at Full stations when conditions were favourable. Basic Stations 134 and 138 of the SOLAS transect had the 4x1-m^2 square net replaced by a Hydrobios cast. With Station 138, this will provide the third vertical profile of Arctic zooplankton distribution deeper than 1000 meters since the multinet Hydrobios is part of the scientific pool of equipment of the *Amundsen*. The two other deep profiles were made on the continental slope of the Beaufort Sea in October 2003 and July 2008, respectively.

In the North Water polynya, daytime as well as nighttime Hydrobios casts were carried out at Full Stations 108 and 126 to investigate the occurrence of zooplankton diel vertical migration (DVM). From a very quick glance at the surface samples of the two casts, it can easily be seen that the copepod *Metridia longa* was involved in a DVM at the two sites.

At Full Station 118, the ice, wind and current conditions made for a close to catastrophic Hydrobios cast. The gear hit the bottom and the deepest layer sample was contaminated by benthic organisms and mud. Furthermore, the zipper of net #2, attaching it to the frame, broke. Then, the necessity to manoeuvre the ship during towing up mixed the surface layer and the samples collected were thus most probably not representative of the natural zooplankton surface distribution. Unfortunately, it was not possible to make another deployment and the station was left before its completion. A series of small incidents involving loss of communication with the gear occurred during several deployments. Each time, the vigilance of the Hydrobios operator prevented the set to zero of the parameters that could have had serious consequences on the sampling. Furthermore, most of the nets are in a poor state and are worn out after five years of sampling and ill treatment on the foredeck of the ship. The now three year recurrent problem with the *Hydrobios*'s flowmeters has not been resolved yet (they work on deck, but not in the water).

Rosette: In the absence of a sampler under 200µm mesh size able to stratify the water colum, the Rosette was used at the median depth sampled with the Hydrobios (Nielson and Anderson 2002) as to obtain the vertical distribution of the small zooplankton. Nine samples originating from 2 bottles at each depth (i.e. 24 L total) were collected, concentrated on 50µm mesh sieves and preserved in 4% buffered formalin for ulterior taxonomic identification and count. Only 3 stations were sampled, mainly due to time constraints on Full stations and unsuitable weather.

<u>Oblique tows</u>

Double 1-m² (Tucker Net, Figure 13.1c): Rigged with two 1 m^2-opening nets (500 µm mesh each), out-trigged with a 10 cm diameter net (50 µm mesh) and equipped with flowmeters (1 GO & 1 TSK) and a temperature-depth recorded (TDR). When towed, ship sailed at 2.0-2.5 knots. Winch speed down was around 30 m/min (0.5 m s^{-1}) and around 20 m/min on the way up. This gear was mainly used to catch fish larvae (see Figure 13.5 for details of the catches) and to provide water column zooplankton samples from the upper 90 m layer. One of the 500-µm mesh net was preserved in 4% buffered formaldehyde for taxonomy and the other 500 µm mesh net was sorted for contaminants, lipids and genetics studies. This gear was deployed at Basic and Full stations when conditions were favourable. No oblique tow was carried out at Station 101 due to severe wind conditions.

RMT: Rectangular Mid-water Trawl (Figure 13.1d) of an opening of 9 m^2 fitted with a 1600 µm mesh-net and equipped with a flowmeter and a TDR. When towed, ship speed was typically 2-3 knots; winch speed down was 30 m/min (0.5 m s^{-1}) and around 20 m/min on the way up. This net, only deployed at Full stations, was used to catch larval and juvenile fish. Collected zooplankton was equally divided for taxonomic and contaminant studies.

At Station 126, the codent hit the frame and broke in two parts so that the RMT had to be brought back on deck. The tail of the net was tightly tied with a rope to allow the sampling. However, the larvae caught on this cast were in a poor state and barely exploitable for analysis. Thus it was decided to replace the RMT deployment at the next Full station by another double 1-m^2 net tow. This decision was made because the RMT did not show much more fish sampling efficiency than the double 1-m^2 net on the previous deployments.

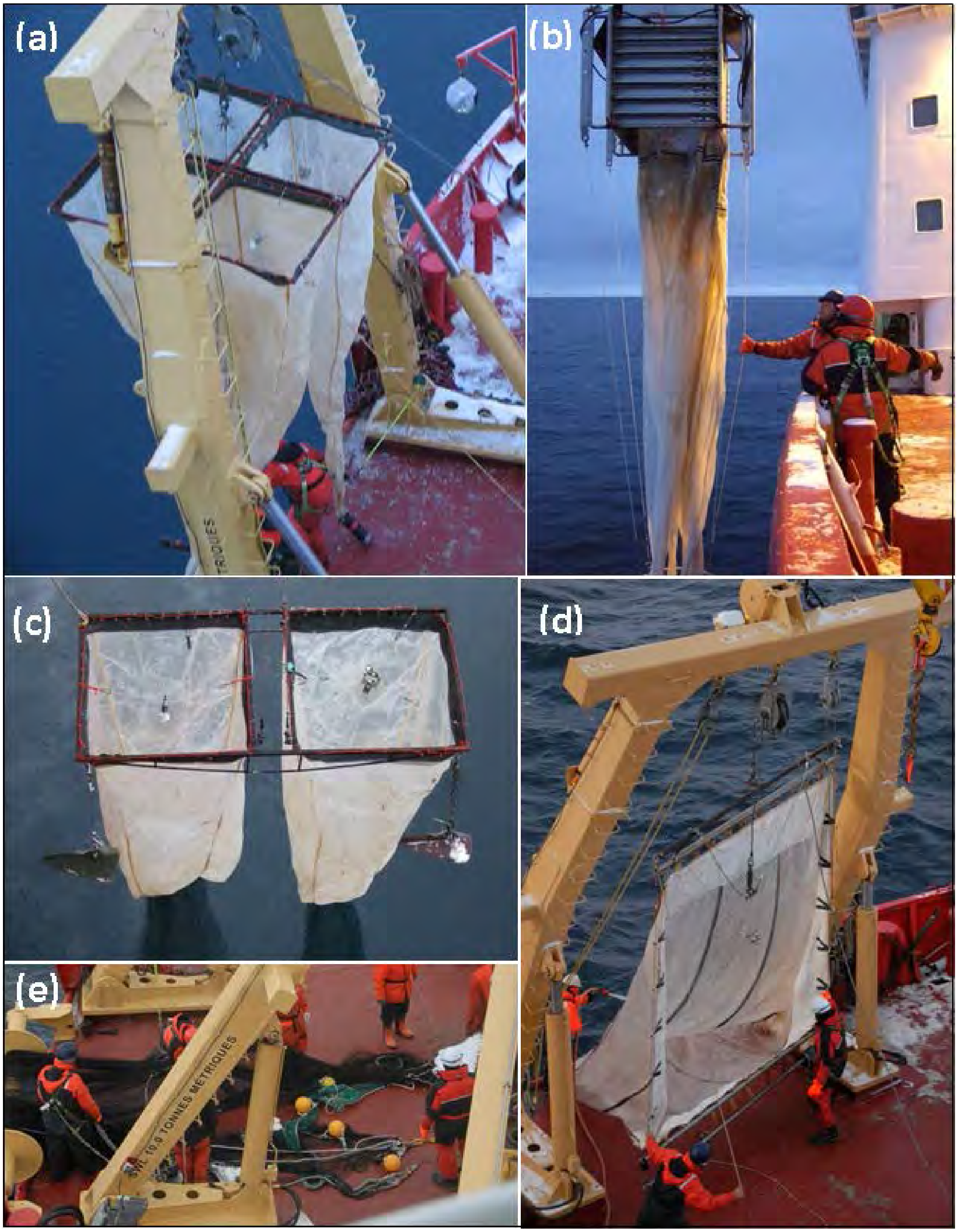

Figure 13.1. Photos of the different sampling equipment used to collect zooplankton and young fish. (a) 4x1-m^2 Square (Monster Net), (b) Hydrobios Multi plankton sampler, (c) Double 1-m^2 (Tucker Net), (d) RMT (Rectangular Mid-water Trawl) and (e) Experimental Mid-water Trawl.

13.2.2 Acoustic monitoring

The *Amundsen* is equipped with a scientific echosounder, the EK-60 that continuously monitored the distribution of zooplankton and fish in the water column. A particular attention was devoted to Arctic cod, *Boreogadus saida*, which plays a key role in Arctic marine ecosystems. At least, on a daily basis, one member of the team went to verify that the data recorder was on. Near the end of the mission, the more precise EK-60 depth reading than the ship's echosounder was used to set the sampling depth for vertical deployments at deep stations.

13.2.3 Sediment traps

The automated sediment traps were installed on oceanographic moorings to collect sequentially over the year the vertical flux of sinking particles (e.g. senescent plankton, fecal pellets and detritus). The characterization of the vertical particle flux constitutes key information to understand marine ecosystem dynamics and the impacts of environmental changes. For example, the magnitude of the flux's biogenic component (the organic fraction) is directly linked to surface biological production and food web processes. In coastal shelf areas (such as Beaufort Sea), the collection of sinking particles also serves to estimate the input of terrigenous material (the inorganic fraction) into the Arctic Ocean. Both biological production and terrigenous inputs are expected to increase with sea ice reduction and temperature increases in the Arctic. The consequences of these environmental changes on the food web and carbon cycling are unknown. Hence, the sediment trap deployments constitute a crucial element of ArcticNet's monitoring program that aims to establish a long-term series of marine observatories in the Canadian Arctic.

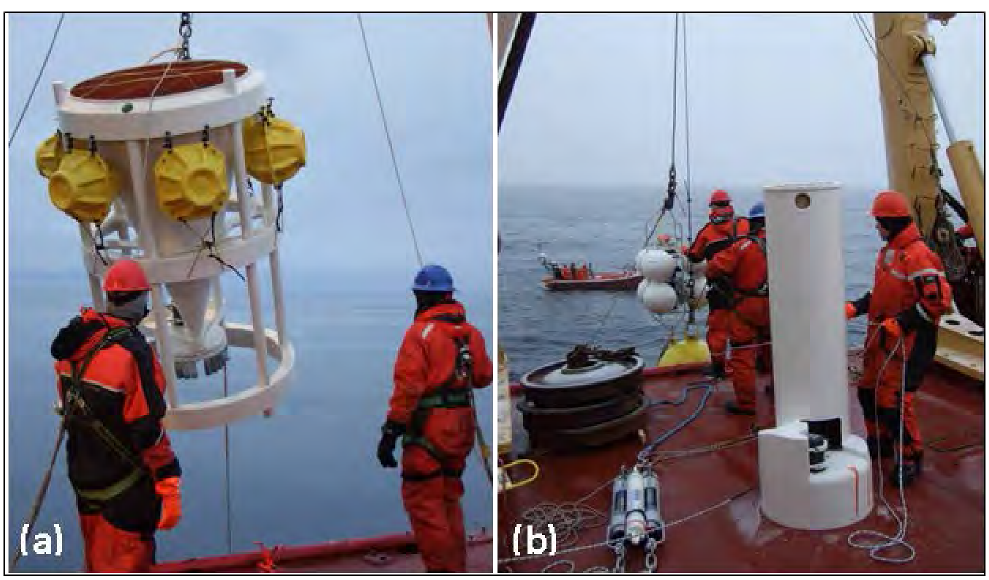

Figure 13.2. Moored sediment traps: (a) large PP5 retrieved at CA18 and (b) new PP3-24 cups deployed at CA05.

One deep sediment trap deployed in 2005, and which sampled from the time of deployment to summer 2006 at Station BA-01, could not be recovered during the 2006 ArcticNet mission. Thus an ROV dive was programmed as an attempt to bring it back from the depths. The operation proved to be a total success and the 24 cups holding the sediments from the 2005-06 year were all recovered and stored for future analysis at Laval University.

13.2.4 Laboratory analysis

Preservation for dry weight measurements

At Stations 126 and 233 in the North Water Polynya, copepodites of developmental stages 4, 5 and adults of *Calanus glacialis*, *C. hyperboreus* and *Metridia longa* were sorted and put individually in tin cups kept on desiccant for dry weight and CHN measurements back at Laval University.

Biomass and Transfer System (ETS) activity

Samples were sorted for dry mass and ETS activity assays to permit the realization of zooplankton respiration and biomass profiles at 5 and 6 stations, respectively. At these stations, each Hydrobios net was subdivided: 50% for taxonomy (i.e. preserved in 4% buffered formaldehyde), 25% for population dry mass and carbon estimates and 25% for ETS activity measurements. For dry mass estimates, the sub-sample (i.e. 25% of total sample) was fractionated with sieves in >1000 µm and <1000 µm size classes; these fractions were preserved at -20°C. Sub-samples for zooplankton population ETS activity assays (i.e. 25% of the total sample) were also sieved through the same two size fractions. As no Sanyo incubator was available for the ETS experiments, samples were incubated in a Pyrex plate filled with water and heated to 40°C on a hot plate. Temperature of this 'hot tub' proved to remain constant during the required incubation time.

Respiration experiments

To derive respiration from the activity of the Electron Transfer System (ETS), a ratio of respiration on ETS activity is required. Thus a number of direct measurements of respiration by incubations in sealed chambers were carried out to measure oxygen consumption of zooplankton assemblages (5 experiments) and selected copepods species (6 experiments). After the measurement of the concentration of dissolved oxygen at the end of the incubation, the zooplankton was treated for ETS activity measurements.

Larval fish sampling and laboratory analysis

Larval fish were mainly sampled with double Tucker net and RMT oblique tows, and occasionally with other gears. Upon net recovery, larval fishes were removed from samples (to avoid mortality caused by jellyfishes) and kept in beakers filled with cold seawater. Arctic cod were individually measured and photographed as fast as possible to avoid shrinking due to death. A minimum of 25 individuals per sampling device was treated when stations were close to each other (more when time allowed), while the remaining fishes were preserved as bulk. Two types of preservations were used; into ethanol (95% pure) for age determination (otolithometry) and gut content analysis, or frozen (-80°C) for later fresh weight measurement and genetics at Laval University. The two preservation methods were equally used and fishes were distributed in order to cover the widest size range possible for each treatment.

13.3 Preliminary results

A total of 473 larval and juvenile fishes were captured as follows:

- 347 with the oblique double Tucker net (17 deployments);
- 117 with the RMT (5 deployments);
- 7 with the vertical quadruple net (4 deployments);
- 2 with the Hydrobios (1 deployment).

Arctic cod accounted for 90 % of total catch (Figure 13.3) and *Liparis* dominated the remaining percentage.

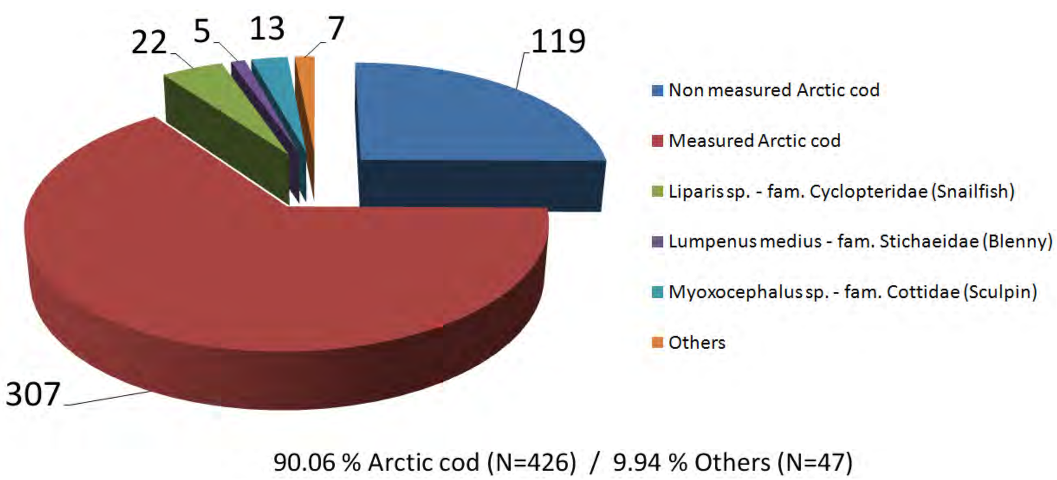

Figure 13.3. Species chart pie of larval and juvenile fishes captured during ArcticNet 2008 Leg 11.

Preliminary results show the presence of two, maybe three, cohorts (Figure 13.4). The smaller individuals were caught at the beginning of the cruise in Lancaster Sound (Stations 303, 301 and 134) and belong therefore to the latest hatched individuals. The North Water

Polynya covers the widest size range, and as in Gibbs Fjord (GB2), was inhabited by the bigger individuals. The individuals captured in these two regions have therefore hatched the soonest, underlying the importance of water temperature increase during the polynya opening in North Water (as it has already been observed) and possibly thanks to freshwater runoff in Gibbs fjord. Individuals captured in Baffin Bay had an average length close to the overall average length and could belong to the Northwater area, or result from a mixing between individuals from Lancaster Sound and individuals from the North Water Polynya.

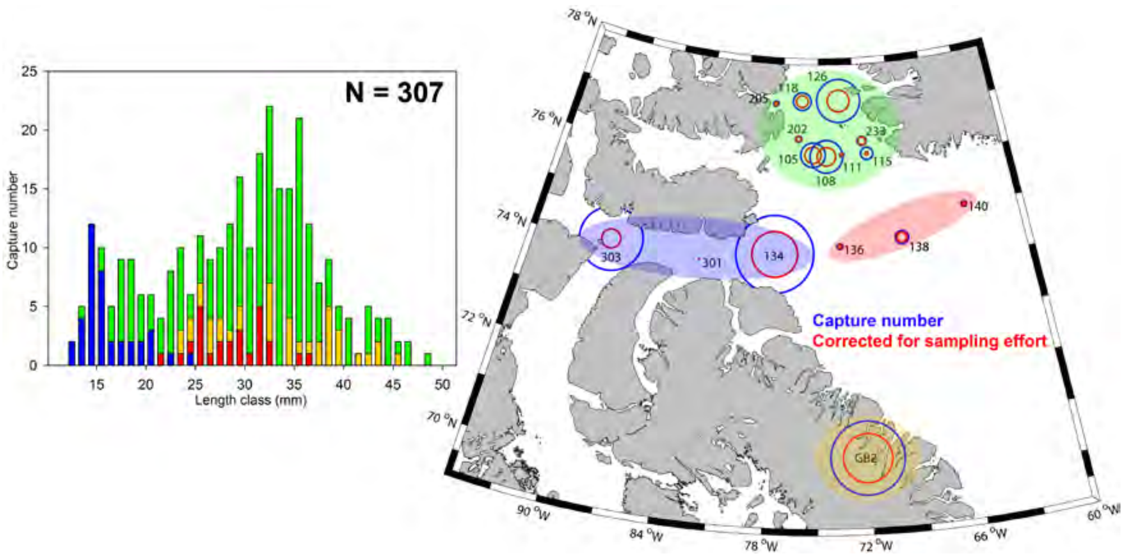

Figure 13.4. Length class frequency and spatial distribution of young Arctic cod captured during ArcticNet 2008 Leg 11. Colored areas in the map correspond to the colors used in the length class frequency distribution.

13.4 Comments and recommendations

For the deployment of the vertical sampling gears, we recommend the systematic use of the EK-60 depth reading to set the sampling depth. This will limit the incidents when the nets hit the bottom and possibly get damaged.

A platform could be built on the foredeck to receive Hydrobios nets and carousel and protect them from tearing. Some of the nets should be renewed as they are worn out after two full years (CASES and CFL programs) and several harsh sampling seasons. This holds also for the Monster and Tucker nets. Moreover, the flowmeters on the Hydrobios should be repaired for deployments from the foredeck. The TSK and GO flowmeters installed on the other samplers should be verified and repaired as well.

Quality of the data on juvenile Arctic cods would greatly benefit from a better set up for image capture and treatment. The gain in efficiency then would allow the allocation of some of the time thus saved to other experiments.

Reference

Nielsen, T.G. and Andersen, C.M., 2002. Plankton community structure and production along a freshwater-influenced Norwegian fjord system. Marine biology, 141(4): 707-724.

14 Contaminants sampling program – Leg 11

ArcticNet Phase I – Project 1.3 Contaminant Cycling in the Coastal Environment. http://www.arcticnet.ulaval.ca/pdf/phase1/13.pdf

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14.1 Introduction

This project addressed the questions of how climate variability in physical forcing and the biogeochemical response to this primary forcing affect hexachlorocyclohexane (HCH) and mercury (Hg)/methyl mercury (MeHg) contaminant cycling in the Arctic. Ultimately, changes in delivery and biogeochemical cycling of these contaminants will be related to their levels in fish, marine mammals and the people who consume them as part of their traditional diets.

14.1.1 Hexachlorocyclohexane (HCH)

Technical HCH is a mixture of several isomers, the most abundant being α-HCH (60-70%), γ-HCH (5-12%) and β-HCH (10-15%) (Iwata et al. 1993). Technical HCH and pure γ-HCH (lindane, pesticide active isomer) have been used for over 50 years and are now ubiquitous in water throughout the northern hemisphere (Dickhut et al. 2004, Harner et al. 1999, Iwata et al. 1993, Jantunen and Bidleman 1995, 1996, 1998, Jantunen et al. 2004, Lakaschus et al. 2002, Schreitmüller and Ballschmiter, 1995) with the highest levels found in the surface water layers near pack ice in the Arctic Ocean. Global production of technical HCH was estimated at 10 megatons between 1948-1997, where China consumed the largest amount, almost half global production followed by the former Soviet Union and India (Li 1999).

Technical HCH was banned or heavily restricted by China, the former Soviet Union and India between the mid-1980s and 1990 (Li et al. 1998, 2003). Concentrations of α-HCH in Arctic air responded quickly to these large-scale usage changes and declined by an order of magnitude from the early 1980s to mid-1990s in steps that closely matched global usage and emission estimates. As a consequence, the direction of net gas exchange in Arctic waters reversed from deposition in the 1980s to air-water equilibrium or volatilization in the mid-1990s.

