Joint Ocean Ice Study (JOIS) 2007
Cruise Report

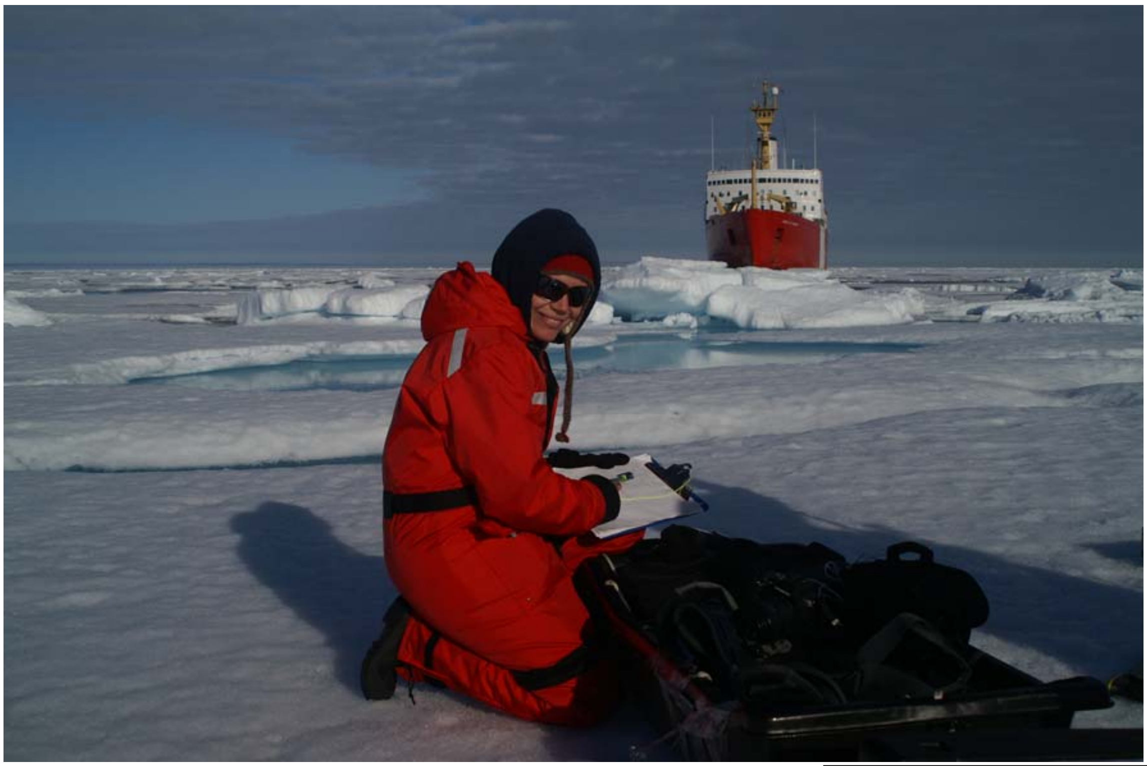

Photo: Celine Gueguen

Report on the Oceanographic Research Conducted aboard the *CCGS Louis S. St-Laurent,* July 26 to August 31, 2007

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1. OVERVIEW

The Joint Ocean Ice Study (JOIS) program is a component of Canada's International Polar Year. It is an observationally-driven climate study waters in the southern Canada Basin and includes the Beaufort Sea. Emphasis is on the study of the effects of climate variability and the changing properties of the Pacific and Atlantic waters within the Arctic. The ongoing study is a combination of the Joint Western Arctic Climate Study (JWACS), a collaboration between Fisheries and Oceans Canada (IOS) and the Japan Agency for Marine-Earth Science and Technology (JAMSTEC) scientists; and the Beaufort Gyre Exploration Project (BGEP), a collaboration between Fisheries and Oceans Canada (IOS) and Woods Hole Oceanographic Institution scientists. In 2007 JOIS also included ancillary programs carried out by researchers from the International Arctic Research Center in Fairbanks Alaska, University of Victoria, Laval University, Trent University and the University of Washington. In addition, a film crew from the Asahi Broadcasting Company of Japan were on board to document the research. Our research questions seek to:

- Understand the impacts of global change on the physical environment and corresponding biological responses by tracking and linking decadal scale perturbations in the Arctic atmosphere (e.g. Arctic Oscillation and Beaufort Gyre) to interannual basin-scale changes in water mass properties and their distribution, ocean circulation and biota distribution.
- Understand the impacts of global change on sea ice and other fresh water products by utilizing a suite of stable isotopes and geochemical markers to quantify freshwater components and investigate water mass pathways.
- Investigate physical processes such as thermohaline intrusions, ventilation, boundary currents and nutrient fluxes.

2. CRUISE SUMMARY

This science program onboard the *CCGS Louis S St-Laurent* took place between 26^{th} July and 31^{st} August in the Canada Basin from the Mackenzie and Beaufort shelves out to 80°N. Full depth CTD casts with water samples were conducted, measuring biological, geochemical and physical properties of the seawater. The deployment of expendable temperature, salinity and current meter probes increased the spatial resolution of measurements. Moorings and ice-buoys were both serviced and deployed in the deep basin for daily time-series. Hourly ice observations were taken and on-ice surveys conducted. Zooplankton net tows, productivity studies, and sampling genetic material of microbes looked at the lower trophic levels. Underway measurements were made of the sea surface. A team from the Japanese Asahi Broadcasting Corporation was on board to make a documentary of the changing Arctic and the science being conducted.