The α-isomer is the prominent in Arctic air, water, biota and soil, and moves northward via cold-condensation, a process whereby the contaminant evades into the atmosphere, drifts with atmospheric currents, and condenses in colder climates where at colder temperatures increasingly favours the water and extensive ice cover inhibit further evasion. Hence the contaminant accumulates disproportionately in the Arctic.

14.1.2 Perfluorooctanoic acid (PFOA) and perfluorooctane sulfonic acid (PFOS)

PFOA and PFOS are the two major perfluorinated surfactants present in North Atlantic waters. They range in concentrations from <10 to 500 pg/L. Previous work has shown that they are present in somewhat higher concentrations in near shore waters sampled around Nain and Resolute Bay, suggesting that rivers, carrying runoff from the terrestrial environment, might be contributing perflouros to the oceans. The objective was to obtain a more detailed picture of PFOA and PFOS concentrations in near shore and open ocean sites to test the hypothesis that concentrations follow a declining gradient away from land.

Flourinated materials are used in a wide range of applications because of their unique stability toward redox agents as well as for their inert and nonadhering surface properties. They are used in many commercial products such as paints, polishes, packaging, lubricants, firefighting foams, cookware, and stain repellents. During the past six years, scientists and consumers became more aware of these materials when 3M, a longtime major manufacturer of these compounds, declared that it was stopping production of some perfluorinated compounds, including PFOS and PFOA. The primary reason for withdrawing PFOS from the marketplace was the discovery that it is persistent, bioaccumulative, and toxic in animal studies. The U.S. Environmental Protection Agency subsequently requested more information on PFOA to ascertain the sources of human exposure and to determine the environmental effects.

14.1.3 Mercury (Hg) and Methyl Mercury (MeHg)

Mercury (Hg) has long been known as a neurotoxin, and has emerged as a contaminant of great concern in the Arctic. Although global Hg emissions are declining, marine mammals in certain areas in the Arctic have exhibited increasing Hg concentrations during the past three decades, but with unexplained deviations in trends. Hg concentrations have been observed in liver of beluga whales from the Beaufort Sea area since 1982, peaking in 1996, and declining by about half up to 2005. There are also regional differences in Hg trends, which so far remain unexplained. The Lancaster Sound – North Water – northern Davis Strait region of the eastern Arctic is a locus of increasing biological Hg, with significant increases occurring across a range of species including beluga, ringed seal, narwhal, seabirds and polar bears. The biomagnification of Hg throughout the foodweb is well documented; however, the cyclical behavior of Hg and how abiotic Hg interacts with the foodweb is not well understood. These interactions are occurring against a backdrop of rapid polar climate change, which has the potential to drastically alter Hg biogeochemical cycling and biological uptake. This project also investigated in the role of changing oceanic and terrestrial inputs/exports of Hg via glaciers and rivers into or out of specific geographical regions such as the North Water polynya, which is a biological “hot spot” for marine mammals.

14.1.4 Seabed sediments and river material

Recent studies on Arctic lake sediments have provided evidence that climate change is shifting patterns of contaminant exposure in the Arctic by, for example, altering aquatic primary production (Outridge et al. 2007). However, little is known about the mechanisms or consequences of change in Arctic marine systems. It is believed that processes involving organic carbon in the upper ocean will have a large impact on marine Hg dynamics. The organic carbon cycle of marine systems is at the heart of the predicted impacts of Arctic climate change, and many of the key processes that control contaminants involve the organic carbon cycle.

J. Bailey’s project focused on understanding how past climate change has affected marine primary productivity and the associated scavenging of Hg from the Arctic Ocean’s euphotic zone. It aimed to gain insight into the relative importance of terrestrial vs. marine sources (primary production) of suspended particulate organic and inorganic matter in seawater, the transport and modification the organic matter undergoes after it is created or enters the ocean, the rate of Hg removal by SPOM or inorganic SPM scavenging from the upper ocean into seabed sediments, and how these processes may be modified by predicted climate change. Seabed sediments were used as recorders of Hg – SPOM interactions in the water column over historical periods of time. Vertically fluxing Hg and SPOM (also inorganic SPM) enters sediments and, with some degree of *in situ* recycling and resuspension, down-core changes in sedimentary organic matter and Hg should reflect the history of these parameters in seawater, especially the euphotic zone. Thus, this work drew on insights into nutrient and productivity studies in seawater overlying our study sites, from other parts of the ArcticNet research suite.

14.2 Methodology

14.2.1 Hexachlorocyclohexane (HCH)

Water (4 L) was collected from the Rosette at all Full and Basic stations. In the lab, water was pumped through a glass-fiber filter followed by a 1gram OASIS HLB solid-phase extraction (SPE) cartridge using peristaltic pumps (Figure 14.1). A total of 9 profiles were collected, usually consisting of 8 depths, with the emphasis on the upper water column. Filters and cartridges were frozen and brought back to the Freshwater Institute for analysis.

$^{18}\delta O$ and salinity samples were also collected at each site and depth where HCH samples were taken.

Figure 14.1. HCH water filtration in the aft chemistry lab.

Salinity samples were analyzed onboard using the salinometer. $^{18}\delta O$ samples were stored at 2 ºC and shipped to DFO-Winnipeg. $^{18}\delta O$ analysis will be performed at Fisheries and Oceans Canada, Sidney.

14.2.2 Perfluorooctanoic acid (PFOA) and perfluorooctane sulfonic acid (PFOS)

PFOA and PFOS are likely present as residuals in polymers used on the ship because of past use as stain repellents, floor polishes, lubricants in Teflon (PFOA only) and therefore could be sources of contamination, especially in ship and lab air. Water was collected off the Rosette through Norprene and Tygon tubing directly into polyethylene containers to limit contact with ship air as much as possible (Figure 14.2 left). Other possible sources of contamination to be avoided were Teflon tubing and bottles, Gortex or other stain repellent coated clothing, and possibly KimWipes and waterproof paper.

Figure 14.2. Collection of water from the Rosette for PFOS and PFOA analyses (left) and filtration of water through WAX cartridge with additional cartridge acting as an air filter (right).

Water volumes were pumped through 20 ml (1g) WAX solid phase extraction cartridges at a flow rate of 15 ml/minute using peristaltic pumps. The cartridges were preconditioned and shipped dry in 50 ml polypropylene vials, sealed with parafilm wax. Prior to filtration, the cartridges were spiked with 50 µl of an internal standard made up of 11 PFC's. In order to avoid air contamination during filtration, an additional 150 mg WAX cartridge packed with polyurethane foam was used as an air filter. After filtration, cartridges were returned to the polypropylene vials, resealed with Parafilm and refrigerated at 4°C.

Water blanks using pre-cleaned HPLC water and cartridge recovery checks were performed to identify contamination sources. As an additional check of on-board collections and extractions, duplicate water samples were collected at a number of stations. These duplicate water samples will be sent back for extraction in a clean room setting for comparison to ship extraction efficiencies and as an additional check on on-board contamination.

Water was collected in depth profiles using a plastic bucket for surface water and the Rosette for 10, 50, 100, 200, and every 200 meters thereafter to the bottom at 5 stations (301, 137, 205, 126 and 355). Glacial meltwater was collected on Prince of Wales Glacier and surface water only was collected at Stations 101, 108 and 115.

A spatial study was completed in Gibbs fjord off Baffin Island as well as in Nachvak, Saglek and Anaktalak fjords off Labrador. Water samples were collected at the fjords' mouth and along the freshwater gradient as the ship moved up the fjords. Surface water was collected using the TSG water input line in Gibbs fjord and was collected using plastic bucket in the three other fjords. Depth profiles were also collected in the NOW Polynya near the mouth of Lancaster Sound and in Hudson Strait in order to gather data about perflouros transport from the Canadian Arctic into the Atlantic Ocean.

14.2.3 Air sampling

The air sampler was set up on the bow of the ship on the starboard side for all Full stations, most Basic stations, and several transects. Samples were collected on a glass-fiber filter and polyurethane foam (PUF) for analysis of organic contaminants. Air samples collection time ranged between 7 and 21 hours. A total of 9 samples were collected during the leg. Filters and PUFs were frozen at -20°C and shipped frozen back to the Freshwater Institute for HCH contaminant analysis.

Figure 14.3. Air sampler / Ptarmigan perch on the bow of the ship.

14.2.4 Mercury and Methyl Mercury

During Leg 11, the team focused only on total and methyl mercury in the water column, with particular attention given to the North Water Polyna around the Prince of Wales Ice Field (Table 14.1) as to determine if the input of freshwater from the glacial melt is contributing to the Hg level in the water and subsequent levels in biota. Previous work has shown elevated levels of mercury in zooplankton collected from this area.

Table 14.1. List of stations sampled during Leg 11.

Station ID	Total Mercury	Methyl Mercury	Surface Water
301	Y	N	Y
136	Y	N	N
140	Y	N	Y
115	Y	Y	N
108	Y	N	Y
101	Y	Y	N
202	Y	Y	N
PWIF 1	Y	Y	Y
205	Y	Y	N
126	Y	Y	N
233	Y	Y	N
Gibbs 1	Y	Y	N
Gibbs 2	Y	N	N

Stations 301, 136 and 140 were located in Lancaster Sound and Baffin Bay, while Stations 205, 202 and 101 focused on mixed water masses, composed of glacial melt water and Arctic/Baffin Bay water. Station PWIF-1, in addition to Stations 205, 202 and 201 focused on freshwater, as a mix of glacial melt/runoff water and water masses influenced by the Prince of Wales Ice Field. Sampling of melt water ponds on the glacier itself and finding an area where water could be collected directly at the base of a large glacier, where it met the open ocean, would have been great. However, the *Amundsen* was not able to get close enough to the base of a glacier to deploy the Rosette and all melt ponds on the glaciers were frozen. It was not possible to sample some surface water from an area further up a fjord, which would have likely been fresh water runoff during glacial melt earlier in the season. The water here was brackish, indicating that there was mixing with seawater from the open coast.

Stations 115 and 126 were located along Greenland coast, across the line formed by Stations 101, 202 and 205.

Stations Gibbs 1 and 2 allowed to sample the ocean water at the fjord's mouth and sample up the freshwater gradient as the ship moved up the fjords. MeHg was sampled at the mouth only due to the limited amount of sample bottles available.

Preliminary CTD profiles were conducted at each station and were used to pick different water masses to sample based on salinity and temperature measurements. This sampling method represents mercury movement with horizontal oceanic water mass transport. Water was collected from the Rosette for Hg profiles (~20 depths) along with corresponding ^{18}O and salinity samples. To complete the Hg profile, surface water at 1, 3, 5 and 7 m was collected with a Niskin water sampler from the Zodiac when possible. Whenever the sea surface was rough, this was not conducted due to the complete mixing of the upper layers. These shallower depths of 1 and 3 m could not be accurately sampled with the Rosette due to contamination from the ship itself. For total Hg analyses, 50 ml of water was collected in duplicate from each depth in clean, polypropylene tubes (Falcon Tubes). A minimum of 125 ml was required for MeHg and an individual sample was collected in tested clean Teflon bottles.

Figure 14.4. The Portable In-Situ Laboratory for Mercury Speciation (PILMS) onboard the *Amundsen* (left). Tekran 2600 for Total Mercury analysis (right) and a Brooks Rand Distillation, Purge and Trap system for the Methyl Mercury analysis.

All Hg and MeHg samples were preserved with hydrochloric acid or sulfuric acid, respectively. Time permitting, all samples were analyzed either in the Portable In-situ Laboratory for Mercury Speciation built specifically for the ship or back in Winnipeg at the Ultra Clean Trace Elements Lab at the University of Manitoba.

14.2.5 Biota sampling (mercury, stable isotopes)

The main focus of this study was to link physical and biological processes to mercury levels in the food web and to target the pelagic food web biomagnification and bioaccumulation of mercury with stable isotopes and fatty acids. Thus, all biological samples collected were measured for total mercury and MeHg along with stable isotopes to place organisms into their associated trophic levels.

Biological samples were collected at some Basic and Full stations along the cruise transect. Various zooplankton families and fish samples were collected using the vertically towed Monster net (200 and 500 µm), an oblique Tucker net (2x500 µm). Zooplankton and fish were sorted into families, placed into plastic vials and Whirlpak bags and frozen until they can be analyzed for THg, MeHg, stable isotopes and fatty acids. Zooplankton was collected at 10 stations during Leg 11. The most commonly found species included *Calanus sp*., *Euchaeta sp*., *Sagitta sp*., *Themisto abyssorum*, *Themisto libellula*, *Cleone limacine*, *Limacina helicina*, Euphasiids, Cnidarians, and Ctenophores.

14.2.6 Seabed sediments and river material sampling

Duplicate sediment cores were collected from box cores retrieved from 8 sites in northern Davis Strait and the NOW Polynya. These cores were sliced as 0.5 cm intervals in the upper 10 cm, then at 1 cm intervals thereafter. The samples were frozen at 20°C, awaiting detailed geochemical analyses in southern laboratories of the Geological Survey of Canada and the University of Manitoba.

Various organic geochemical techniques were used to characterize the sedimentary organic matter in the samples. Bulk properties such as organic and inorganic carbon content, nitrogen content, stable isotope ratios ($\delta^{3}C$, $\delta^{5}N$), and trace and major elements were determined. Rock-Eval™ pyrolysis and alkaline CuO oxidation (a method for quantifying lignin) were conducted.

A geochronology for the sediment cores was established using ^{210}Pb and ^{137}Cs in the upper cores, and radiocarbon dating by accelerator mass spectrometry at intervals below the point of ^{210}Pb extinction (before ~ 1850 AD). Inorganic chemical analysis includes Hg and a suite of other trace and minor elements to aid in interpretation of the Hg profiles. Organic contaminant analyses could also be carried out depending on sediment availability and contaminant concentrations present.

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15 Seabed mapping – Leg 11

ArcticNet Phase I – Project 1.2: Coastal Vulnerability in a Warming Arctic.
http://www.arcticnet.ulaval.ca/pdf/phase1/12.pdf
ArcticNet Phase I – Project 1.6: The Opening NW Passage: Resources, Navigation, Sovereignty & Security. http://www.arcticnet.ulaval.ca/pdf/phase1/16.pdf

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15.1 Introduction

The Ocean Mapping Group (OMG) was on board the *Amundsen* to perform seabed mapping as part of its role in ArcticNet's research program. The primary purpose of the mapping was to complete surveys of an area containing pockmarks in Barrow Strait and an area with reported oil seeps near Smith Inlet. As well, a continuing priority was to collect as much bathymetry and sub-bottom information as possible while transiting between science stations throughout Barrow Strait, Lancaster Sound, Baffin Bay and Davis Strait.

15.2 Methodology

15.2.1 Equipment

- Kongsberg-Simrad EM300 30 kHz multibeam echosounder;
- Knudsen K320R 3.5 kHz sub-bottom profiler;
- Applanix POS/MV 320 motion and orientation sensor;
- C&C Technologies CNAV GPS;
- Surface sound speed probe (temporary replacement);
- Seabird SBE911 CTD, deployed from the Rosette.

15.2.2 Onboard logging and processing procedures

Multibeam and sub-bottom profile collection began near Resolute at the beginning the leg. CNAV GPS was logged on a dedicated PC. Both the multibeam and sub-bottom systems were logged continuously throughout the entire leg.

The EM300 data were logged in the Kongsberg-Simrad raw format and converted to the OMG format after line completion (new survey lines were automatically generated every half hour). The soundings were cleaned and inspected in near real-time with the two crew members maintaining a 24-hour watch throughout the cruise. Backups of the raw and processed data were made onto external USB hard drives.

The K320R data were logged in the Knudsen binary format (.keb). Data were converted to OMG format and then backed up in the manner mentioned earlier.

The CNAV data consisted of NMEA strings and was captured to a text file using HyperTerminal, with a new files being created at approximately midnight (GMT) every day. At the end of each day (GMT), this data was backed up to the processing computer and converted to OMG format. The data were then plotted geographically for visual inspection.

For surface sound speed, the probe data was logged and utilized real time by SIS. Sound speed profiles (Rosette CTD) were collected at each station. Raw files (collected in binary format) were converted to text files, copied to the processing PC and finally converted to OMG format, at which time the profiles were visually inspected for spurious data points. High-resolution CTD casts were decimated to 1-metre bins using a median filter. Profiles were tagged with time and ship's position in real-time. If CTD profiles did not extend to full ocean depth, they were extended using the SVP editor in the SIS software package before being input to the EM300 logging software. Post-processing of the multibeam soundings with respect to sound speed profiles will be done upon return to UNB. Data from the Moving Vessel Profiler (MVP) was also collected for later processing.

15.2.3 Mapping procedures and system performance

During transit between stations, coverage from previous transits was loaded into Aldebaran. This allowed the helmsman to steer coverage and build upon the previously collected data.

In addition to surveying tracks between science stations, time was specifically dedicated for the following areas during Leg 11:

- Barrow Strait pockmarks;
- Station 205 (Smith Bay);
- Station 115 (Mooring Location);
- Scott Inlet, Oil Seep Survey.

Multibeam data quality was good in most cases, but severely degraded or even non-existent during heavy swell and sea ice. Sub bottom data was generally good under most circumstances including ice breaking and heavy seas. Survey line running was at times freehand, with the helmsman steering coverage to maintain overlap between adjacent lines, but mostly performed with the use of survey lines plotted on either Aldebaran or SIS.

Multibeam data was used to assist the ROV during the recovery of mooring BA 01-05 at Station 115 and during all text dives. Sub bottom data was used to facilitate box cores in locations that would not damage the equipment and provide useful sediment samples.

15.3 Preliminary results

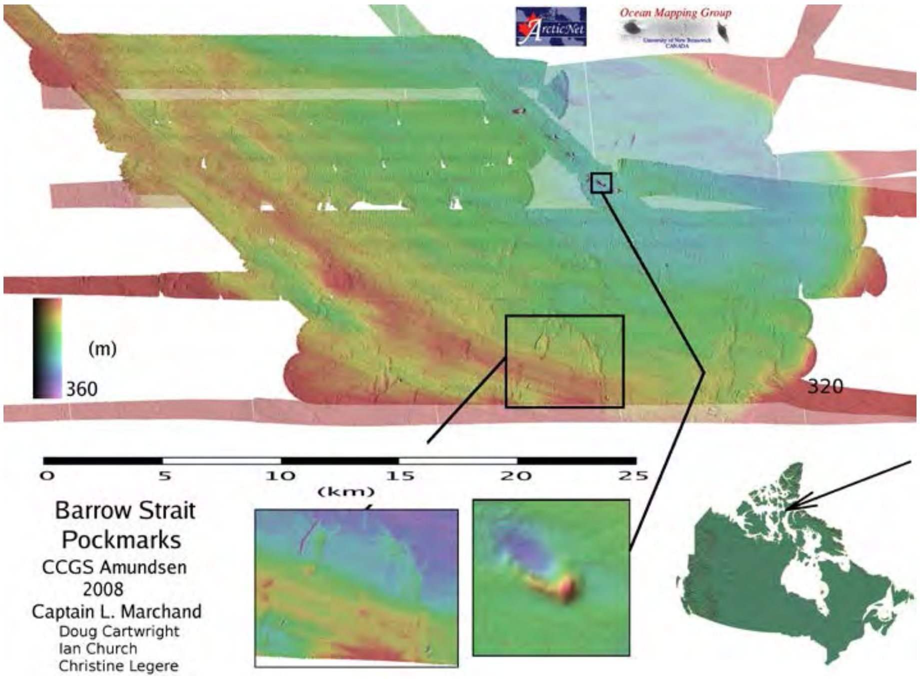

Figure 15.1. Bathymetry of the seafloor with pockmarks surveyed with the multibeam in Barrow Strait, during Leg 11.

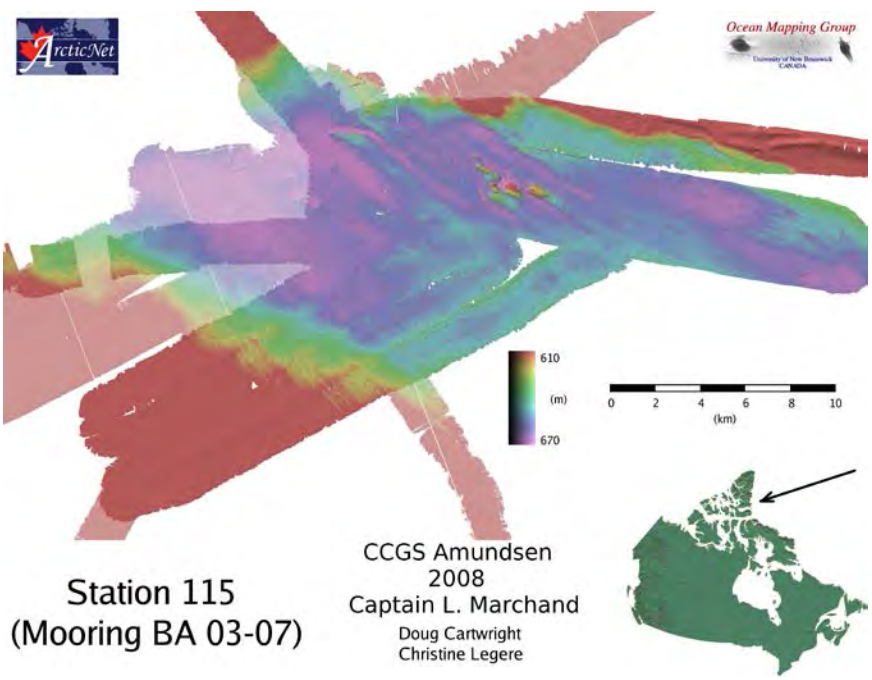

Figure 15.2. Bathymetry of the seafloor surveyed with the multibeam at Station 115 (mooring location), during Leg 11

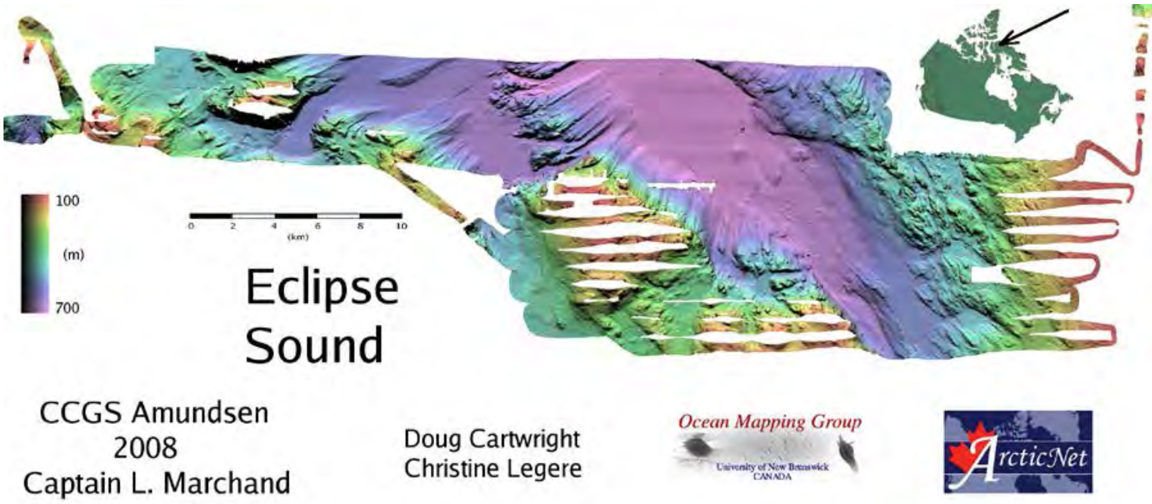

Figure 15.3. Bathymetry of the seafloor surveyed with the multibeam in Eclipse Sound during Leg 11.

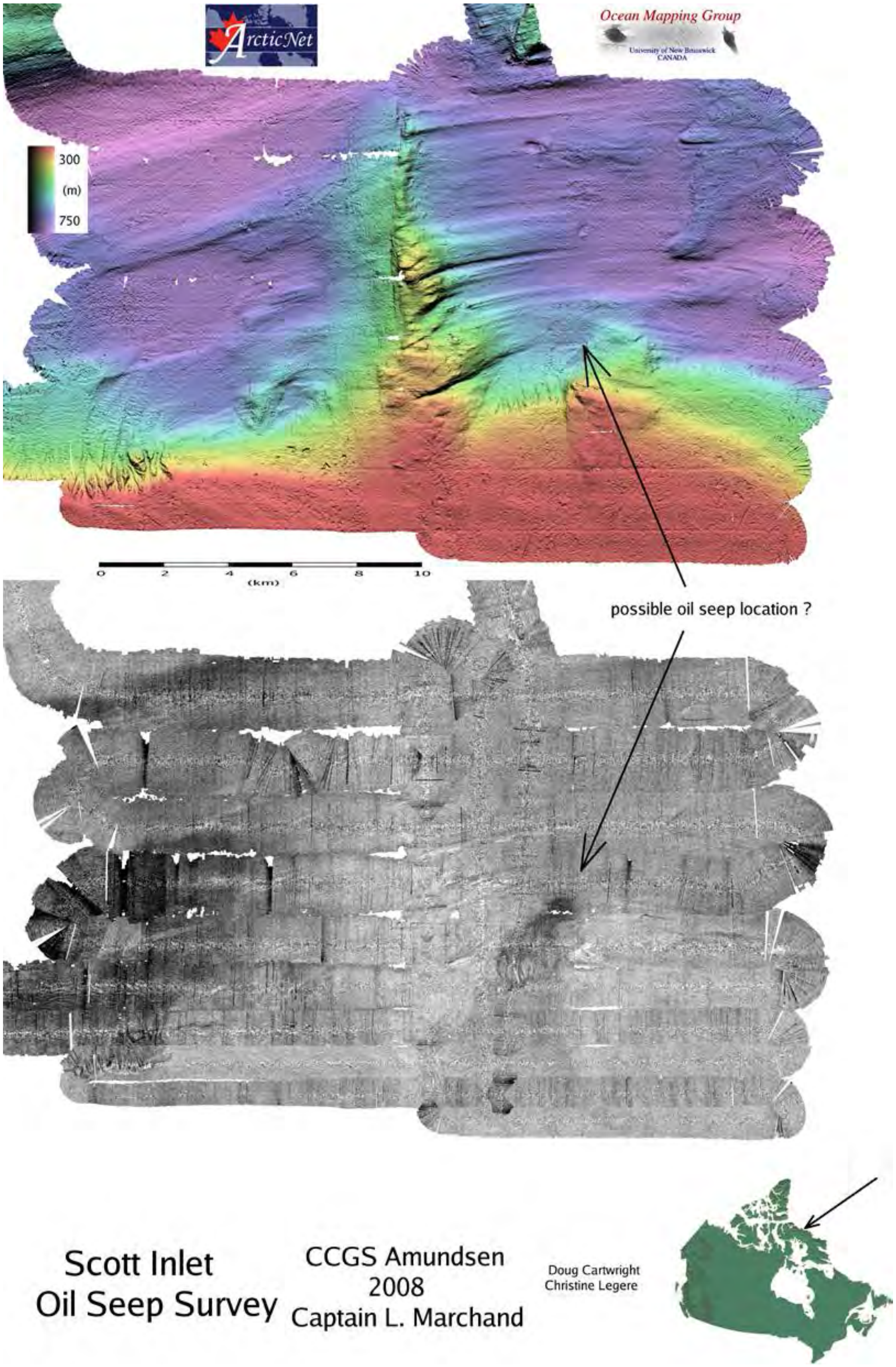

Figure 15.4. Bathymetry of the seafloor surveyed with the multibeam in an area with reported oil seeps near Smith Inlet, during Leg 11.

16 Remotely Operated Vehicle (ROV) operations – Leg 11

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16.1 Introduction

The CGSS *Amundsen* is equipped with a Super Mohawk ROV. This is a small inspection class ROV with limited capabilities but a great capacity for development. During Leg 11, several very tall moorings have failed to surface when released and one was lost during recovery. Investigation into the cause of the mooring losses and retrieval of the remaining mooring gear was the primary purpose of the operations. The Super Mohawk ROV was also used for scientific investigations of the benthic habitat in the area of the moorings and few video transects were performed.

16.2 Methodology

16.2.1 ROV preparation

The moorings were lost in waters off Greenland and Ellesmere Island. The Super Mohawk ROV currently has a TCM2 magnetic compass integrated into its system. The northern location of the operations required a Ring Laser Gyro (RLG) as a compass since the magnetic compass would be unable to provide an accurate or timely heading at these high latitudes. An Octans 3000m unit was rented for the duration of the cruise. It was readily integrated into the ROV system, having suitable power and ballast demands. The TCM2 was replaced by the Octans for this leg.

Other routine maintenance was performed prior to deploying the ROV, including repositioning the lights, flushing the hydraulic system, etc.

16.2.2 Science

Limited science work was attempted during these dives. The priority was the retrieval of the moorings, which severely restricted any capacity to carry samples to the surface. The only possible samples that could have been retrieved were clams at vents. With the limited time available, it was impossible to spend much time searching for venting and no vents were found.

16.2.3 Dive operations

Several recovery dives were performed, including the retrieval of all remaining parts of the mooring lost during recovery (BA01-05). All other moorings were determined to be missing everything except the train wheel anchor stack and acoustic releases. It was not possible to recover the releases at BA01-06 because of equipment failure. A second attempt was unsuccessful, as the subsea navigation could not give us an accurate position. The recovery of the mooring equipment does demonstrate the ability of this ROV to effectively perform very useful functions. It also shows that the ship and crew are able to work very well together with the ROV to accomplish complex tasks. In general, ship operations were very good, seldom restricting the operation of the ROV and always ensuring a safe working environment. The future involvement of dynamic positioning will improve the ship handling and the safety and ease of ROV operations.

Further training of ROV operators and technicians is still required to operate the ROV in a secure and efficient manner. It is very difficult to gain useful and detailed knowledge with the limited number of dives this ROV does in a year. Other training aids, such as a simulator or offshore experience with a different ROV, will help the development of skills and expertise for the personnel involved.

Table 16.1. Leg 11 dives summary.

Dive #	Location	Latitude (N)	Longitude (W)	Duration	Depth (m)	Task
11	Barrow Strait	74°16.274	091°14.659	4:48	340	Visual survey of pockmarks
12	BA01-06	76°19.695	071°13.629	5:07	670	Located mooring release
13	Northumberland	77°10.950	072°30.190	1:35	545	Test dive
14	BA01-05	76°17.162	071°17.162	8:37	670	Sediment trap recover
15	BA01-05	76°17.162	071°17.162	7:37	670	Mooring recovery
16	BA01-06	76°19.668	071°13.532	5:48	670	Benthic survey, search for releases

16.3 Comments and recommendations

During the cruise the system presented several problems, which had to be remedied. The most difficult problem was the intermittent loss of communications, sonar, and colour camera video at depth. This problem did not present itself at the surface and we were unable to find a definite source of the problem until getting the ROV back in the water. Numerous possibilities were explored. In the end, it was determined that damage to the fibre optic strands in the tether was the source of the problem. The tether was reterminated after removing 7m of cable from service. It was also found that the fibres were extremely fragile when spliced. The cause of this fragility is a question that requires further investigation and will continue to be a problem until the tether is replaced.

Water ingress into the TMS pressure housing thru a poorly assembled (by the manufacturer) vacuum port ended a dive, which probably would have recovered the releases at BA01-06. The presence of water in the pressure housing caused significant damage and many hours of repair. It is one of several issues, which will be discussed with the ROV manufacturer – Sub Atlantic.

Other mechanical failures included faulty assembly of the starboard vertical thrusters, which caused the thrusters to leak water and begin to wear severely. The Pan and Tilt was also disassembled for cleaning, which required a considerable length of time.

The navigation system also worked very poorly at depth. This system can be improved with calibration. The mounting of the transducer on the ships hull instead of the cable guide pole would also help a great deal. The poor performance of the navigation system contributed largely to the difficulty finding known targets on the sea floor and thus the loss of significant lengths of operation time. Calibration and Hull mounting should be accomplished before the next offshore operation.

17 Sediments and benthos – Leg 11

ArcticNet Phase I – Project 1.4: Marine Productivity & Sustained Exploitation of Emerging Fisheries. http://www.arcticnet.ulaval.ca/pdf/phase1/14.pdf.
ArcticNet Phase I – Project 3.7 Nunatsiavut Nuluak: Baseline Inventory and Comparative Assessment of Three Northern Labrador Fiord-based Marine Ecosystems. http://www.arcticnet.ulaval.ca/pdf/phase1/37.pdf.

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17.1 Introduction

17.1.1 Comparison of "Hot" and "Cold" spots for the establishment of future sentinel sites for monitoring the impact of climate change on the Arctic benthos

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, that coincides with a reduction of benthic prey populations. According to a widely accepted conceptional 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. In the context of the potential benthic community changes, it is essential to establish benchmarks in biodiversity at key locations in the Canadian Arctic prior to (a) the expected changes in ice cover, ocean chemistry and climate and (b) the future human activities (transport, trawling or dredging, drilling, etc.) that are likely to happen in response to the predicted environmental changes. Unlike Canada's two other oceans, there is an opportunity to document pristine conditions before ocean change and exploitation occur.

The objective of this component of the project was to describe and compare the biodiversity and secondary productivity of benthic communities in areas of enhanced and reduced ("hot spots" and "cold spots") productivity and diversity in the Canadian Arctic.

17.1.2 Canadian Healthy Oceans Network (CHONe)

This cruise was conducted in collaboration with the NSERC Canadian Healthy Oceans Network (CHONe), which is a 5-year strategic partnership between Canadian university researchers, government, and ArcticNet. CHONe addresses a need for scientific criteria for conservation and sustainable use of marine biodiversity resources. The research themes had three broad foci: Marine Biodiversity, Ecosystem Function and Population Connectivity. This collaborative cruise permitted to obtain samples for 8 different projects inside CHONe in addition to the ArticNet project.

Theme Marine Biodiversity

The scientific objective of this theme was to understand functional and species biodiversity in relation to habitat diversity. Specific goals were to:

- Test hypotheses that link functional and species biodiversity to habitat diversity, especially in frontier areas such as the Arctic and deep water;
- Explore diversity at multiple taxonomic levels (including cryptic diversity) and as a function of time as revealed by genetic barcode and morphological data.

Within this goal, benchmarks in biotic diversity at key locations in the ocean will be established prior to expected changes in ocean chemistry and climate, characterize cryptic diversity, and uncover ecological and evolutionary relationships of organisms to understand how biodiversity of Canada's Oceans has changed over evolutionary time and may change in the future. This overarching theme includes many objectives and researchers:

- Philippe Archambault and Kathy Conlan (Biodiversity in Arctic corridor): evaluate the natural benthic diversity along the Arctic Corridor to search for new species, for curation and to establish benchmarks in specific areas of the Arctic.
- Connie Lovejoy (Arctic corridor): extend the diversity-rugosity concept to the water column, by documenting the present taxonomic, genetic, and function diversity of water column microbes (both eukaryotes and prokaryotes) relative to water column complexity generated by flow structure.
- Paul Hebert and France Dufresne (Divergence rate and Cryptic species): barcode groups of planktonic and benthic organisms.

Theme Ecosystem Function

The scientific objective of Theme Ecosystem Function was to determine how ecosystem function and health are linked to biodiversity and agents of *disturbance, including natural and anthropogenic sources*.

Specific goals were to:

- Understand and predict the role of biodiversity in marine ecosystem services by quantifying links between biodiversity and ecosystem function measures, and to

provide predictive models to help minimize anthropogenic impacts on ecosystem services and health;
- Provide quantitative tools for managing ecosystem health such as survey tools to collect data more efficiently, and new tools for ecosystem modeling and design of conservation strategies.

To understand and quantify the role of biodiversity in ecosystem services, a project initiated by Sam Bentley (Chemical and geological signatures in sediment deposits) aimed to:

- Relate the present benthic macrofaunal community to associated biogenic sedimentary structures (trace fossils or ichnofabric, through X-radiography), and bioturbation rates and depths (through ADR modeling of sediment-bound radioisotope distributions such as ^{234}Th, ^{7}Be, and ^{210}Pb);
- Elucidate present rates and mechanisms of sediment delivery from radioisotopic and X-radiographic observations (including disturbances such as trawling and storms, which leave clear indicators in the form of physical sedimentary structures);
- Evaluate lateral and downcore gradients in these processes and patterns, such as changes in the frequency and intensity of seafloor disturbance, and changes in character of sedimentary structures and fabric that record changes in benthic community structure along Atlantic and Arctic corridors.

A project led by Philippe Archambault and Christian Nozais (Biodiversity and ecosystem services in Arctic environments) aimed to compare the ecosystem services (fluxes) by different trophy levels in areas of high and low complexity and 2) to evaluate the influence of the potential changes in species diversity that will happen with any kind of human activities.

17.2 Methodology

To achieve the aforementioned goals, the box corer (Figure 17.1) was deployed to quantitatively sample diversity and abundance of macrobenthic, meiobenthic and bacterial infauna, and to obtain sediment cores. The latter were used to determine sediment properties and the carbon utilisation and nutrient recycling by the benthic community. The second objective contributed to the goal to comparatively quantify major fluxes and pathways of carbon and nutrients to gain an additional measure of productivity for benthic communities. The measurements provided a bulk parameter, commonly termed the 'sediment oxygen demand' (SOD), integrating total aerobic respiration of the community of benthic organisms contained in the core.

At the same time, changes in nutrient concentration for ammonia, nitrate, nitrite, silicate and phosphate in the ambient water were measured, to gain first knowledge on the role of benthic activity for the nutrient cycles in Arctic waters.

From seven box corers, sediments of usually a surface area of 0.09 m^2, varying 10-15 cm in depth were collected and passed through a 0.5 mm mesh sieve and preserved in a 10 % buffered seawater formalin solution for further identification in the laboratory (Table 17.1).

For SOD, seafloor sediments were collected from ten box cores with a total of three replicate sub-cores (with a diameter of 11.5 cm, i.e., an area of 0.1 m^2 each, down to sediment depths of 15 to 20 cm) for subsequent on-board SOD incubations (Table 17.1). Incubations of sediment sub-cores were performed in a dark and temperature controlled room (ca. 3°C). The decrease in oxygen concentrations in the water overlying the sediment (bottom water collected from rosette water samples obtained at the same station) in the incubation cores was measured periodically (4-8 h intervals) over 1-3 days to assess SOD.

Figure 17.1. Left: The box corer is being deployed. Right: Box core with SOD/Nutrient cores (grey), bioturbation cores (white), pigment concentration cores (orange), CN cores (big syringes), Meiofauna samples (big syringes), Meiofauna/Microfauna incubation samples (small syringes), and X-ray tray and push core for Sam Bentley.

Nutrient samples from the ambient water were taken at the beginning of incubations (ca. 100 % oxygen in the water), at midway (ca. 90 % oxygen), and at the end of incubations (ca. 80 % oxygen). Except ammonia, nutrient concentration was analysed by Jean-Eric Tremblay's team onboard. Three incubation cores containing water only acted as controls. At the end of the incubations (after 15 to 20% of the oxygen has been consumed), the sediment in the cores was sieved on a 0.5 mm mesh sieve to determine diversity and biomass of infauna. The sieve residue, including fauna, was preserved in a 10% buffered seawater-formalin solution for later analyses of species composition, abundance and biomass.

In addition, three sub-cores for chlorophyll *a* (diameter of 5 cm each) and three sub-cores for CN analyses (2.54 cm diameter each) were taken from each box core. Sub-cores for chlorophyll *a* were sliced in 1 cm sections to 10 cm depth. For CN, the top 2 cm were collected. These samples were frozen and transported off the ship for analyses in the home lab.

Three sediment cores with a 10.0 cm diameter, 15 cm depth, were collected for onboard bioturbation experiments from five box cores (Table 17.1). Luminophores were added to the sediment surface and then cores were held with oxygen saturated overlying water for 10 days in the incubation room. At the end, cores were sliced in 0.5 cm slices for the first 3 cm, and the 1 cm slices until the bottom of the core. Samples were frozen and transported to the home lab for further analyses.

At six stations, the Agassiz trawl was successfully deployed to survey epibenthic diversity and abundance of species (Table 17.1). Species were counted or estimated in abundance and identified to the lowest possible taxonomic level. Some specimens were preserved for further identification in the home lab. Where possible, this data should be compared to visual surveys conducted by the ROV.

Furthermore, several specimen gained from a trawl sample where preserved in 95% ethanol for genetic analysis.

The ROV work was aimed on an analysis of the epibenthic macro- and megafauna, in order to complement concomitant survey work, using the box corer, targeting other smaller size groups of the benthic assemblages (e.g. endobenthic macrofauna). During this leg, the ROV was deployed for a total of six dives (Table 17.1).

On a long-term perspective, ROV visual surveys of benthic sentinel sites should at least partially replace invasive sampling.

Table 17.1. Benthic sampling stations during Leg 11, with numbers of samples or cores collected for Diversity, Sediment Oxygen Demand (SOD), bioturbation experiments, and other researchers. SOD includes 3 samples for each, pigment concentration, CN, and Meio-/Microfauna incubations.

Station	Type	Date	Depth (m)	Latitude (N)	Longtitude (W)	Equipment	SOD/Nutrients	Bioturbation	Archamb./Conlan	Nozais (Diversity)	Nozais (isotopes)	Hebert	Bradbury	Lovejoy	Bentley	Comment
Barrow Strait	Full	06/09	344	74°16.270	091°17.650	ROV dive										
Pockmarks			353	74°16.280	091°14.850	Box corer	3	3		3	1				2	
			335	74°16.150	091°14.780	Box corer			1	6	3			1		
			336	74°27.090	091°23.450	Agassiz			1			2				
303	Full	07/09	229	74°14.180	089°39.810	Box corer				1	1					gravel
			230	74°14.150	089°39.900	Box corer					1	2				
301	Basic	08/09	707	74°09.183	083°12.525	Box corer	3	3		3				1	2	
136	Basic	10/09	795	74°47.150	073°37.960	Box corer	3			6	2				2	
			790	74°47.350	073°39.860	Box corer			1		1			2		
138	Basic	11/09	1079	74°56.186	069°04.124	Box corer				2				1		
140	Full	11/09	286	75°01.670	064°28.640	Box corer	3	3		6	7			1	2	
			277	75°02.230	064°29.070	Agassiz			1			1				
115	Mooring	12/09	670	76°19.503	071°13.500	ROV dive										
		13/09	668	76°19.534	071°12.918	Box corer	3				7				2	
			660	76°19.506	071°12.453	Box corer			1	5				1		
			670	76°19.520	071°12.380	Agassiz			1			4				
111	Basic	13/09	611	76°18.340	073°13.180	Box corer				6	8				2	
108	Full	14/09	446	76°16.101	074°35.518	Box corer			1		7					
			444	76°16.180	074°35.630	Box corer	3	3		6				1	2	
			448	76°16.041	074°34.371	Agassiz			1			2				
105	Basic	15/09	324	76°18.906	075°37.289	Box corer					7			1		gravel
101	Mooring	15/09	402	76°24.040	077°29.530	Box corer	3			6	7			?	2	
205	Basic	17/09	623	77°13.143	078°58.879	Box corer	3			6	6			1	2	
			758	77°13.287	078°30.003	Agassiz			1			3				
126	Basic	18/09	323	77°20.557	073°26.459	Box corer										gravel
Northumberland	Island	18/09	545	77°10.950	072° 30.270	ROV dive										
233	Full	20/09	721	76°44.357	071°49.106	Box corer			1	4	6			1		
			696	76°44.337	071°50.628	Box corer	3	3		2					2	2nd attempt

Station	Type	Date	Depth (m)	Latitude (N)	Longtitude (W)	Equipment	SOD/Nutrients	Bioturbation	Archamb./Conlan	Nozais (Diversity)	Nozais (isotopes)	Hebert	Bradbury	Lovejoy	Bentley	Comment
			700	76°44.515	071°50.688	Agassiz			1			3				cable knots
BA01-05	Mooring	20/09	670	76°17.110	071°17.060	ROV dive										
		21/09	670	76°19.670	071°13.580	ROV dive										
115	Mooring	22/09	670	73°52.460	074°17.780	ROV dive										
Gibbs fjord 2	Basic	24/09	452	70°46.110	072°15.680	Box corer			1	4	7			1		
			452	70°46.090	072°15.820	Box corer	3			2					2	

17.3 Preliminary results

Diversity

Composition and abundance of species varied considerably among stations. For more detailed results, samples need to be analysed especially for taxonomy in the home labs.

SOD

Of all stations, benthic respiration was highest at the central and western stations in the southern part of the North Water Polynya. This coincides with the expected highest sedimentation rates in this part of the study area. However, data still needs to be analysed more thoroughly, taking temperature and benthic biomass changes into account.

ROV Dives

The Super Mohawk ROV was deployed 6 times for benthic video surveys during Leg 11.

Dive 1: Barrow Strait Pockmarks (06/09/08)

The objectives of this dive were to investigate epibenthic macrofauna associated with the Barrow Strait Pockmark structures and to train the ROV pilots. The team was particularly interested in determining if gas seeps and chemosynthetic ecosystems where present. Sub-bottom mapping indicated possible venting on the southeast corner. No venting was observed during the dive, however visibility was very poor surrounding the target site. It would therefore be recommended to revisit this site during future expeditions. A northward transect away from the target site was followed revealing lush communities of brittle stars, basket stars and tube dwelling anemones. The ROV then followed a southward transect up the mound on the southern end of the pockmark structure.

Dive 2: Mooring recovery (13/09/08)

The objectives of this dive were to recover a mooring, observe epibenthic macrofauna and to train the ROV pilots. The mooring was located; however very few benthic observations were made due to a malfunctioning of the ROV. The dive was aborted shortly after the mooring was located.

Dive 3: Greenland Coast, Test Dive (19/09/08)

The objective of this dive was to test the ROV following repairs made after Dive 2. A benthic transect was followed where numerous observations of brittle stars and soft coral were made. The ROV malfunctioned shortly after the beginning of the transect and the dive was aborted.

Dive 4: Mooring Recovery (21/09/08)

A sediment trap from the first mooring site (see Dive 1) was successfully recovered. The instruments were in the water column and therefore no benthic observations were made.

Dive 5: Mooring Recovery (22/09/08)

An ADCP from the first mooring site (see Dive 1 and Dive 6) was successfully recovered. The instruments were in the water column and therefore no benthic observations were made.

Dive 6: Mooring Recovery (23/09/08)

The objectives of this dive were to locate and recover acoustic releases from the second mooring site (see Dive 2) and conduct visual benthic surveys. The releases were not located and therefore very little time was used for benthic transects. A short transect was followed during the end of the dive. Brittle stars and coral were relatively abundant. Other observations include shrimp and stalked anemones.

17.4 Comments and recommendations

Visual benthic surveys were made during some dives. This imagery will be useful to characterize Arctic benthic communities and to compare it to diversity counts made by the Agassiz trawl and box cores. However, all data obtained from ROV dives is strictly qualitative. Quantitative data is difficult to obtain using the Super Mohawk ROV at this time. Mounting lasers for scale on the sub calibrated at 10 cm apart would greatly increase the capability of the ROV to obtain quantitative data, particularly involving animal abundances and sizes of organisms, and geological features. This is the most pressing requirement for the ROV. A third camera for high-resolution still images would also be useful for characterizing benthic habitats. In order to use the ROV to sample organisms and geological features and bring them to the surface a bio-box is required to store samples. This would involve the extension of the cage structure, which is addressed in the ROV section of the cruise report. Suction samplers would also greatly improve the sampling abilities of the submersible. These modifications would greatly increase the scientific capabilities of the vehicle for future ArcticNet cruises.

Leg	Station ID	Station Type	Local Date	Local Time	UTC to local	Latitude (N)	Longitude (W)
11	Barrow Strait	Full	06/Sep/2008	06h20	UTC-5	74°16.520	091°38.910
11	303	Full	07/Sep/2008	02h10	UTC-5	74°14.345	089°39.671
11	302	Nutrient	07/Sep/2008	22h30	UTC-5	74°09.230	086°15.780
11	301	Basic	08/Sep/2008	03h30	UTC-5	74°07.355	083°19.891
11	N/A	MVP	08/Sep/2008	19h13	UTC-5	73°47.020	079°59.500
11	300	Nutrient	09/Sep/2008	04h36	UTC-5	74°19.130	080°06.660
11	134	Basic	09/Sep/2008	09h20	UTC-5	74°29.150	078°02.330
11	136	Basic	10/Sep/2008	02h38	UTC-5	74°45.385	073°45.888
11	137	Nutrient	10/Sep/2008	16h23	UTC-4	74°51.780	071°20.540
11	138	Basic	10/Sep/2008	21h00	UTC-4	74°56.210	069°04.150
11	139	Nutrient	11/Sep/2008	06h51	UTC-4	74°59.390	066°46.550
11	140	Full	11/Sep/2008	11h00	UTC-4	75°02.150	064°29.220
11	115	Full	12/Sep/2008	04h25	UTC-4	76°19.690	071°16.470
11	114	CTD	13/Sep/2008	10h40	UTC-4	76°19.580	071°47.050
11	113	Nutrient	13/Sep/2008	12h18	UTC-4	76°19.257	072°13.144
11	112	CTD	13/Sep/2008	14h08	UTC-4	76°18.893	072°42.321
11	111	Basic	13/Sep/2008	15h22	UTC-4	76°18.335	073°12.497
11	110	Nutrient	13/Sep/2008	23h15	UTC-4	76°17.950	073°37.820
11	109	CTD	14/Sep/2008	01h33	UTC-4	76°17.358	074°06.997
11	108	Full	14/Sep/2008	03h14	UTC-4	76°15.960	074°34.948
11	107	Nutrient	14/Sep/2008	19h00	UTC-4	76°17.380	074°56.600
11	106	CTD	14/Sep/2008	21h05	UTC-4	76°18.510	075°21.420
11	105	Basic	14/Sep/2008	22h40	UTC-4	76°19.100	075°37.420
11	104	CTD	15/Sep/2008	03h16	UTC-4	76°20.365	076°10.410
11	103	Nutrient	15/Sep/2008	04h45	UTC-4	76°21.650	076°34.790
11	102	CTD	15/Sep/2008	06h53	UTC-4	76°23.900	076°59.900
11	101	Full	15/Sep/2008	10h35	UTC-4	76°23.170	077°24.730
11	200	Nutrient	15/Sep/2008	23h23	UTC-4	76°32.470	077°16.270
11	201	CTD	16/Sep/2008	01h24	UTC-4	76°39.987	077°03.228
11	202	Basic	16/Sep/2008	03h02	UTC-4	76°48.936	076°54.200
11	203	CTD	16/Sep/2008	10h30	UTC-4	76°56.900	076°55.440
11	204	Nutrient	16/Sep/2008	12h17	UTC-4	77°07.556	077°27.611
11	205	Basic	16/Sep/2008	16h43	UTC-4	77°15.400	078°12.800
11	206	CTD	17/Sep/2008	02h47	UTC-4	77°17.807	078°06.257
11	207	Nutrient	17/Sep/2008	04h56	UTC-4	77°18.640	077°20.600
11	118	Full	17/Sep/2008	07h45	UTC-4	77°19.290	076°31.840
11	126	Full	17/Sep/2008	22h15	UTC-4	77°20.960	073°25.180
11	N/A	Mapping	18/Sep/2008	02h15	UTC-4	77°20.000	073°25.000
11	126	Full	18/Sep/2008	03h35	UTC-4	77°20.577	073°25.636
11	N/A	ROV	18/Sep/2008	19h10	UTC-4	77°10.950	072°30.270
11	N/A	Mapping	18/Sep/2008	21h54	UTC-4	77°09.600	072°28.670
11	230	Nutrient	19/Sep/2008	10h10	UTC-4	77°06.010	072°25.080
11	232	Nutrient	19/Sep/2008	12h43	UTC-4	76°56.707	072°11.954
11	233	Full	19/Sep/2008	15h37	UTC-4	76°43.903	071°48.210

Leg	Station ID	Station Type	Local Date	Local Time	UTC to local	Latitude (N)	Longitude (W)
11	234	Nutrient	20/Sep/2008	05h34	UTC-4	76°32.380	071°32.160
11	BA01-05	Mooring	20/Sep/2008	10h50	UTC-4	76°17.290	071°17.070
11	N/A	Mapping	22/Sep/2008	07h00	UTC-4	76°19.710	071°13.810
11	BA01-06	Mooring	22/Sep/2008	12h00	UTC-4	76°19.670	071°13.580
11	115	CTD	22/Sep/2008	18h30	UTC-4	76°19.880	071°13.390
11	141	CTD	23/Sep/2008	08h25	UTC-4	73°52.460	074°17.780
11	Gibbs 2	Basic	24/Sep/2008	09h50	UTC-4	70°58.780	071°36.350
11	Gibbs 1	Nutrient	25/Sep/2008	02h55	UTC-4	71°07.304	070°57.912
11	N/A	N/A	25/Sep/2008	03h50	UTC-4	71°07.370	070°59.047

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					
11	Barrow Strait	Full	06/Sep/2008	06h20	UTC-5	74°16.520	091°38.910	CTD-Rosette ↓ (calibration)	320	156	320	16	0.2	0.5	1002.0	87	0/10
11	Barrow Strait	Full	06/Sep/2008	06h51	UTC-5	74°16.300	091°38.600	CTD-Rosette ↑ (calibration)	319	167	320	18	-0.7	0.5	1002.0	88	0/10
11	Barrow Strait	Full	06/Sep/2008	14h38	UTC-5	74°16.270	091°14.650	ROV ↓	340	90	270	20	0.8	0.3	998.6	87	0/10
11	Barrow Strait	Full	06/Sep/2008	15h05	UTC-5	74°16.270	091°14.650	ROV ↑ (end)	340	90	270	20	0.8	0.3	998.6	87	0/10
11	Barrow Strait	Full	06/Sep/2008	18h28	UTC-5	74°16.300	091°14.550	ROV ↓	342	105	280	12	0.7	0.1	998.0	86	0/10
11	Barrow Strait	Full	06/Sep/2008	18h45	UTC-5	74°16.230	091°14.100	ROV ↑ (end)	344	160	280	14	-0.2	0.2	998.0	89	0/10
11	Barrow Strait	Full	06/Sep/2008	19h25	UTC-5	74°16.290	091°14.800	Box Core ↓	351	112	280	16	-1.0	0.1	998.0	92	0/10
11	Barrow Strait	Full	06/Sep/2008	19h31	UTC-5	74°16.280	091°14.850	Box Core (bottom)	353	113	280	13	0.9	0.1	998.0	87	0/10
11	Barrow Strait	Full	06/Sep/2008	19h39	UTC-5	74°16.280	091°14.800	Box Core ↑	351	115	280	13	0.9	0.1	998.0	87	0/10
11	Barrow Strait	Full	06/Sep/2008	19h50	UTC-5	74°16.300	091°14.800	Box Core ↓	330	115	280	13	0.9	0.1	998.0	87	0/10
11	Barrow Strait	Full	06/Sep/2008	20h07	UTC-5	74°16.150	091°14.780	Box Core (bottom)	335	140	280	16	0.9	0.1	998.0	87	0/10
11	Barrow Strait	Full	06/Sep/2008	20h14	UTC-5	74°16.140	091°14.460	Box Core ↑	334	108	280	12	0.2	0.17	1000.0	88	0/10
11	Barrow Strait	Full	06/Sep/2008	22h27	UTC-5	74°27.000	091°23.450	Agassiz Trawl (bottom)	336	335	270	13	-1.2	0.18	999.2	93	0/10
11	Barrow Strait	Full	06/Sep/2008	22h30	UTC-5	74°16.200	091°14.100	Agassiz Trawl ↑	336	335	270	13	-1.2	0.18	999.2	93	0/10
11	303	Full	07/Sep/2008	02h10	UTC-5	74°14.345	089°39.671	CTD-Rosette ↓	226	127	280	11	-1.4	0.44	995.7	96	0/10
11	303	Full	07/Sep/2008	02h50	UTC-5	74°14.592	089°38.337	CTD-Rosette ↑	252	106	290	9	-1.4	0.49	998.0	93	0/10
11	303	Full	07/Sep/2008	03h11	UTC-5	74°14.225	089°40.381	Phytoflash ↓	227	49	280	9	-1.2	0.44	998.0	92	0/10
11	303	Full	07/Sep/2008	03h40	UTC-5	74°14.235	089°39.360	Phytoflash ↑	229	45	280	9	-1.3	0.48	997.8	91	0/10
11	303	Full	07/Sep/2008	04h01	UTC-5	74°14.340	089°39.670	CTD-Rosette ↓	230	100	280	9	-1.0	0.5	997.0	91	0/10
11	303	Full	07/Sep/2008	04h51	UTC-5	74°14.490	089°38.400	CTD-Rosette ↑	234	90	280	10	-1.0	0.5	997.0	94	0/10
11	303	Full	07/Sep/2008	05h12	UTC-5	74°14.230	089°39.530	RMT ↓	230	80	290	8	-1.0	0.4	997.0	95	0/10
11	303	Full	07/Sep/2008	05h28	UTC-5	74°14.670	089°39.170	RMT ↑	232	267	290	9	-1.2	0.4	997.0	94	0/10
11	303	Full	07/Sep/2008	05h50	UTC-5	74°14.060	089°40.360	Horizontal Net Tow ↓	230	153	280	10	-0.8	0.4	997.6	95	0/10
11	303	Full	07/Sep/2008	06h06	UTC-5	74°14.200	089°38.970	Horizontal Net Tow ↑	232	359	290	10	-1.0	0.4	997.7	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					
11	303	Full	07/Sep/2008	06h25	UTC-5	74°14.350	089°38.350	Vertical Net Tow ↓	235	120	280	9	0.0	0.4	997.7	94	0/10
11	303	Full	07/Sep/2008	06h37	UTC-5	74°14.380	089°38.000	Vertical Net Tow ↑	235	67	290	11	-0.4	0.4	997.7	92	0/10
11	303	Full	07/Sep/2008	07h33	UTC-5	74°14.190	089°40.370	CTD-Rosette ↓	228	83	280	9	0.1	0.3	997.6	91	0/10
11	303	Full	07/Sep/2008	08h09	UTC-5	74°14.190	089°39.690	CTD-Rosette ↑	228	100	280	10	-0.6	0.34	997.6	93	0/10
11	303	Full	07/Sep/2008	08h30	UTC-5	74°14.180	089°40.240	Secchi Disk ↓↑	224	100	280	10	-1.3	0.33	997.6	92	0/10
11	303	Full	07/Sep/2008	08h34	UTC-5	74°14.170	089°40.250	PNF ↓↑	224	100	280	10	-1.3	0.33	997.6	92	0/10
11	303	Full	07/Sep/2008	09h37	UTC-5	74°14.530	089°40.100	CTD-Rosette ↓	226	113	280	4	0.1	0.4	997.4	88	0/10
11	303	Full	07/Sep/2008	10h30	UTC-5	74°14.180	089°38.810	CTD-Rosette ↑	232	126	270	6	0.1	0.54	997.3	89	0/10
11	303	Full	07/Sep/2008	11h00	UTC-5	74°14.250	089°40.440	Hydrobios ↓	228	83	260	3	-0.2	0.51	997.2	92	0/10
11	303	Full	07/Sep/2008	11h18	UTC-5	74°14.230	089°40.090	Hydrobios ↑	226	88	260	3	0.2	0.55	997.2	92	0/10
11	303	Full	07/Sep/2008	12h00	UTC-5	74°13.996	089°39.257	PNF ↓	279	140	275	7	0.5	0.6	997.2	90	0/10
11	303	Full	07/Sep/2008	12h05	UTC-5	74°13.996	089°39.057	PNF ↑	230	135	275	7	0.5	0.6	997.2	90	0/10
11	303	Full	07/Sep/2008	12h07	UTC-5	74°13.996	089°39.257	SCAMP ↓	279	140	275	7	0.5	0.6	997.2	90	0/10
11	303	Full	07/Sep/2008	12h14	UTC-5	74°13.987	089°38.809	CTD-Rosette ↓	228	165	270	4	0.9	0.6	997.1	90	0/10
11	303	Full	07/Sep/2008	12h56	UTC-5	74°13.922	089°38.026	CTD-Rosette ↑	231	109	260	6	-1.2	0.6	997.0	92	0/10
11	303	Full	07/Sep/2008	14h02	UTC-5	74°14.313	089°39.613	SCAMP ↑	229	347	270	6	-1.2	0.6	997.0	93	0/10
11	303	Full	07/Sep/2008	14h10	UTC-5	74°14.288	089°39.567	CTD-Rosette ↓	228	78	270	6	-1.2	0.6	997.0	93	0/10
11	303	Full	07/Sep/2008	14h46	UTC-5	74°14.156	089°39.133	CTD-Rosette ↑	253	53	260	6	-1.3	0.7	996.9	93	0/10
11	303	Full	07/Sep/2008	16h30	UTC-5	74°14.210	089°39.840	Box Core ↓	229	66	270	4	-1.2	0.7	996.9	91	0/10
11	303	Full	07/Sep/2008	16h35	UTC-5	74°14.180	089°39.810	Box Core (bottom)	229	90	250	4	-1.1	0.6	996.9	92	0/10
11	303	Full	07/Sep/2008	16h40	UTC-5	74°14.170	089°39.790	Box Core ↑	230	94	250	4	-1.1	0.6	996.9	91	0/10
11	303	Full	07/Sep/2008	16h58	UTC-5	74°14.135	089°39.732	Box Core ↓	233	53	250	2	0.2	0.7	997.0	89	0/10
11	303	Full	07/Sep/2008	17h05	UTC-5	74°14.150	089°39.900	Box Core (bottom)	230	53	270	4	-0.4	0.7	997.0	89	0/10
11	303	Full	07/Sep/2008	17h07	UTC-5	74°14.105	089°39.600	Box Core ↑	230	47	270	4	-0.4	0.7	997.0	89	0/10
11	302	Nutrient	07/Sep/2008	22h30	UTC-5	74°09.230	086°15.780	CTD-Rosette ↓	522	103	230	2	0.0	0.5	997.0	88	0/10
11	302	Nutrient	07/Sep/2008	23h25	UTC-5	74°09.810	086°15.870	CTD-Rosette ↑	533	94	240	2	-0.1	0.6	997.0	88	0/10
11	301	Basic	08/Sep/2008	03h30	UTC-5	74°07.355	083°19.891	Phytoflash ↓	682	224	90	2	-1.2	1.01	997.3	93	0/10
11	301	Basic	08/Sep/2008	03h48	UTC-5	74°07.637	083°21.822	Phytoflash ↑	680	155	60	6	-0.8	1.18	997.4	91	0/10
11	301	Basic	08/Sep/2008	04h07	UTC-5	74°07.290	083°19.710	CTD-Rosette ↓	682	157	70	5	-1.2	1.2	997.3	92	0/10
11	301	Basic	08/Sep/2008	05h25	UTC-5	74°07.850	083°24.690	CTD-Rosette ↑	675	273	80	2	-0.5	1.2	997.5	95	0/10
11	301	Basic	08/Sep/2008	05h50	UTC-5	74°07.440	083°19.720	Vertical Net Tow ↓	680	221	50	11	-0.9	1.1	997.4	96	0/10
11	301	Basic	08/Sep/2008	06h25	UTC-5	74°08.010	083°21.190	Vertical Net Tow ↑	678	250	50	8	-0.8	1.2	997.5	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					
11	301	Basic	08/Sep/2008	06h58	UTC-5	74°07.170	083°20.720	Horizontal Net Tow ↓	676	121	70	12	-0.6	1.1	997.6	96	0/10
11	301	Basic	08/Sep/2008	07h11	UTC-5	74°07.460	083°21.340	Horizontal Net Tow ↑	680	310	70	13	-0.3	1.1	997.6	96	0/10
11	301	Basic	08/Sep/2008	07h33	UTC-5	74°08.170	083°23.580	Secchi Disk + PNF ↓	680	134	70	15	-0.2	1.1	997.8	96	0/10
11	301	Basic	08/Sep/2008	07h41	UTC-5	74°08.240	083°24.240	Secchi Disk + PNF ↑	679	149	60	13	-0.5	1.2	998.0	96	0/10
11	301	Basic	08/Sep/2008	08h07	UTC-5	74°07.450	083°19.990	CTD-Rosette ↓	678	306	90	10	-0.1	1.17	997.8	95	0/10
11	301	Basic	08/Sep/2008	09h15	UTC-5	74°08.200	083°24.170	CTD-Rosette ↑	679	300	80	6	1.0	1.22	998.0	90	0/10
11	301	Basic	08/Sep/2008	09h38	UTC-5	74°07.980	083°23.000	SCAMP ↓	677	300	80	6	1.0	1.22	998.0	90	0/10
11	301	Basic	08/Sep/2008	10h30	UTC-5	74°07.490	083°19.880	CTD-Rosette ↓	678	317	110	8	-0.9	1.01	998.1	92	0/10
11	301	Basic	08/Sep/2008	11h09	UTC-5	74°07.660	083°21.360	CTD-Rosette ↑	677	294	100	9	3.1	0.84	998.2	76	0/10
11	301	Basic	08/Sep/2008	11h19	UTC-5	74°07.600	083°22.420	SCAMP ↑	679	180	100	10	4.8	0.97	998.2	71	0/10
11	301	Basic	08/Sep/2008	12h10	UTC-5	74°09.126	083°12.369	Box Core ↓	694	137	120	11	0.3	1.25	998.7	83	0/10
11	301	Basic	08/Sep/2008	12h22	UTC-5	74°09.281	083°12.281	Box Core (bottom)	694	129	N/A	N/A	N/A	N/A	N/A	N/A	Icebergs
11	301	Basic	08/Sep/2008	12h32	UTC-5	74°09.196	083°12.387	Box Core ↑	694	140	120	11	0.4	1.24	998.9	81	0/10
11	301	Basic	08/Sep/2008	13h05	UTC-5	74°09.194	083°12.784	Box Core ↓	694	117	110	13	0.2	1.26	999.1	84	0/10
11	301	Basic	08/Sep/2008	13h26	UTC-5	74°09.183	083°12.525	Box Core (bottom)	694	N/A	110	13	0.2	1.26	999.1	84	0/10
11	301	Basic	08/Sep/2008	13h38	UTC-5	74°09.407	083°13.723	Box Core ↑	694	196	90	12	0.3	1.27	999.2	82	0/10
11	N/A	MVP	08/Sep/2008	19h13	UTC-5	73°47.020	079°59.500	MVP ↓	792	345	50	3	-0.8	1.3	998.7	93	0/10
11	N/A	MVP	09/Sep/2008	02h50	UTC-5	74°32.800	080°11.400	MVP ↑	679	15	320	6	0.0	1.5	1000.0	99	0/10
11	300	Nutrient	09/Sep/2008	04h36	UTC-5	74°19.130	080°06.660	CTD-Rosette ↓	690	255	270	7	0.0	2.1	1000.0	99	0/10
11	300	Nutrient	09/Sep/2008	05h46	UTC-5	74°19.200	080°06.110	CTD-Rosette ↑	670	112	250	1	1.0	2.5	1000.0	99	0/10
11	134	Basic	09/Sep/2008	09h20	UTC-5	74°29.150	078°02.330	SCAMP ↓	611	290	190	9	1.0	3.2	1001.0	86	0/10
11	134	Basic	09/Sep/2008	09h38	UTC-5	74°28.840	078°00.620	CTD-Rosette ↓	620	30	210	8	2.2	3.2	1002.0	79	0/10
11	134	Basic	09/Sep/2008	10h13	UTC-5	74°28.950	078°00.660	CTD-Rosette ↑	628	35	210	8	1.7	3.2	1002.0	74	0/10
11	134	Basic	09/Sep/2008	10h38	UTC-5	74°28.980	078°00.880	Horizontal Net Tow ↓	617	300	190	7	1.2	3.2	1002.6	75	0/10
11	134	Basic	09/Sep/2008	10h55	UTC-5	74°29.240	078°02.730	Horizontal Net Tow ↑	611	205	190	8	1.4	3.2	1002.7	76	0/10
11	134	Basic	09/Sep/2008	11h15	UTC-5	74°28.820	077°59.910	SCAMP ↑	620	30	190	9	1.6	3.2	1002.8	75	0/10
11	134	Basic	09/Sep/2008	11h30	UTC-5	74°28.800	077°59.970	Hydrobios ↓	622	46	200	5	2.5	3.2	1003.1	72	0/10
11	134	Basic	09/Sep/2008	12h10	UTC-5	74°28.713	078°00.310	Hydrobios ↑	533	19	150	4	2.4	3.3	1001.1	83	0/10
11	134	Basic	09/Sep/2008	12h30	UTC-5	74°28.746	078°00.235	Light Profile ↓	619	296	150	8	1.3	3.3	1004.0	85	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					
11	134	Basic	09/Sep/2008	12h38	UTC-5	74°28.757	078°00.246	Light Profile ↑	621	300	150	8	0.9	3.3	1004.0	86	0/10
11	134	Basic	09/Sep/2008	12h59	UTC-5	74°28.773	078°00.363	CTD-Rosette ↓	621	345	140	4	2.8	3.2	1003.8	79	0/10
11	134	Basic	09/Sep/2008	13h50	UTC-5	74°28.832	078°01.461	CTD-Rosette ↑	618	2	130	2	2.7	3.3	1004.2	78	0/10
11	134	Basic	09/Sep/2008	14h08	UTC-5	74°28.804	078°00.980	Zodiac Deployed	621	225	120	3	2.7	3.3	1004.3	77	0/10
11	134	Basic	09/Sep/2008	15h08	UTC-5	74°28.760	078°00.812	CTD-Rosette ↓	624	274	60	3	2.0	3.3	1004.6	76	0/10
11	134	Basic	09/Sep/2008	16h00	UTC-5	74°28.400	078°02.420	CTD-Rosette ↑	625	320	80	4	2	3.3	1005.0	81	0/10
11	134	Basic	09/Sep/2008	16h33	UTC-5	74°28.400	078°04.300	RMT ↓	626	177	60	6	0.8	3.3	1005.0	86	0/10
11	134	Basic	09/Sep/2008	16h49	UTC-5	74°28.180	078°03.060	RMT ↑	634	353	50	5	0.4	3.3	1005.0	90	0/10
11	134	Basic	09/Sep/2008	17h15	UTC-5	74°28.800	078°00.100	CTD-Rosette ↓	620	290	50	9	0.5	3.3	1005.0	90	0/10
11	134	Basic	09/Sep/2008	18h17	UTC-5	74°28.493	078°02.308	CTD-Rosette ↑	624	334	60	6	2.1	3.3	1005.0	87	0/10
11	136	Basic	10/Sep/2008	02h38	UTC-5	74°45.385	073°45.888	Vertical Net Tow ↓	782	332	150	13	3.4	3.5	1007.0	93	0/10
11	136	Basic	10/Sep/2008	03h25	UTC-5	74°45.556	073°35.607	Vertical Net Tow ↑	783	309	120	20	2.5	3.6	1007.0	92	0/10
11	136	Basic	10/Sep/2008	03h44	UTC-5	74°45.736	073°36.154	Horizontal Net Tow ↓	782	293	120	15	3.9	3.5	1007.5	88	0/10
11	136	Basic	10/Sep/2008	04h00	UTC-5	74°45.913	073°35.939	Horizontal Net Tow ↑	783	20	130	14	2.9	3.5	1007.0	92	0/10
11	136	Basic	10/Sep/2008	04h50	UTC-4	74°46.500	073.37.100	CTD-Rosette ↓	670	306	130	19	3.0	3.5	1007.0	92	0/10
11	136	Basic	10/Sep/2008	06h00	UTC-4	74°46.800	073°38.000	CTD-Rosette ↑	782	289	120	22	2.3	3.4	1008.0	91	0/10
11	136	Basic	10/Sep/2008	07h05	UTC-4	74°45.980	073°36.360	PNF ↓	783	72	130	23	2.6	3.4	1008.0	91	0/10
11	136	Basic	10/Sep/2008	07h17	UTC-4	74°46.210	073°35.840	PNF ↑	784	144	120	24	1.9	3.4	1008.0	93	0/10
11	136	Basic	10/Sep/2008	07h52	UTC-4	74°46.250	073°36.310	CTD-Rosette ↓	782	305	110	18	2.5	3.5	1008.0	96	0/10
11	136	Basic	10/Sep/2008	08h48	UTC-4	74°46.420	073°37.000	CTD-Rosette ↑	782	335	120	18	3.8	3.4	1008.0	90	0/10
11	136	Basic	10/Sep/2008	09h15	UTC-4	74°47.080	073°37.890	Box Core ↓	782	290	120	19	1.1	3.4	1008.6	95	0/10
11	136	Basic	10/Sep/2008	09h34	UTC-4	74°47.150	073°37.960	Box Core (bottom)	781	310	120	16	2.2	3.4	1008.7	95	0/10
11	136	Basic	10/Sep/2008	09h48	UTC-4	74°47.170	073°37.980	Box Core ↑	780	310	120	15	3.9	3.4	1008.7	87	0/10
11	136	Basic	10/Sep/2008	10h15	UTC-4	74°47.320	073°39.850	Box Core ↓	777	310	120	17	3.0	3.4	1008.6	90	0/10
11	136	Basic	10/Sep/2008	10h28	UTC-4	74°47.350	073°39.860	Box Core (bottom)	777	310	120	18	3.4	3.4	1008.6	87	0/10
11	136	Basic	10/Sep/2008	10h40	UTC-4	74°47.370	073°39.670	Box Core ↑	777	300	120	17	3.0	3.4	1008.7	88	0/10
11	136	Basic	10/Sep/2008	12h16	UTC-4	74°45.569	073°36.051	CTD-Rosette ↓	784	276	120	19	3.1	3.4	1008.5	87	0/10
11	136	Basic	10/Sep/2008	13h08	UTC-4	74°45.694	073°36.502	CTD-Rosette ↑	781	321	120	14	5.9	3.3	1009.0	76	0/10
11	137	Nutrient	10/Sep/2008	16h23	UTC-4	74°51.780	071°20.540	CTD-Rosette ↓	921	306	100	11	1.1	3.8	1010.0	90	0/10
11	137	Nutrient	10/Sep/2008	17h37	UTC-4	74°52.280	071°22.160	CTD-Rosette ↑	906	303	120	7	1.5	3.9	1010.0	86	0/10
11	138	Basic	10/Sep/2008	21h00	UTC-4	74°56.210	069°04.150	Hydrobios ↓	1079	8	160	2	0.4	2.9	1010.0	87	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					
11	138	Basic	10/Sep/2008	22h05	UTC-4	74°56.180	069°04.030	Hydrobios ↑	1081	295	70	2	1.1	3.1	1009.6	81	0/10
11	138	Basic	10/Sep/2008	22h32	UTC-4	74°56.190	069°03.940	Phytoflash ↓	1080	320	50	2	0.9	3.1	1009.5	83	0/10
11	138	Basic	10/Sep/2008	22h50	UTC-4	74°56.200	069°03.950	Phytoflash ↑	1080	340	80	3	0.2	3.1	1009.4	85	0/10
11	138	Basic	10/Sep/2008	23h05	UTC-4	74°56.190	069°04.060	CTD-Rosette ↓	1080	0	100	2	0.2	3.1	1009.3	85	0/10
11	138	Basic	10/Sep/2008	23h55	UTC-4	74°56.190	069°04.500	CTD-Rosette ↑	1080	10	70	2	0.0	2.9	1009.1	84	0/10
11	138	Basic	11/Sep/2008	00h30	UTC-4	74°56.256	069°04.625	Horizontal Net Tow ↓	1078	58	Calm	Calm	0.0	2.9	1009.0	83	0/10
11	138	Basic	11/Sep/2008	00h44	UTC-4	74°56.193	069°04.857	Horizontal Net Tow ↑	1082	111	Calm	Calm	0.0	2.8	1009.0	83	0/10
11	138	Basic	11/Sep/2008	01h10	UTC-4	74°56.195	069°04.112	CTD-Rosette ↓	1080	46	Calm	Calm	-0.4	2.9	1009.0	84	0/10
11	138	Basic	11/Sep/2008	02h24	UTC-4	74°56.175	069°03.882	CTD-Rosette ↑	1079	48	280	5	-0.5	2.8	1008.5	85	0/10
11	138	Basic	11/Sep/2008	02h51	UTC-4	74°56.250	069°04.620	Box Core ↓	1080	N/A	290	6	-0.7	2.8	1008.4	85	0/10
11	138	Basic	11/Sep/2008	03h07	UTC-4	74°56.186	069°04.124	Box Core (bottom)	1079	356	330	4	-0.5	2.7	1008.4	85	0/10
11	138	Basic	11/Sep/2008	03h26	UTC-4	74°56.123	069°04.164	Box Core ↑	1082	28	340	2	-0.6	2.8	1008.4	85	0/10
11	139	Nutrient	11/Sep/2008	06h51	UTC-4	74°59.390	066°46.550	CTD-Rosette ↓	538	26	270	6	-0.5	2.0	1008.0	85	0/10
11	139	Nutrient	11/Sep/2008	07h50	UTC-4	74°59.640	066°45.940	CTD-Rosette ↑	546	167	260	2	1.0	2.7	1009.0	80	0/10
11	140	Full	11/Sep/2008	11h00	UTC-4	75°02.150	064°29.220	Secchi Disk + PNF ↓	276	161	280	3	0.3	3.5	1008.0	85	0/10
11	140	Full	11/Sep/2008	11h08	UTC-4	75°02.140	064°29.250	Secchi Disk + PNF ↑	273	169	320	3	0.8	3.7	1008.0	82	0/10
11	140	Full	11/Sep/2008	11h35	UTC-4	75°02.180	064°29.130	CTD-Rosette ↓	280	180	330	3	0.9	3.8	1007.7	83	0/10
11	140	Full	11/Sep/2008	12h35	UTC-4	75°02.160	064°29.157	CTD-Rosette ↑	279	145	280	2	1.0	3.7	1007.4	83	0/10
11	140	Full	11/Sep/2008	13h05	UTC-4	75°02.065	064°29.102	Zodiac Deployed	280	132	300	2	2.4	3.7	1007.0	79	0/10
11	140	Full	11/Sep/2008	13h09	UTC-4	75°02.037	064°29.018	Vertical Net Tow ↓	280	164	280	3	2.4	3.7	1007.0	79	0/10
11	140	Full	11/Sep/2008	13h30	UTC-4	75°01.944	064°29.049	Vertical Net Tow ↑	280	40	280	5	0.6	3.8	1006.7	84	0/10
11	140	Full	11/Sep/2008	13h49	UTC-4	75°01.930	064°28.739	Horizontal Net Tow ↓	279	83	280	7	0.4	3.9	1006.7	85	0/10
11	140	Full	11/Sep/2008	14h06	UTC-4	75°02.312	064°29.172	Horizontal Net Tow ↑	274	250	290	5	0.4	3.8	1006.6	85	0/10
11	140	Full	11/Sep/2008	14h30	UTC-4	75°02.150	064°28.700	CTD-Rosette ↓	282	128	282	9	1.9	3.7	1006.4	82	0/10
11	140	Full	11/Sep/2008	15h27	UTC-4	75°02.204	064°27.945	CTD-Rosette ↑	273	122	280	7	2.6	3.7	1006.3	81	0/10
11	140	Full	11/Sep/2008	15h34	UTC-4	75°02.204	064°27.945	Zodiac Recovered	269	140	280	7	2.6	3.7	1006.3	81	0/10
11	140	Full	11/Sep/2008	15h55	UTC-4	75°01.180	064°28.450	Box Core ↓	286	118	290	9	1.0	4	1006.0	85	0/10
11	140	Full	11/Sep/2008	16h10	UTC-4	75°01.670	064°28.640	Box Core ↑	285	104	300	7	1.0	4	1006.0	86	0/10
11	140	Full	11/Sep/2008	16h33	UTC-4	75°02.230	064°29.070	Agassiz Trawl ↓	277	82	290	7	1.5	4	1005.6	86	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					
11	140	Full	11/Sep/2008	16h50	UTC-4	75°02.400	064°27.790	Agassiz Trawl ↑	267	30	290	10	0.5	4	1005.6	88	0/10
11	115	Full	12/Sep/2008	04h25	UTC-4	76°19.690	071°16.470	CTD-Rosette ↓	684	14	250	3	-0.5	4	1005.0	82	0/10
11	115	Full	12/Sep/2008	05h15	UTC-4	76°19.740	071°16.510	CTD-Rosette ↑	674	138	300	2	0.7	4	1005.0	77	0/10
11	115	Full	12/Sep/2008	05h35	UTC-4	76°19.660	071°15.950	RMT ↓	669	120	300	4	0.4	4	1005.0	78	0/10
11	115	Full	12/Sep/2008	05h55	UTC-4	76°19.950	071°15.060	RMT ↑	670	325	330	6	0.1	4	1005.0	80	0/10
11	115	Full	12/Sep/2008	06h33	UTC-4	76°20.030	071°15.530	Phytoflash ↓	670	130	340	5	0.6	4	1005.0	80	0/10
11	115	Full	12/Sep/2008	06h50	UTC-4	76°20.040	071°15.530	Phytoflash ↑	670	284	330	4	0.0	4	1005.0	79	0/10
11	115	Full	12/Sep/2008	07h05	UTC-4	76°19.980	071°18.560	CTD-Rosette ↓	670	278	310	4	0.0	4	1004.0	80	0/10
11	115	Full	12/Sep/2008	08h20	UTC-4	76°19.960	071°18.640	CTD-Rosette ↑	670	228	350	2	1.2	4.2	1003.6	78	0/10
11	115	Full	12/Sep/2008	08h35	UTC-4	76°19.410	071°14.630	Triangulation	670	225	310	12	0.2	3.8	1002.8	82	0/10
11	115	Full	12/Sep/2008	13h00	UTC-4	76°19.503	071°13.364	ROV ↓	684	327	300	11	0.8	3.7	1001.3	86	Bergy
11	115	Full	12/Sep/2008	18h01	UTC-4	76°19.659	071°13.668	ROV ↑ Cage Sampling ↓	684	277	280	10	0.5	3.7	999.8	89	0/10
11	115	Full	12/Sep/2008	18h10	UTC-4	76°19.657	071°13.488	ROV in moonpool	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0/10
11	115	Full	12/Sep/2008	18h21	UTC-4	76°19.657	071°13.488	ROV ↑ Cage Sampling ↑	681	202	310	2	0.9	3.7	999.8	90	Bergy
11	115	Full	12/Sep/2008	18h29	UTC-4	76°19.614	071°13.483	Secchi Disk ↓	676	236	310	2	0.9	3.7	999.8	90	0/10
11	115	Full	12/Sep/2008	18h31	UTC-4	76°19.614	071°13.483	Secchi Disk ↑	676	236	310	2	0.9	3.7	999.8	90	0/10
11	115	Full	12/Sep/2008	18h35	UTC-4	76°19.615	071°13.497	PNF ↑	676	225	300	8	1.1	3.7	999.7	89	0/10
11	115	Full	12/Sep/2008	18h48	UTC-4	76°19.670	071°13.780	CTD-Rosette ↓	672	320	300	10	0.8	4	1000.0	90	0/10
11	115	Full	12/Sep/2008	19h36	UTC-4	76°19.850	071°13.450	CTD-Rosette ↑	660	026	290	10	2.0	4	1000.0	86	0/10
11	115	Full	12/Sep/2008	19h50	UTC-4	76°19.840	071°13.000	Horizontal Net Tow ↓	655	105	290	12	0.5	4	1000.0	90	0/10
11	115	Full	12/Sep/2008	20h05	UTC-4	76°20.330	071°11.940	Horizontal Net Tow ↑	661	300	290	11	1.0	3.6	999.0	91	0/10
11	115	Full	12/Sep/2008	20h25	UTC-4	76°19.780	071°14.050	Vertical Net Tow ↓	676	120	290	11	1.0	3.6	999.0	91	0/10
11	115	Full	12/Sep/2008	21h10	UTC-4	76°19.800	071°13.690	Vertical Net Tow ↑	672	175	300	7	1.0	3.7	999.0	88	0/10
11	115	Full	12/Sep/2008	21h45	UTC-4	76°19.710	071°13.450	CTD-Rosette ↓	670	110	300	4	1.9	3.6	999.0	85	0/10
11	115	Full	12/Sep/2008	22h30	UTC-4	76°19.620	071°12.660	CTD-Rosette ↑	665	166	290	4	1.5	3.6	999.2	85	0/10
11	115	Full	12/Sep/2008	23h07	UTC-4	76°19.620	071°13.240	Hydrobios ↓	669	99	270	6	1	3.7	999.2	86	0/10
11	115	Full	12/Sep/2008	23h50	UTC-4	76°19.680	071°13.470	Hydrobios ↑	666	113	280	2	1.8	3.7	999.1	83	0/10
11	115	Full	13/Sep/2008	00h30	UTC-4	76°19.640	071°13.300	CTD-Rosette ↓	673	N/A	265	6	2.1	3.7	999.2	82	0/10
11	115	Full	13/Sep/2008	01h15	UTC-4	76°19.470	071°12.500	CTD-Rosette ↑	667	164	260	3	1.2	3.7	999.0	86	Bergy
11	115	Full	13/Sep/2008	02h07	UTC-4	76°19.553	071°13.054	Box Core ↓	669	330	210	4	0.3	3.7	999.7	88	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					
11	115	Full	13/Sep/2008	02h18	UTC-4	76°19.534	071°12.918	Box Core (bottom)	668	318	200	4	0.2	3.7	999.8	88	Bergy
11	115	Full	13/Sep/2008	02h29	UTC-4	76°19.514	071°12.789	Box Core ↑	666	318	200	4	0.2	3.7	999.9	88	Bergy
11	115	Full	13/Sep/2008	02h46	UTC-4	76°19.505	071°12.567	Box Core ↓	663	313	200	5	0.2	3.7	999.9	88	Bergy
11	115	Full	13/Sep/2008	02h56	UTC-4	76°19.506	071°12.453	Box Core (bottom)	660	302	200	4	0.2	3.7	1000.0	88	Bergy
11	115	Full	13/Sep/2008	03h06	UTC-4	76°19.506	071°12.353	Box Core ↑	660	302	180	5	0.2	3.7	1000.0	88	Bergy
11	115	Full	13/Sep/2008	03h22	UTC-4	76°19.537	071°12.291	Agassiz Trawl ↓	659	293	180	5	0.2	3.7	1000.5	89	Bergy
11	115	Full	13/Sep/2008	04h07	UTC-4	76°19.520	071°12.380	Agassiz Trawl ↑	670	111	210	2	1.0	3.6	1000.8	87	0/10
11	114	CTD	13/Sep/2008	10h40	UTC-4	76°19.580	071°47.050	CTD ↓	631	6	130	6	1.4	2.3	1003.7	78	0/10
11	114	CTD	13/Sep/2008	11h10	UTC-4	76°19.630	071°46.980	CTD ↑	634	38	170	4	2.2	2.7	1003.9	75	0/10
11	113	Nutrient	13/Sep/2008	12h18	UTC-4	76°19.257	072°13.144	CTD-Rosette ↓	562	185	160	5	0.8	3.7	1004.2	80	Bergy
11	113	Nutrient	13/Sep/2008	13h15	UTC-4	76°19.363	072°11.894	CTD-Rosette ↑	564	350	150	2	2.4	4.1	1004.4	73	Bergy
11	112	CTD	13/Sep/2008	14h08	UTC-4	76°18.893	072°42.321	CTD ↓	575	345	110	3	0.9	4.0	1004.5	79	Bergy
11	112	CTD	13/Sep/2008	14h32	UTC-4	76°18.884	072°41.989	CTD ↑	570	36	130	6	1.9	4.1	1004.8	79	Bergy
11	111	Basic	13/Sep/2008	15h22	UTC-4	76°18.335	073°12.497	Light Profile ↓	603	313	110	10	N/A	4.0	1004.9	80	Bergy
11	111	Basic	13/Sep/2008	15h29	UTC-4	76°18.363	073°13.283	Light Profile ↑	604	348	130	7	0.8	4.2	1005.0	81	Bergy
11	111	Basic	13/Sep/2008	16h23	UTC-4	76°18.370	073°14.080	CTD-Rosette ↓	614	300	110	5	3	4	1005.0	76	Icebergs
11	111	Basic	13/Sep/2008	17h12	UTC-4	76°18.040	073°14.130	CTD-Rosette ↑	580	221	100	6	2	4	1005.0	74	Icebergs
11	111	Basic	13/Sep/2008	17h55	UTC-4	76°18.730	073°12.960	Horizontal Net Tow ↓	620	260	80	7	1	4	1005.0	80	Icebergs
11	111	Basic	13/Sep/2008	18h11	UTC-4	76°18.298	073°13.320	Horizontal Net Tow ↑	610	67	80	4	1	4	1004.9	81	Icebergs
11	111	Basic	13/Sep/2008	18h35	UTC-4	76°18.400	073°12.908	Vertical Net Tow ↓	606	273	80	4	1.5	4	1004.9	80	Icebergs
11	111	Basic	13/Sep/2008	19h15	UTC-4	76°18.380	073°13.170	Vertical Net Tow ↑	604	196	40	6	2	4	1004.0	80	Icebergs
11	111	Basic	13/Sep/2008	20h00	UTC-4	76°18.160	073°13.400	CTD-Rosette ↓	592	222	40	8	2.4	4	1004.5	86	Icebergs
11	111	Basic	13/Sep/2008	21h00	UTC-4	76°18.050	073°13.470	CTD-Rosette ↑	581	226	40	13	2.3	4.1	1003.8	91	Icebergs
11	111	Basic	13/Sep/2008	21h35	UTC-4	76°18.350	073°13.140	Box Core ↓	602	232	50	18	2.2	4	1003.4	90	Icebergs
11	111	Basic	13/Sep/2008	21h45	UTC-4	76°18.340	073°13.180	Box Core (bottom)	611	260	70	16	2	4	1003.4	92	Icebergs
11	111	Basic	13/Sep/2008	21h55	UTC-4	76°18.290	073°13.600	Box Core ↑	611	300	70	16	2	4	1003.4	92	Icebergs
11	110	Nutrient	13/Sep/2008	23h15	UTC-4	76°17.950	073°37.820	CTD-Rosette ↓	535	265	80	10	2.2	1.7	1002.9	91	0/10
11	110	Nutrient	14/Sep/2008	01h11	UTC-4	76°17.763	073°38.033	CTD-Rosette ↑	538	334	70	7	3.4	2.0	1002.4	95	0/10
11	109	CTD	14/Sep/2008	01h33	UTC-4	76°17.358	074°06.997	CTD ↓	449	255	60	13	1.4	0.7	1001.8	92	Bergy
11	109	CTD	14/Sep/2008	01h52	UTC-4	76°17.252	074°07.019	CTD ↑	451	259	40	9	2.4	1.4	1001.7	89	Bergy
11	108	Full	14/Sep/2008	03h14	UTC-4	76°15.960	074°34.948	Hydrobios ↓	445	278	60	11	2.3	0.6	1001.5	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					
11	108	Full	14/Sep/2008	03h45	UTC-4	76°15.686	074°34.852	Hydrobios ↑	442	213	40	6	2.7	0.7	1001.3	86	Bergy
11	108	Full	14/Sep/2008	04h00	UTC-4	76°15.500	074°35.130	Phytoflash ↓	443	247	40	14	2.5	0.6	1001.0	85	Bergy
11	108	Full	14/Sep/2008	04h15	UTC-4	76°15.490	074°35.000	Phytoflash ↑	443	217	40	12	1.3	0.6	1001.0	90	Bergy
11	108	Full	14/Sep/2008	04h20	UTC-4	76°15.490	074°35.000	CTD-Rosette ↓	443	91	40	12	1.3	0.6	1001.0	90	Bergy
11	108	Full	14/Sep/2008	05h07	UTC-4	76°15.460	074°33.930	CTD-Rosette ↑	440	87	40	10	4.4	1	1001.0	80	Bergy
11	108	Full	14/Sep/2008	05h31	UTC-4	76°15.410	074°34.800	RMT ↓	441	212	60	7	2.2	1	1001.0	87	Bergy
11	108	Full	14/Sep/2008	05h47	UTC-4	76°14.940	074°34.030	RMT ↑	437	158	60	9	1.5	0.7	1001.0	89	Bergy
11	108	Full	14/Sep/2008	06h10	UTC-4	76°16.390	074°34.930	Horizontal Net Tow ↓	445	251	60	13	1.5	0.7	1001.0	91	Bergy
11	108	Full	14/Sep/2008	06h25	UTC-4	76°16.060	074°34.900	Horizontal Net Tow ↑	442	133	70	10	1.2	0.5	1001.0	91	Bergy
11	108	Full	14/Sep/2008	07h07	UTC-4	76°16.030	074°35.140	Secchi Disk + PNF ↓	447	0	70	9	1	0.6	1001.0	91	Bergy
11	108	Full	14/Sep/2008	07h13	UTC-4	76°16.070	074°35.100	Secchi Disk + PNF ↑	444	8	70	9	1	0.7	1001.0	93	Bergy
11	108	Full	14/Sep/2008	07h31	UTC-4	76°16.120	074°34.890	CTD-Rosette ↓	443	30	60	6	2.3	0.7	1000.0	93	Bergy
11	108	Full	14/Sep/2008	08h30	UTC-4	76°16.240	074°35.120	CTD-Rosette ↑	443	220	70	6	1.4	0.6	1000.5	93	Bergy
11	108	Full	14/Sep/2008	08h50	UTC-4	76°15.980	074°34.850	Vertical Net Tow ↓	4446	233	60	7	1	0.5	1000.4	94	0/10
11	108	Full	14/Sep/2008	09h20	UTC-4	76°16.040	074°34.870	Vertical Net Tow ↑	444	227	70	9	0.9	0.6	1000.3	94	0/10
11	108	Full	14/Sep/2008	09h55	UTC-4	76°16.950	074°37.220	Zodiac Deployed	447	180	70	8	1.4	0.6	1000.0	92	0/10
11	108	Full	14/Sep/2008	10h15	UTC-4	76°16.000	074°34.620	CTD-Rosette ↓	447	270	70	8	1.4	0.6	1000.0	92	0/10
11	108	Full	14/Sep/2008	11h15	UTC-4	76°16.000	074°35.060	CTD-Rosette ↑	447	282	90	7	2.4	1.1	1000.0	92	0/10
11	108	Full	14/Sep/2008	11h28	UTC-4	76°16.000	074°35.060	Zodiac Recovered	447	120	90	7	2.4	1.1	1000.0	92	0/10
11	108	Full	14/Sep/2008	12h22	UTC-4	76°16.006	074°34.539	Hydrobios ↓	448	222	70	14	2.1	1.2	999.7	91	Bergy
11	108	Full	14/Sep/2008	12h53	UTC-4	76°15.780	074°35.068	Hydrobios ↑	444	166	60	10	3.1	0.9	999.7	88	Bergy
11	108	Full	14/Sep/2008	13h47	UTC-4	76°15.783	074°35.750	Helicopter Deployed	N/A	16	80	12	1.9	0.8	999.6	92	Bergy
11	108	Full	14/Sep/2008	13h57	UTC-4	76°15.828	074°36.130	CTD-Rosette ↓	450	288	80	11	1.6	0.8	999.6	95	Bergy
11	108	Full	14/Sep/2008	14h35	UTC-4	76°18.793	074°36.730	Helicopter Recovered	N/A	341	90	7	2.2	0.8	999.8	92	Bergy
11	108	Full	14/Sep/2008	14h57	UTC-4	76°15.805	074°37.334	CTD-Rosette ↑	447	327	80	15	2.4	0.88	999.8	93	Bergy
11	108	Full	14/Sep/2008	15h18	UTC-4	76°16.088	074°35.549	Box Core ↓	446	285	80	12	1.8	0.7	999.8	93	Bergy
11	108	Full	14/Sep/2008	15h29	UTC-4	76°16.101	074°35.518	Box Core (bottom)	446	264	80	11	3.7	1.0	999.9	88	Bergy
11	108	Full	14/Sep/2008	15h39	UTC-4	76°16.121	074°35.338	Box Core ↑	446	266	80	11	3.7	1.0	999.9	88	Bergy
11	108	Full	14/Sep/2008	15h55	UTC-4	76°16.158	074°35.549	Box Core ↓	444	282	80	10	3.5	1.2	999.9	88	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					
11	108	Full	14/Sep/2008	16h05	UTC-4	76°16.180	074°35.630	Box Core (bottom)	444	260	70	9	3.6	1.0	1000.0	87	Bergy
11	108	Full	14/Sep/2008	16h30	UTC-4	76°13.200	074°54.310	Agassiz Trawl ↓	454	251	50	9	2.0	1.0	1000.0	91	Bergy
11	108	Full	14/Sep/2008	17h03	UTC-4	76°16.041	074°34.371	Agassiz Trawl ↑	448	113	30	10	1.2	0.7	999.7	93	Bergy
11	107	Nutrient	14/Sep/2008	19h00	UTC-4	76°17.380	074°56.600	CTD-Rosette ↓	450	232	30	15	2.0	2.0	1000.0	86	Bergy
11	107	Nutrient	14/Sep/2008	19h50	UTC-4	76°17.250	074°56.920	CTD-Rosette ↑	460	245	30	8	4.0	2.0	1000.0	81	Bergy
11	106	CTD	14/Sep/2008	21h05	UTC-4	76°18.510	075°21.420	CTD ↓	386	236	20	12	3.6	0.6	998.2	83	0/10
11	106	CTD	14/Sep/2008	21h25	UTC-4	76°18.490	075°21.610	CTD ↑	388	214	10	13	3.3	1.0	998.2	84	0/10
11	105	Basic	14/Sep/2008	22h40	UTC-4	76°19.100	075°37.420	CTD-Rosette ↓	324	200	10	12	3.1	0.1	997.6	86	0/10
11	105	Basic	14/Sep/2008	23h45	UTC-4	76°18.930	075°38.190	CTD-Rosette ↑	322	182	0	5	1.8	0.4	997.3	89	0/10
11	105	Basic	14/Sep/2008	23h55	UTC-4	76°18.864	075°38.585	Horizontal Net Tow ↓	322	230	0	14	0.1	0.4	997.1	92	0/10
11	105	Basic	15/Sep/2008	00h10	UTC-4	76°18.864	075°38.585	Horizontal Net Tow ↑	322	240	0	14	0.1	0.4	999.1	92	0/10
11	105	Basic	15/Sep/2008	00h25	UTC-4	76°18.695	075°39.474	Vertical Net Tow ↓	320	240	10	5	0.6	0.5	999.0	94	0/10
11	105	Basic	15/Sep/2008	00h52	UTC-4	76°18.477	075°40.651	Vertical Net Tow ↑	320	180	10	10	0.2	0.7	997.0	93	0/10
11	105	Basic	15/Sep/2008	01h24	UTC-4	76°18.946	075°37.339	Box Core ↓	324	225	350	13	-0.1	0.6	996.7	94	0/10
11	105	Basic	15/Sep/2008	01h30	UTC-4	76°18.906	075°37.289	Box Core (bottom)	324	221	350	6	1.0	0.4	997.7	92	0/10
11	104	CTD	15/Sep/2008	03h16	UTC-4	76°20.365	076°10.410	CTD ↓	196	216	40	10	0.2	0.2	996.2	95	1/10
11	104	CTD	15/Sep/2008	03h25	UTC-4	76°20.136	076°10.278	CTD ↑	192	223	350	12	0.9	0.1	996.3	92	1/10
11	103	Nutrient	15/Sep/2008	04h45	UTC-4	76°21.650	076°34.790	CTD-Rosette ↓	147	131	10	16	0.5	0.0	996.3	88	1/10
11	103	Nutrient	15/Sep/2008	05h11	UTC-4	76°21.320	076°34.760	CTD-Rosette ↑	147	165	350	13	2.5	0.0	996.1	80	1/10
11	102	CTD	15/Sep/2008	06h53	UTC-4	76°23.900	076°59.900	CTD ↓	245	214	10	25	0	0.0	996.3	86	1/10
11	102	CTD	15/Sep/2008	07h04	UTC-4	76°23.960	077°00.060	CTD ↑	248	206	10	23	0	0.0	996.3	86	1/10
11	101	Full	15/Sep/2008	10h35	UTC-4	76°23.170	077°24.730	Triangulation	1	Var	10	24	1.4	-0.2	995.3	77	1/10
11	101	Full	15/Sep/2008	13h07	UTC-4	76°21.773	077°26.141	Light Profile ↓	409	340	0	35	-1.7	-0.4	994.4	85	Bergy
11	101	Full	15/Sep/2008	13h16	UTC-4	76°21.418	077°27.011	Light Profile ↑	398	180	0	32	-1.8	-0.4	994.5	84	Bergy
11	101	Full	15/Sep/2008	13h35	UTC-4	76°21.386	077°26.811	CTD-Rosette ↓	399	213	10	32	-1.2	-0.3	994.9	81	Bergy
11	101	Full	15/Sep/2008	14h13	UTC-4	76°21.087	077°26.786	CTD-Rosette ↑	402	206	10	35	-0.1	-03	995.0	78	Bergy
11	101	Full	15/Sep/2008	14h47	UTC-4	76°21.938	077°28.552	Vertical Net Tow ↓	375	176	0	40	-1.0	-0.4	995.4	74	Bergy
11	101	Full	15/Sep/2008	15h13	UTC-4	76°21.846	077°28.877	Vertical Net Tow ↑	375	226	0	33	-1.3	-0.3	995.4	75	Bergy
11	101	Full	15/Sep/2008	15h40	UTC-4	76°22.497	077°25.980	Phytoflash ↓	399	190	0	35	-1.6	-0.3	995.0	83	Bergy
11	101	Full	15/Sep/2008	15h52	UTC-4	76°22.410	077°26.370	Phytoflash ↑	402	180	0	33	-1.6	-0.3	995.0	83	Bergy
11	101	Full	15/Sep/2008	16h03	UTC-4	76°22.280	077°26.720	CTD-Rosette ↓	386	282	10	28	0.6	-0.3	995.5	75	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					
11	101	Full	15/Sep/2008	16h47	UTC-4	76°22.090	077°26.720	CTD-Rosette ↑	387	223	10	24	2.0	0.0	996.0	71	Bergy
11	101	Full	15/Sep/2008	17h05	UTC-4	76°21.900	077°27.700	Hydrobios ↓	379	278	10	27	1.0	0.0	996.0	73	Bergy
11	101	Full	15/Sep/2008	17h30	UTC-4	76°22.020	077°27.870	Hydrobios ↑	375	290	10	21	2.6	0.0	996.0	71	Bergy
11	101	Full	15/Sep/2008	17h19	UTC-4	76°21.526	077°30.359	CTD-Rosette ↓	377	219	5	33	-0.8	-0.3	996.2	80	Bergy
11	101	Full	15/Sep/2008	18h50	UTC-4	76°21.500	077°30.700	CTD-Rosette ↑	380	25	10	22	2.4	0.0	996.6	70	Bergy
11	101	Full	15/Sep/2008	20h05	UTC-4	76°24.270	077°29.450	CTD-Rosette ↓	403	203	10	30	2.3	-0.2	996.9	76	Bergy
11	101	Full	15/Sep/2008	20h38	UTC-4	76°24.230	077°29.370	CTD-Rosette ↑	403	220	10	30	2.4	-0.2	997.5	71	Bergy
11	101	Full	15/Sep/2008	21h05	UTC-4	76°24.080	077°29.500	Box Core ↓	402	198	10	30	-1.6	-0.2	997.5	82	Bergy
11	101	Full	15/Sep/2008	21h13	UTC-4	76°24.040	077°29.530	Box Core (bottom)	402	210	10	28	-0.8	-0.2	997.7	81	Bergy
11	101	Full	15/Sep/2008	21h20	UTC-4	76°23.940	077°29.810	Box Core ↑	395	210	20	28	1.1	-0.2	997.8	75	Bergy
11	200	Nutrient	15/Sep/2008	23h23	UTC-4	76°32.470	077°16.270	CTD-Rosette ↓	344	180	355	25	-1.9	-0.1	998.5	86	3/10
11	200	Nutrient	15/Sep/2008	23h58	UTC-4	76°32.300	077°15.860	CTD-Rosette ↑	236	155	350	25	-0.5	0.0	999.0	87	3/10
11	201	CTD	16/Sep/2008	01h24	UTC-4	76°39.987	077°03.228	CTD ↓	267	165	325	22	-1.5	-0.1	997.4	90	Bergy
11	201	CTD	16/Sep/2008	01h37	UTC-4	76°39.869	077°03.031	CTD ↑	277	179	325	25	-0.7	-0.2	999.8	82	Bergy
11	202	Basic	16/Sep/2008	03h02	UTC-4	76°48.936	076°54.200	CTD-Rosette ↓	189	140	325	18	-0.5	-0.4	1000.7	93	0/10
11	202	Basic	16/Sep/2008	03h43	UTC-4	76°48.458	076°55.289	CTD-Rosette ↑	185	181	328	16	0.7	-0.3	1001.2	87	0/10
11	202	Basic	16/Sep/2008	04h05	UTC-4	76°48.340	076°55.850	Vertical Net Tow ↓	192	268	320	10	0.0	-0.3	1001.4	90	0/10
11	202	Basic	16/Sep/2008	04h22	UTC-4	76°48.160	076°56.690	Vertical Net Tow ↑	208	188	320	12	2.6	-0.3	1001.5	82	0/10
11	202	Basic	16/Sep/2008	04h40	UTC-4	76°47.710	076°57.150	Horizontal Net Tow ↓	216	163	320	8	2.3	-0.3	1001.6	83	0/10
11	202	Basic	16/Sep/2008	04h58	UTC-4	76°47.630	076°55.880	Horizontal Net Tow ↑	204	233	337	16	0.0	0.0	1001.7	91	0/10
11	202	Basic	16/Sep/2008	06h55	UTC-4	76°48.620	076°54.240	Secchi Disk + PNF ↓	193	304	30	18	-0.4	-0.5	1002.1	97	0/10
11	202	Basic	16/Sep/2008	07h03	UTC-4	76°48.500	076°54.500	Secchi Disk + PNF ↑	190	167	20	15	-1.0	-1.0	1003.0	97	0/10
11	202	Basic	16/Sep/2008	07h40	UTC-4	76°48.600	076°55.600	CTD-Rosette ↓	177	328	20	13	1.8	-0.6	1003.0	95	0/10
11	202	Basic	16/Sep/2008	08h18	UTC-4	76°48.540	076°56.920	CTD-Rosette ↑	183	250	20	13	0.3	-0.6	1003.0	92	0/10
11	202	Basic	16/Sep/2008	08h30	UTC-4	76°48.520	076°57.390	CTD-Rosette ↓	184	235	20	12	1	-0.5	1003.0	92	0/10
11	202	Basic	16/Sep/2008	08h58	UTC-4	76°48.520	076°58.020	CTD-Rosette ↑	186	240	20	20	3.2	-0.6	1002.9	81	0/10
11	203	CTD	16/Sep/2008	10h30	UTC-4	76°56.900	076°55.440	CTD ↓	157	200	20	25	-0.5	-0.7	1003.0	88	Bergy 2/10
11	203	CTD	16/Sep/2008	10h48	UTC-4	76°56.670	076°55.180	CTD ↑	158	207	30	22	-1.4	-0.7	1003.0	91	Bergy 2/10

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					
11	204	Nutrient	16/Sep/2008	12h17	UTC-4	77°07.556	077°27.611	CTD-Rosette ↓	177	218	7	27	-1.6	0.94	1003.0	85	Bergy 2/10
11	204	Nutrient	16/Sep/2008	12h51	UTC-4	77°07.195	077°27.267	CTD-Rosette ↑	170	230	20	24	-1.2	1.3	1004.0	70	Bergy 2/10
11	205	Basic	16/Sep/2008	16h43	UTC-4	77°15.400	078°12.800	Secchi Disk + PNF ↓↑	514	135	40	5	-1.7	-0.3	1005.0	84	Bergy 2/10
11	205	Basic	16/Sep/2008	18h54	UTC-4	77°13.480	078°49.880	CTD-Rosette ↓	504	340	150	3	-1.3	-0.5	1005.0	81	Bergy 2/10
11	205	Basic	16/Sep/2008	19h40	UTC-4	77°12.900	078°50.100	CTD-Rosette ↑	587	200	160	4	-2.2	-0.4	1005.0	83	Bergy 2/10
11	205	Basic	16/Sep/2008	19h57	UTC-4	77°13.270	078°52.490	Vertical Net Tow ↓	612	48	170	5	-1.5	-0.6	1004.7	84	Bergy 2/10
11	205	Basic	16/Sep/2008	20h33	UTC-4	77°13.060	078°52.740	Vertical Net Tow ↑	621	10	165	6	-0.9	-0.5	1004.5	81	Bergy 2/10
11	205	Basic	16/Sep/2008	21h04	UTC-4	77°13.050	078°13.610	Horizontal Net Tow ↓	658	0	165	6	-0.9	-0.5	1004.4	82	Bergy 2/10
11	205	Basic	16/Sep/2008	21h20	UTC-4	77°12.450	078°31.510	Horizontal Net Tow ↑	654	228	165	5	-0.9	-0.5	1004.3	83	Bergy 2/10
11	205	Basic	16/Sep/2008	21h50	UTC-4	77°12.160	078°49.140	CTD-Rosette ↓	607	240	180	8	-2.4	-0.5	1004.1	86	Bergy 2/10
11	205	Basic	16/Sep/2008	22h45	UTC-4	77°11.680	078°48.220	CTD-Rosette ↑	539	297	200	8	-2.5	-0.5	1003.6	87	Bergy 2/10
11	205	Basic	16/Sep/2008	23h45	UTC-4	77°13.170	078°53.020	Box Core ↓	622	342	240	2	-2.6	-0.5	1003.3	89	Bergy 2/10
11	205	Basic	17/Sep/2008	00h04	UTC-4	77°13.143	078°58.879	Box Core (bottom)	623	340	240	2	-2.8	-0.6	1003.4	90	Bergy
11	205	Basic	17/Sep/2008	00h12	UTC-4	77°13.133	079°52.729	Box Core ↑	623	341	230	2	-1.6	-0.6	1003.4	90	Bergy
11	205	Basic	17/Sep/2008	01h02	UTC-4	77°13.357	078°29.766	Agassiz Trawl ↓	786	170	Calm	Calm	-1.6	-0.3	1003.0	98	Bergy
11	205	Basic	17/Sep/2008	01h22	UTC-4	77°13.287	078°30.003	Agassiz Trawl (bottom)	758	305	Calm	Calm	-1.6	-0.8	1003.0	86	Bergy
11	205	Basic	17/Sep/2008	01h39	UTC-4	77°13.243	078°30.869	Agassiz Trawl ↑	759	250	340	4	-1.5	-0.1	1003.0	87	Bergy
11	206	CTD	17/Sep/2008	02h47	UTC-4	77°17.807	078°06.257	CTD ↓	491	285	340	2	-1.9	-0.6	1002.9	86	Bergy
11	206	CTD	17/Sep/2008	03h06	UTC-4	77°17.713	078°07.088	CTD ↑	488	249	48	5	-1.7	-0.5	1003.0	81	Bergy
11	207	Nutrient	17/Sep/2008	04h56	UTC-4	77°18.640	077°20.600	CTD-Rosette ↓	515	248	300	10	-2.3	-1.0	1002.0	77	Bergy
11	207	Nutrient	17/Sep/2008	05h45	UTC-4	77°18.690	077°21.650	CTD-Rosette ↑	515	272	0	7	-2.4	-1.0	1003.0	83	Bergy
11	118	Full	17/Sep/2008	07h45	UTC-4	77°19.290	076°31.840	Horizontal Net Tow ↓	479	183	340	20	-2.4	-1.0	1002.0	76	Bergy
11	118	Full	17/Sep/2008	08h00	UTC-4	77°18.400	076°32.470	Horizontal Net Tow ↑	485	180	0	22	-2.5	-1.0	1002.0	74	Bergy
11	118	Full	17/Sep/2008	08h35	UTC-4	77°19.650	076°30.420	Secchi Disk + PNF ↓	463	212	340	20	-2.5	-1.0	1002.0	74	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					
11	118	Full	17/Sep/2008	08h45	UTC-4	77°19.630	076°30.700	Secchi Disk + PNF ↑	463	190	340	20	-2.5	-1.0	1002.0	74	Bergy
11	118	Full	17/Sep/2008	09h08	UTC-4	77°19.210	076°33.040	CTD-Rosette ↓	475	210	340	16	-0.1	-1.0	1002.2	69	Bergy
11	118	Full	17/Sep/2008	10h00	UTC-4	77°18.820	076°36.900	CTD-Rosette ↑	480	205	340	18	0.5	-1.0	1002.0	71	Bergy
11	118	Full	17/Sep/2008	10h22	UTC-4	77°18.620	076°38.660	Hydrobios ↓	476	202	350	26	0.5	-1.0	1002.0	71	Bergy
11	118	Full	17/Sep/2008	10h57	UTC-4	77°18.660	076°39.250	Hydrobios ↑	480	200	350	20	0.6	-1.0	1002.0	71	Bergy
11	126	Full	17/Sep/2008	22h15	UTC-4	77°20.960	073°25.180	Vertical Net Tow ↓	324	185	0	15	-1.5	3.0	1001.8	90	Icebergs
11	126	Full	17/Sep/2008	22h35	UTC-4	77°20.930	073°26.820	Vertical Net Tow ↑	N/A	220	350	14	0.2	3.0	1001.8	78	Icebergs
11	126	Full	17/Sep/2008	22h55	UTC-4	77°20.540	073°27.110	Horizontal Net Tow ↓	685	120	350	14	0.2	3.0	1001.8	78	Icebergs
11	126	Full	17/Sep/2008	23h10	UTC-4	77°20.610	073°24.370	Horizontal Net Tow ↑	341	90	350	14	0.2	3.0	1001.8	78	Icebergs
11	126	Full	17/Sep/2008	23h41	UTC-4	77°20.880	073°26.050	Hydrobios ↓	330	203	40	10	0.0	3.3	1001.3	73	0/10
11	126	Full	18/Sep/2008	00h02	UTC-4	77°21.157	073°25.782	Hydrobios ↑	332	195	50	11	0.5	3.1	1001.3	79	Bergy
11	126	Full	18/Sep/2008	00h42	UTC-4	77°20.667	073°25.826	Phytoflash ↓	331	170	50	16	0.8	3.3	1001.3	87	Bergy
11	126	Full	18/Sep/2008	00h56	UTC-4	77°21.687	073°25.201	Phytoflash ↑	327	160	30	14	0.8	3.3	1001.2	87	Bergy
11	126	Full	18/Sep/2008	01h14	UTC-4	77°20.563	073°26.228	CTD-Rosette ↓	326	250	30	12	0.6	3.3	1001.2	88	Bergy
11	126	Full	18/Sep/2008	01h57	UTC-4	77°20.255	073°25.892	CTD-Rosette ↑	337	234	10	13	0.2	3.5	1001.5	80	Bergy
11	N/A	Mapping	18/Sep/2008	02h15	UTC-4	77°20.000	073°25.000	Bottom Mapping ↓	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0/10
11	N/A	Mapping	18/Sep/2008	03h17	UTC-4	77°21.080	073°28.500	Bottom Mapping ↑	324	208	0	16	0.4	3.2	1001.0	69	0/10
11	126	Full	18/Sep/2008	03h35	UTC-4	77°20.577	073°25.636	CTD-Rosette ↓	325	185	0	17	0.3	3.2	1001.0	68	Bergy
11	126	Full	18/Sep/2008	04h00	UTC-4	77°20.340	073°24.960	CTD-Rosette ↑	343	160	0	12	6.0	3.0	1001.0	56	Bergy
11	126	Full	18/Sep/2008	07h50	UTC-4	77°20.790	073°25.450	CTD-Rosette ↓	330	235	340	21	-1.0	3.0	1001.0	80	Bergy
11	126	Full	18/Sep/2008	08h23	UTC-4	77°20.650	073°25.560	CTD-Rosette ↑	327	190	340	22	-1.5	3.4	1000.6	74	Bergy
11	126	Full	18/Sep/2008	08h57	UTC-4	77°20.080	073°24.260	RMT ↓	350	110	355	23	-1.3	3.5	1000.3	80	0/10
11	126	Full	18/Sep/2008	09h18	UTC-4	77°19.300	073°19.460	RMT ↑	368	200	340	23	-1.3	3.5	1000.3	80	0/10
11	126	Full	18/Sep/2008	09h58	UTC-4	77°20.800	073°25.560	Hydrobios ↓	328	152	350	17	-1.0	3.5	1000.4	78	0/10
11	126	Full	18/Sep/2008	10h20	UTC-4	77°20.860	073°25.250	Hydrobios ↑	333	130	355	22	-0.8	3.4	1000.2	73	0/10
11	126	Full	18/Sep/2008	10h50	UTC-4	77°20.300	073°22.950	CTD-Rosette ↓	351	204	340	25	-0.9	3.4	999.9	81	0/10
11	126	Full	18/Sep/2008	11h27	UTC-4	77°20.390	073°22.980	CTD-Rosette ↑	352	210	340	24	-0.9	3.6	999.9	72	0/10
11	126	Full	18/Sep/2008	12h11	UTC-4	77°20.547	073°26.287	Box Core ↓	319	168	350	26	0.8	3.6	999.5	75	Bergy
11	126	Full	18/Sep/2008	12h18	UTC-4	77°20.557	073°26.459	Box Core (bottom)	323	165	350	26	0.8	3.6	999.5	76	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					
11	126	Full	18/Sep/2008	12h25	UTC-4	77°20.567	073°26.535	Box Core ↑	322	170	350	26	-0.8	3.5	999.5	77	Bergy
11	126	Full	18/Sep/2008	12h56	UTC-4	77°20.277	073°27.459	Light Profile ↓	325	160	350	23	-0.6	3.6	999.2	78	Bergy
11	126	Full	18/Sep/2008	13h07	UTC-4	77°20.187	073°27.367	Light Profile ↑	324	158	350	25	-0.6	3.5	999.3	80	Bergy
11	126	Full	18/Sep/2008	13h36	UTC-4	77°20.688	073°25.457	CTD-Rosette ↓	325	183	350	25	-0.7	3.6	998.9	76	Bergy
11	126	Full	18/Sep/2008	14h18	UTC-4	77°20.578	073°24.699	CTD-Rosette ↑	335	180	350	22	-0.9	3.6	999.3	71	Bergy
11	N/A	ROV	18/Sep/2008	19h10	UTC-4	77°10.950	072°30.270	ROV ↓	572	157	320	8	-0.3	3.7	998.5	67	Bergy
11	N/A	ROV	18/Sep/2008	21h14	UTC-4	77°10.920	072°30.220	ROV ↑	570	140	350	15	1.0	3.7	998.3	65	Bergy
11	N/A	Mapping	18/Sep/2008	21h54	UTC-4	77°09.600	072°28.670	Bottom Mapping ↓	N/A	149	340	14	1.0	3.7	998.3	65	Bergy
11	N/A	Mapping	19/Sep/2008	07h00	UTC-4	77°14.800	072°41.500	Bottom Mapping ↑	322	290	330	19	-1.4	3.0	995.8	72	Bergy
11	230	Nutrient	19/Sep/2008	10h10	UTC-4	77°06.010	072°25.080	CTD-Rosette ↓	592	270	50	11	0.6	3.2	996.8	66	Bergy
11	230	Nutrient	19/Sep/2008	11h15	UTC-4	77°06.380	072°25.350	CTD-Rosette ↑	578	315	90	5	0.0	3.3	996.7	63	Bergy
11	232	Nutrient	19/Sep/2008	12h43	UTC-4	76°56.707	072°11.954	CTD-Rosette ↓	835	210	20	4	1.5	3.4	996.5	63	Bergy
11	232	Nutrient	19/Sep/2008	13h52	UTC-4	76°56.365	072°11.574	CTD-Rosette ↑	839	133	35	7	1.3	3.4	996.4	66	Bergy
11	233	Full	19/Sep/2008	15h37	UTC-4	76°43.903	071°48.210	Horizontal Net Tow ↓	714	115	25	3	0.6	3.2	996.0	67	Bergy
11	233	Full	19/Sep/2008	15h50	UTC-4	76°44.073	071°46.795	Horizontal Net Tow ↑	737	8	0	7	0.0	3.2	994.0	67	Bergy
11	233	Full	19/Sep/2008	16h00	UTC-4	76°44.230	071°47.190	Horizontal Net Tow ↓	747	12	10	9	-0.5	3.0	996.0	67	Bergy
11	233	Full	19/Sep/2008	16h20	UTC-4	76°44.580	071°46.820	Horizontal Net Tow ↑	762	351	0	11	-0.6	3.0	996.0	68	Bergy
11	233	Full	19/Sep/2008	16h26	UTC-4	76°44.570	071°46.940	Secchi Disk + PNF ↓↑	764	303	20	10	-0.7	3.0	996.0	68	Bergy
11	233	Full	19/Sep/2008	16h45	UTC-4	76°44.370	071°47.460	CTD-Rosette ↓	746	209	20	9	-0.7	3.0	996.0	68	Bergy
11	233	Full	19/Sep/2008	17h40	UTC-4	76°44.050	071°47.620	CTD-Rosette ↑	727	140	350	6	0.4	3.0	996.0	62	Bergy
11	233	Full	19/Sep/2008	18h32	UTC-4	76°44.122	071°50.741	Hydrobios ↓	684	105	340	12	0.0	3.2	995.8	66	Bergy
11	233	Full	19/Sep/2008	19h12	UTC-4	76°44.120	071°51.110	Hydrobios ↑	677	140	340	10	1.3	3.2	995.6	60	Bergy
11	233	Full	19/Sep/2008	20h08	UTC-4	76°43.920	071°52.040	CTD-Rosette ↓	658	190	325	12	0	3.0	995.2	63	Bergy
11	233	Full	19/Sep/2008	21h15	UTC-4	76°43.900	071°52.810	CTD-Rosette ↑	593	212	315	10	0	3.0	994.7	64	Bergy
11	233	Full	19/Sep/2008	21h30	UTC-4	76°43.740	071°52.000	Vertical Net Tow ↓	693	90	315	10	0	3.0	994.6	63	Bergy
11	233	Full	19/Sep/2008	22h06	UTC-4	76°44.120	071°54.170	Vertical Net Tow ↑	573	180	315	5	0	3.0	994.3	62	Bergy
11	233	Full	19/Sep/2008	22h45	UTC-4	76°44.320	071°49.540	CTD-Rosette ↓	706	206	315	5	0	3.0	993.8	64	Bergy
11	233	Full	19/Sep/2008	23h33	UTC-4	76°44.450	071°50.960	CTD-Rosette ↑	700	232	0	7	0	3.0	993.5	65	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					
11	233	Full	20/Sep/2008	00h00	UTC-4	76°44.300	071°49.137	Box Core ↓	713	270	5	10	-0.2	3.3	993.3	63	Bergy
11	233	Full	20/Sep/2008	00h11	UTC-4	76°44.387	071°49.106	Box Core (bottom)	721	205	0	12	0.1	3.3	993.3	63	Bergy
11	233	Full	20/Sep/2008	00h22	UTC-4	76°44.387	071°49.224	Box Core ↑	718	209	350	11	-0.1	3.3	993.3	61	Bergy
11	233	Full	20/Sep/2008	00h39	UTC-4	76°44.357	071°49.556	Box Core ↓	714	168	0	7	0.2	3.3	993.0	60	Bergy
11	233	Full	20/Sep/2008	00h51	UTC-4	76°44.428	071°49.828	Box Core (bottom)	711	184	0	6	-0.1	3.3	993.0	64	Bergy
11	233	Full	20/Sep/2008	01h03	UTC-4	76°44.428	071°49.939	Box Core ↑ (did not work)	710	180	0	6	0.0	3.3	993.0	64	Bergy
11	233	Full	20/Sep/2008	01h39	UTC-4	76°44.348	071°50.452	Box Core ↓	701	177	30	7	0.0	3.2	993.0	66	Bergy
11	233	Full	20/Sep/2008	01h53	UTC-4	76°44.337	071°50.628	Box Core (bottom)	696	167	25	7	0.0	3.2	993.0	65	Bergy
11	233	Full	20/Sep/2008	02h03	UTC-4	76°44.327	071°50.804	Box Core ↑	694	174	25	7	-0.2	3.2	993.0	65	Bergy
11	233	Full	20/Sep/2008	02h13	UTC-4	76°44.308	071°50.982	Agassiz Trawl ↓	690	175	20	7	-0.1	3.2	993.0	64	Bergy
11	233	Full	20/Sep/2008	02h57	UTC-4	76°44.515	071°50.688	Agassiz Trawl ↑	700	62	90	9	-1.0	3.1	993.0	68	Bergy
11	233	Full	20/Sep/2008	03h35	UTC-4	76°44.165	071°49.464	CTD-Rosette ↓	704	310	100	10	-1.0	3.0	993.0	66	Bergy
11	233	Full	20/Sep/2008	04h20	UTC-4	76°44.060	071°49.740	CTD-Rosette ↑	695	180	80	10	-1.5	3.0	993.3	71	Bergy
11	234	Nutrient	20/Sep/2008	05h34	UTC-4	76°32.380	071°32.160	CTD-Rosette ↓	465	292	60	12	-1.6	3.0	993.6	69	Bergy
11	234	Nutrient	20/Sep/2008	06h21	UTC-4	76°32.010	071°32.500	CTD-Rosette ↑	467	246	70	2	-1.0	3.0	994.0	62	Bergy
11	BA01-05	Mooring	20/Sep/2008	10h50	UTC-4	76°17.290	071°17.070	ROV ↓	655	190	60	5	-1.0	2.5	994.3	66	Bergy
11	BA01-05	Mooring	20/Sep/2008	18h16	UTC-4	76°17.066	071°17.118	ROV ↑	670	145	55	10	0.2	2.2	998.6	54	Bergy
11	BA01-05	Mooring	21/Sep/2008	11h45	UTC-4	76°17.110	071°17.060	ROV ↓	655	120	340	12	1.7	2.8	1002.5	63	Bergy
11	BA01-05	Mapping	21/Sep/2008	11h53	UTC-4	76°16.814	071°09.857	Bottom Mapping ↓	650	120	60	17	0.7	2.8	999.1	59	Bergy
11	BA01-05	Mooring	21/Sep/2008	16h05	UTC-4	76°17.120	071°17.150	ROV ↑	655	44	330	14	1.0	3.0	1000.0	71	Bergy
11	N/A	Mapping	22/Sep/2008	07h00	UTC-4	76°19.710	071°13.810	Bottom Mapping ↑	673	240	150	7	0.0	2.0	1003.0	67	Bergy
11	BA01-06	Mooring	22/Sep/2008	12h00	UTC-4	76°19.670	071°13.580	ROV ↓	655	160	120	10	0.0	2.5	1006.5	69	Bergy
11	BA01-06	Mooring	22/Sep/2008	17h50	UTC-4	76°19.650	071°13.800	ROV ↑	669	184	140	7	0.3	2.3	1010.8	69	Bergy
11	115	CTD	22/Sep/2008	18h30	UTC-4	76°19.880	071°13.390	CTD ↓	660	300	170	7	1.4	2.4	1011.5	64	Bergy
11	115	CTD	22/Sep/2008	18h53	UTC-4	76°20.020	071°13.350	CTD ↑	680	117	180	5	0.7	2.3	1011.7	66	Bergy
11	141	CTD	23/Sep/2008	08h25	UTC-4	73°52.460	074°17.780	Secchi Disk + PNF ↓↑	853	155	330	14	0.2	1.3	1018.2	76	Bergy
11	141	CTD	23/Sep/2008	08h50	UTC-4	73°52.330	074°17.490	CTD-Rosette ↓	850	170	335	15	0.2	1.5	1018.2	74	Bergy
11	141	CTD	23/Sep/2008	09h52	UTC-4	73°51.980	074°16.840	CTD-Rosette ↑	850	170	330	17	0.4	1.6	1018.4	70	Bergy
11	Gibbs 2	Basic	24/Sep/2008	09h50	UTC-4	70°58.780	071°36.350	MVP ↓	454	232	50	13	0.0	1.0	1018.7	70	Bergy
11	Gibbs 2	Basic	24/Sep/2008	13h33	UTC-4	70°47.700	072°09.400	MVP ↑	N/A	160	N/A	N/A	N/A	N/A	N/A	N/A	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					
11	Gibbs 2	Basic	24/Sep/2008	16h37	UTC-4	70°45.900	072°15.600	CTD-Rosette ↓	454	230	30	15	0.0	1.0	1018.0	69	0/10
11	Gibbs 2	Basic	24/Sep/2008	17h27	UTC-4	70°45.700	072°15.200	CTD-Rosette ↑	430	211	00	7	2.3	1.4	1018.0	63	0/10
11	Gibbs 2	Basic	24/Sep/2008	16h20	UTC-4	70°45.800	072°15.500	Secchi Disk + PNF ↓	452	356	30	14	-0.4	1.3	1018.0	68	0/10
11	Gibbs 2	Basic	24/Sep/2008	16h28	UTC-4	70°45.800	072°15.500	Secchi Disk + PNF ↑	452	356	30	14	0.0	1.0	1018.0	68	0/10
11	Gibbs 2	Basic	24/Sep/2008	18h30	UTC-4	70°45.794	072°15.901	CTD-Rosette ↓	455	234	10	14	0.2	1.5	1017.0	65	0/10
11	Gibbs 2	Basic	24/Sep/2008	19h10	UTC-4	70°45.640	072°15.700	CTD-Rosette ↑	452	202	10	10	1.7	1.5	1017.0	64	0/10
11	Gibbs 2	Basic	24/Sep/2008	19h30	UTC-4	70°45.600	072°15.700	Vertical Net Tow ↓	452	192	10	12	2.4	1.5	1016.0	61	0/10
11	Gibbs 2	Basic	24/Sep/2008	19h55	UTC-4	70°45.600	072°15.900	Vertical Net Tow ↑	456	192	20	14	0.9	1.6	1016.0	63	0/10
11	Gibbs 2	Basic	24/Sep/2008	20h00	UTC-4	70°45.480	072°16.130	Vertical Net Tow ↓	457	207	35	14	0.3	1.5	1016.3	65	0/10
11	Gibbs 2	Basic	24/Sep/2008	20h35	UTC-4	70°45.440	072°16.180	Vertical Net Tow ↑	457	260	35	14	0.3	1.5	1006.3	65	0/10
11	Gibbs 2	Basic	24/Sep/2008	20h45	UTC-4	70°45.400	072°20.380	Horizontal Net Tow ↓	456	40	35	14	0.3	1.5	1015.0	68	0/10
11	Gibbs 2	Basic	24/Sep/2008	21h02	UTC-4	70°45.400	072°20.380	Horizontal Net Tow ↑	453	265	25	14	0.3	1.3	1015.0	68	0/10
11	Gibbs 2	Basic	24/Sep/2008	21h15	UTC-4	70°46.050	072°16.540	CTD-Rosette ↓	451	225	25	14	0.3	1.3	1015.8	68	0/10
11	Gibbs 2	Basic	24/Sep/2008	22h00	UTC-4	70°45.890	072°16.510	CTD-Rosette ↑	453	235	30	18	0.3	1.5	1014.7	58	0/10
11	Gibbs 2	Basic	24/Sep/2008	22h23	UTC-4	70°46.110	072°15.680	Box Core ↓	452	230	35	18	0.2	1.5	1014.2	68	0/10
11	Gibbs 2	Basic	24/Sep/2008	22h30	UTC-4	70°46.100	072°15.690	Box Core (bottom)	452	222	20	15	0.2	1.4	1014.5	64	0/10
11	Gibbs 2	Basic	24/Sep/2008	22h39	UTC-4	70°46.080	072°15.720	Box Core ↑	457	212	35	14	0.2	1.5	1014.3	64	0/10
11	Gibbs 2	Basic	24/Sep/2008	22h50	UTC-4	70°46.090	072°15.760	Box Core ↓	452	214	35	17	0.1	1.6	1014.1	68	0/10
11	Gibbs 2	Basic	24/Sep/2008	23h00	UTC-4	70°46.090	072°15.820	Box Core (bottom)	452	216	38	17	0.2	1.6	1013.9	69	0/10
11	Gibbs 2	Basic	24/Sep/2008	23h09	UTC-4	70°46.080	072°15.890	Box Core ↑	457	213	60	18	0.3	1.5	1013.8	70	0/10
11	Gibbs 1	Nutrient	25/Sep/2008	02h55	UTC-4	71°07.304	070°57.912	CTD-Rosette ↓	449	326	100	5	-0.5	1.6	1013.0	87	0/10
11	Gibbs 1	Nutrient	25/Sep/2008	03h45	UTC-4	71°07.370	070°59.047	CTD-Rosette ↑	461	272	110	4	-0.5	1.9	1013.0	80	0/10
11	N/A	N/A	25/Sep/2008	03h50	UTC-4	71°07.370	070°59.047	Bottom Mapping ↓	460	272	110	4	-0.5	1.9	1013.0	80	0/10
11	N/A	N/A	25/Sep/2008	10h25	UTC-4	71°24.610	069°59.920	Bottom Mapping ↑	280	137	110	16	0.2	1.5	1009.0	74	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	Resolute	Test	05/09/08	20:17	74°39.580	094°50.430	17	8	sensors seems ok	VL
002	BarrowStrait	Full	06/09/08	11:21	74°16.531	091°39.007	320	303	no comments	VL
003	303	Full	07/09/08	07:10	74°14.324	089°39.738	230	223	bottles 15. 16. 17.18. 20. 23. 24 didn't close. cast will be done again	AJ
004	303	Full	07/09/08	09:01	74°14.338	089°39.667	228	222	bottle 5 lost some water because spiggot was open; bottle 23 didn't close	AJ
005	303	Full	07/09/08	12:33	74°14.495	089°38.396	227	212	bottle 24 didn't close	AJ
006	303	Full	07/09/08	14:39	74°14.243	089°40.154	228	218	bottles 12 to 24 did not close. cast will be repeated	AJ
007	303	Full	07/09/08	17:18	74°13.991	089°38.748	228	219	bottle 24 didn't close	AJ
008	303	Full	07/09/08	19:13	74°13.919	089°37.967	229	220	bottle 24 didn't close	AJ
009	302	Nutrient	08/09/08	03:26	74°09.389	086°16.188	522	515	bottle 21 didn't close	VL
010	301	Basic	08/09/08	09:10	74°07.405	083°20.687	682	676	bottle 24 didn't close. 22-23 closed surface	DB
011	301	Basic	08/09/08	13:08	74°07.422	083°19.805	678	669	no comments	AJ
012	301	Basic	08/09/08	15:26	74°08.142	083°23.833	678	667	no comments	AJ
013	300	Nutrient	09/09/08	09:38	74°19.126	080°06.653	655	643	altimeter didn't work. program stopped responding for btl 13 & 21 to 24. btl 18 closed on deck and 17 did not close	AJ
014	134	Basic	09/09/08	14:35	74°19.208	080°00.668	620	619	Aborted. no response from the deck unit when closing bottles.	DB
015	134	Basic	09/09/08	18:03	74°28.768	078°00.358	622	617	No nitrate probe. pH probe didn't work. Btls 1.2.3.21.22 closed without info. Btls 23.24 didn't close	DB
016	134	Basic	09/09/08	20:10	74°19.208	078°00.890	625	619	No nitrate probe. pH probe didn't work. Btls 1-5 closed without info. Btls 21.23.24 did not close.	AJ
017	134	Basic	09/09/08	22:13	74°28.812	078°00.241	639	620	No nitrate. pH not working. Btls 19 & 24 didn't close. No info for btls 1 to 13	DB
018	136	Basic	10/09/08	08:52	74°46.492	073°37.108	780	773	pH probe doesn't work	AJ
019	136	Basic	10/09/08	11:55	74°46.253	073°36.328	782	775	Btls 2 to 24 did not close	AJ
020	136	Basic	10/09/08	16:18	74°45.654	073°36.127	779	778	no pH. Btl 24 did not close	DB
021	137	Nutrient	10/09/08	20:25	74°51.772	071°20.544	928	920	no pH	VL
022	138	Basic	11/09/08	03:06	74°56.183	069°04.009	1068	951	no pH	AJ
023	138	Basic	11/09/08	05:15	74°56.189	069°04.132	1080	950	no pH. Btl 24 did not close	AJ
024	139	Nutrient	11/09/08	10:55	74°59.362	066°46.674	546	536	no pH. Btl 17 closed on deck. Btl 21 closed after 22 was launched.	DB
025	140	Full	11/09/08	15:40	75°02.190	064°29.128	280	272	no pH. Btl 24 did not close	DB
026	140	Full	11/09/08	18:32	75°02.153	064°28.967	282	271	no pH	VL

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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
027	115	Full	12/09/08	08:28	76°19.710	071°16.456	678	666	no pH; btl 11 did not close	AJ
028	115	Full	12/09/08	11:01	76°20.012	071°18.688	670	667	no pH; btl 11 didn't close	DB
029	115	Full	12/09/08	22:51	76°19.669	071°13.801	672	666	no pH	DB
030	115	Full	13/09/08	01:46	76°19.714	071°13.490	670	660	no pH. Surface water mixed	AJ
031	115	Full	13/09/08	04:34	76°19.646	071°13.322	673	660	no pH.	AJ
032	114	CTD	13/09/08	14:43	76°19.576	071°47.068	631	604	no pH	DB
033	113	Nutrient	13/09/08	16:21	76°19.253	072°13.133	568	554	no pH. Bottle 11 didn't close	DB
034	112	CTD	13/09/08	18:10	76°18.887	072°42.246	572	556	no pH	VL
035	111	Basic	13/09/08	20:24	76°18.395	073°14.110	613	591	no pH. btl 11 didn't close	VL
036	111	Basic	14/09/08	00:00	76°18.174	073°13.369	600	578	no pH. Btls 11.24 didn't close	VL
037	110	Nutrient	14/09/08	03:19	76°18.064	073°37.813	532	526	no pH. Btl 11.24 didn't close	AJ
038	109	CTD	14/09/08	05:35	76°17.330	074°06.970	449	444	no pH	AJ
039	108	Full	14/09/08	08:22	76°15.502	074°34.992	443	433	no pH. Btl 11.24 didn't close	AJ
040	108	Full	14/09/08	11:38	76°16.132	074°34.841	448	439	no pH. Btl 11.24 didn't close	DB
041	108	Full	14/09/08	14:20	76°16.019	074°34.756	444	438	no pH. Bottle 11 didn't close.	DB
042	108	Full	14/09/08	18:00	76°15.828	074°36.112	450	442	no pH. Btl 11 did not close	AJ
043	107	Nutrient	14/09/08	23:01	76°17.384	074°56.578	460	447	no pH.	AJ
044	106	CTD	15/09/08	01:08	76°18.545	075°21.336	386	378	no pH	VL
045	105	Basic	15/09/08	02:43	76°19.104	075°37.434	324	318	Btl 19.24 didn't close. No pH.	DB
046	104	CTD	15/09/08	07:21	76°20.284	076°10.309	190	180	no pH.	DB
047	103	Nutrient	15/09/08	08:48	76°21.658	076°34.768	147	137	no pH.	DB
048	102	CTD	15/09/08	10:56	76°23.999	076°59.927	245	237	no pH	VL
049	101	Full	15/09/08	17:38	76°21.386	077°26.815	387	382	no pH. Btl 11.15.24 didn't close. Water mixed at 9m	VL
050	101	Full	15/09/08	20:06	76°22.294	077°26.668	392	382	no pH. Btl 11.15.24 did not close	AJ
051	101	Full	15/09/08	22:22	76°21.521	077°30.334	377	367	np pH. Btl 11.24 didn't close	AJ
052	101	Full	16/09/08	00:08	76°24.271	077°29.447	403	393	no pH. Btl 11 did not close	AJ
053	200	Nutrient	16/09/08	03:28	76°32.472	077°16.250	244	238	no pH.	DB
054	201	CTD	16/09/08	05:26	76°39.974	077°03.204	267	264	no pH	DB
055	202	Basic	16/09/08	07:05	76°48.926	076°54.258	192	183	no pH.	DB
056	202	Basic	16/09/08	11:43	76°48.594	076°55.578	179	167	altimeter didn't worked. Aborted. forgot syringe on pump	VL
057	202	Basic	16/09/08	12:31	76°48.511	076°57.208	184	175	Altimeter+pH didn't worked. Remake of cast 056.	VL
058	203	CTD	16/09/08	14:34	76°56.899	076°55.412	155	145	Altimeter+pH didn't worked	VL
059	204	Nutrient	16/09/08	16:20	77°07.748	077°27.569	177	165	Altimeter+pH didn't worked	VL
060	205	Basic	16/09/08	22:53	77°13.558	078°49.052	489	484	Btl 11.24 did not close. Btl 23 closed half out of water. No pH.	AJ
061	205	Basic	17/09/08	01:54	77°12.560	078°49.091	583	581	no pH. Bottle 24 didn't close	AJ/DB

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
062	206	CTD	17/09/08	06:48	77°11.719	078°06.425	491	487	no pH.	DB
063	207	Nutrient	17/09/08	08:58	77°18.642	077°20.615	515	498	no pH.	DB
064	118	Full	17/09/08	13:03	77°19.398	076°31.681	475	465	no pH. Btl 11 didn't close	VL
065	118	Full	17/09/08	15:58	77°18.936	076°34.037	470	467	no pH. Aborted due to hard conditions	VL
066	126	Full	18/09/08	05:17	77°20.573	073°26.220	326	319	no pH.	DB
067	126	Full	18/09/08	07:37	77°20.587	073°25.634	325	319	no pH. Water may be mixed at 10m	DB
068	126	Full	18/09/08	11:49	77°20.803	073°25.469	330	321	no pH. Btl 24 did not close	VL
069	126	Full	18/09/08	14:52	77°20.299	073°22.951	350	344	no pH. Btl 24 did not close	VL
070	126	Full	18/09/08	17:40	77°20.689	073°25.454	326	318	no pH. Btl 24 did not close	AJ
071	230	Nutrient	19/09/08	14:13	77°06.004	072°25.074	592	571	no pH. Btl 5 closed out of water	VL
072	232	Nutrient	19/09/08	16:45	76°56.706	072°11.980	835	834	no pH. Btl 24 did not close	VL
073	233	Full	19/09/08	20:50	76°44.366	071°47.504	746	739	no pH. Btl 24 did not close	AJ
074	233	Full	20/09/08	00:11	76°43.950	071°51.935	658	627	no pH. Btl 24 did not close.	AJ
075	233	Full	20/09/08	02:49	76°44.318	071°49.518	706	700	no pH. Btl 24 did not close. Stopped 17m from bottom	DB
076	233	Full	20/09/08	07:36	76°44.168	071°49.459	704	701	no pH. Btl 17.24 didn't close. Btl 17 to 23 were closed early to prevent the rosette to hit the ship.	DB
077	234	Nutrient	20/09/08	09:37	76°32.390	071°32.154	464	456	no pH.	DB
078	115	CTD	22/09/08	22:33	76°19.870	071°13.364	663	646	no pH.	DB
079	141	CTD	23/09/08	12:52	73°52.344	074°17.500	850	838	no pH. Btl 24 didn't close. Sensors spiked crazily by 300m on downcast	AJ
080	Gibbs2	Basic	24/09/08	20:44	70°45.880	072°15.618	454	439	no pH.	DB
081	Gibbs2	Basic	24/09/08	22:33	70°45.793	072°15.910	455	445	no pH. 24 didn't close	DB
082	Gibbs2	Basic	25/09/08	01:16	70°46.063	072°16.519	451	436	no pH. 24 didn't close	DB
083	Gibbs1	Nutrient	25/09/08	06:56	71°07.307	070°57.880	449	445	no pH	VL

Leg	Name	Position	Affiliation	Network Investigator/supervisor	Embark Date	Disembark Date
Leg 11a	Adam, Ben	Media	NBC Today Show (TBC)	ArcticNet	4-Sep-08	28-Sep-08
Leg 11a	Alexander, Peter	Media	NBC Today Show (TBC)	ArcticNet	4-Sep-08	28-Sep-08
Leg 11b	Archambault, Philippe	Professor	University of Quebec in Rimouski	Archambault, Philippe	28-Sep-08	5-Oct-08
Leg 11a, Leg 11b	Ardyna, Mathieu	MSc Student	University of Quebec in Rimouski	Gosselin, Michel	4-Sep-08	5-Oct-08
Leg 11a	Aubry, Cyril	Research Assistant	University of Quebec in Rimouski	Xie, Huixiang - SOLAS	4-Sep-08	28-Sep-08
Leg 11a	Bailey, Joscelyn	PhD student	NRCan	Outridge, Peter	4-Sep-08	28-Sep-08
Leg 11b	Baya, Pascale Anabelle	PhD student	Trent University	Stern, Gary	28-Sep-08	5-Oct-08
Leg 11b	Bentley, Sam	Research Scientist	Memorial University	Bentley, Sam	28-Sep-08	5-Oct-08
Leg 11a	Berrouard, Mariane	MSc Student	Université Laval	Tremblay, Jean-Eric	4-Sep-08	28-Sep-08
Leg 11a	Blais, Marjolaine	MSc Student	Laval University	Tremblay, Jean-Eric	4-Sep-08	28-Sep-08
Leg 11a, Leg 11b	Boisvert, Dominique	Research Assistant	INRS -ÉTÉ	Gratton, Yves	4-Sep-08	5-Oct-08
Leg 11b	Bourgeois, Luc	Research Assistant	University of Quebec in Rimouski	Gosselin, Michel	28-Sep-08	5-Oct-08
Leg 11b	Brown, Tanya	Research Associate	Royal Military College	Reimer, Ken	28-Sep-08	5-Oct-08
Leg 11a, Leg 11b	Cartwright, Doug	EM-300 operator	UNB - Ocean Mapping Group	Hughes-Clark, John	4-Sep-08	16-Oct-08
Leg 11a, Leg 11b	Darnis, Gérald	PhD Student	Laval University	Fortier, Louis	4-Sep-08	5-Oct-08
Leg 11a, Leg 11b	DeLaronde, Joanne	Research Assistant	Department of Fisheries and Oceans - FW	Stern, Gary	4-Sep-08	5-Oct-08
Leg 11a, Leg 11b	du Preez, Cherisse	PhD Student	University of Victoria	Archambault, Philippe	4-Sep-08	5-Oct-08
Leg 11a	Else, Brent	PhD Student	University of Manitoba	Papakyriakou, Tim	4-Sep-08	28-Sep-08
Leg 11a	Fortier, Martin	Chief scientist	ArcticNet	ArcticNet	4-Sep-08	28-Sep-08
Leg 11b	Fortin, Claude	Media	IMAX-Science North	ArcticNet	28-Sep-08	5-Oct-08
Leg 11a	Gagné, Cynthia	MSc Student	Laval University	Scarratt, Michael - SOLAS	4-Sep-08	28-Sep-08
Leg 11a	Gagnon, Jonathan	Research Assistant	Laval University	Tremblay, Jean-Eric	4-Sep-08	28-Sep-08
Leg 11b	Gosselin, Michel	Chief scientist	University of Quebec in Rimouski	Gosselin, Michel	28-Sep-08	5-Oct-08
Leg 11b	Goudie, Jim	Nunatsiavut Conservation Office	Nunatsiavut	Reimer, Ken	28-Sep-08	5-Oct-08
Leg 11a	Griffiths, Callan	Media	NBC Today Show (TBC)	ArcticNet	4-Sep-08	28-Sep-08
Leg 11a	Hale, Michelle	Research scientist	University of Portsmouth	Levasseur, Maurice - SOLAS	4-Sep-08	28-Sep-08
Leg 11b	Hincapie-Gara, Ysabella	Technician	University of Quebec in Rimouski	Gosselin, Michel	28-Sep-08	5-Oct-08
Leg 11a	Jahn, Alexandra	PhD Student	McGill University	Gratton, Yves	4-Sep-08	28-Sep-08
Leg 11b	Kahlmeyer, Elisabeth	MSc Student	Memorial University	Bentley, Sam	28-Sep-08	5-Oct-08
Leg 11a	Keats, Kimberly	PhD Student	Memorial University	Rivkin, Richard - SOLAS	4-Sep-08	28-Sep-08
Leg 11a, Leg 11b	Lago, Véronique	Research Assistant	INRS -ÉTÉ	Gratton, Yves	4-Sep-08	5-Oct-08
Leg 11a, Leg 11b	Lapoussière, Amandine	Research Assistant	University of Quebec in Rimouski	Gosselin, Michel	4-Sep-08	5-Oct-08
Leg 11a	Latonas, Jeff	MSc Student	University of Manitoba	Stern, Gary	4-Sep-08	28-Sep-08
Leg 11a, Leg 11b	Legere, Christine	EM-300 operator	UNB - Ocean Mapping Group	Hughes-Clark, John	4-Sep-08	5-Oct-08
Leg 11b	Lickley, David	IMAX Producer	IMAX-Science North	ArcticNet	28-Sep-08	5-Oct-08
Leg 11a, Leg 11b	Link, Heike	PhD Student	University of Quebec in Rimouski	Archambault, Philippe	4-Sep-08	5-Oct-08
Leg 11a	Manson, Paul	Media	NBC Today Show (TBC)	ArcticNet	4-Sep-08	28-Sep-08
Leg 11a, Leg 11b	Massot, Pascal	Technician	Laval University	Amundsen	4-Sep-08	5-Oct-08
Leg 11a, Leg 11b	Michaud, Luc	Ship equipment manager	Laval University	Amundsen	4-Sep-08	5-Oct-08
Leg 11a	Michaud, Sonia	Research Assistant	Department of Fisheries and Oceans - IM	Levasseur, Maurice - SOLAS	4-Sep-08	28-Sep-08
Leg 11a	Motard-Côté, Jessie	MSc Student	Laval University	Levasseur, Maurice - SOLAS	4-Sep-08	28-Sep-08
Leg 11a	Murdock, Ian	ROV Pilot	ROPOS	Juniper, Kim	4-Sep-08	28-Sep-08
Leg 11a	Outridge, Peter	Research scientist	NRCan	Outridge, Peter	4-Sep-08	28-Sep-08
Leg 11a, Leg 11b	Piché, Laurence	MSc Student	University of Quebec in Rimouski	Archambault, Philippe	4-Sep-08	16-Oct-08
Leg 11b	Pienitz, Reinhard	Research Scientist	Laval University	Pienitz, Reinhard	28-Sep-08	5-Oct-08
Leg 11a	Rempillo, Ofelia	PhD Student	University of Calgary	Norman, Ann-Lise - SOLAS	4-Sep-08	28-Sep-08

Leg	Name	Position	Affiliation	Network Investigator/supervisor	Embark Date	Disembark Date
Leg 11b	Richerol, Thomas	PhD Student	Laval University	Pienitz, Reinhard	28-Sep-08	16-Oct-08
Leg 11a	Ringuette, Marc	PhD Student	Laval University	Fortier, Louis	4-Sep-08	28-Sep-08
Leg 11a	Rosenberg, Bruno	Research Assistant	Department of Fisheries and Oceans - FW	Stern, Gary	4-Sep-08	28-Sep-08
Leg 11a	Scarratt, Michael	Research scientist	Department of Fisheries and Oceans - IM	Scarratt, Michael - SOLAS	4-Sep-08	28-Sep-08
Leg 11a	Seguin, Allison	PhD Student	University of Calgary	Norman, Ann-Lise - SOLAS	4-Sep-08	28-Sep-08
Leg 11a	Shadwick, Elizabeth	PhD Student	Dalhousie University	Papakyriakou, Tim	4-Sep-08	28-Sep-08
Leg 11b	Sheldon, Tom	Project Manager	Royal Military College	Reimer, Ken	28-Sep-08	5-Oct-08
Leg 11a	Sjostedt, Steve	PDF	University of Toronto	Abbatt, Jonathan - SOLAS	16-Aug-08	28-Sep-08
Leg 11b	Stolze, Lina	PhD Student	Memorial University	Bentley, Sam	28-Sep-08	5-Oct-08
Leg 11b	Teixeira, Filipe	Camera Operator	IMAX-Science North	ArcticNet	28-Sep-08	5-Oct-08
Leg 11a	Thaler, Mary	PhD Student	Laval University	Lovejoy, Connie	4-Sep-08	28-Sep-08
Leg 11a, Leg 11b	Thanassekos, Stephane	PhD Student	Laval University	Fortier, Louis	4-Sep-08	5-Oct-08
Leg 11a	Tyler, Jennifer	Research scientist	University of Victoria	Juniper, Kim	4-Sep-08	28-Sep-08