New science and ship equipment were used this year, greatly benefiting the program. Of particular importance were the two container labs fabricated for use on the boatdeck, a fume hood installed in the main lab and the installation of a sea water loop system.

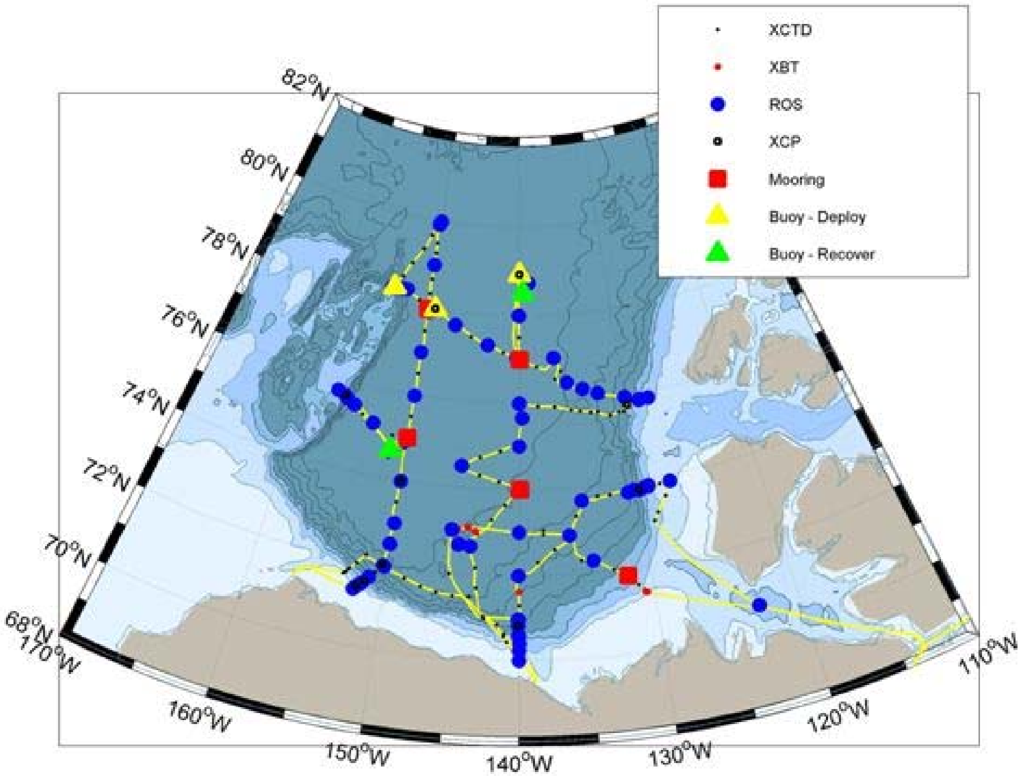

Figure 1. The cruise track for JOIS-2007 with science stations where physical and geochemical measurements were taken.

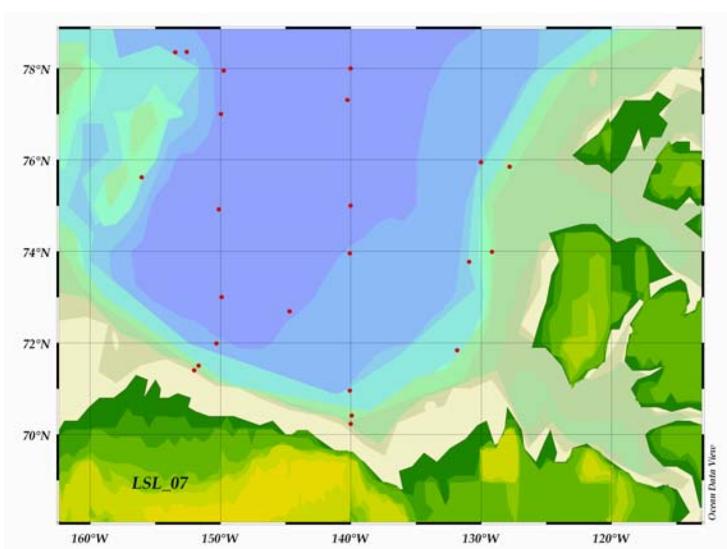

Figure 2. Location of the Vertical Net Tows for zooplankton.

3. PROGRAM COMPONENTS

Distance Covered: 9990km

Measurements:

- 107 CTD/Rosette Casts at 65 Stations
- Upper ocean current measurements from Acoustic Doppler Current Profiler during most CTD casts.
- 2195 Water Samples
  At all stations: Salinity, Oxygen, Nutrients, Barium, O-18, Bacteria, Alkalinity, Colored Dissolved Organic Matter, Chlorophyll-a, C-13
  At selected stations: I-129, Cs-137, Pu, Am, Particulate Organic Carbon, Total Suspended Sediments, Ammonium, Dissolved Inorganic Carbon, RNA, DNA, Urea, Biogenic Silica, HPLC and FISH.
- 5 Mooring Recoveries (4 deep basin, and 1 slope mooring)
- 4 Mooring Deployments (4 deep basin)
- 3 Ice Buoy Deployments
  1 site with a single Ice Tethered Profiler (ITP)
  1 multi-buoy site with an ITP, an Ice Mass Balance Buoy, and an Ice Heat-Flux Buoy
  1 multi-buoy site with an ITP, an Ice Mass Balance Buoy, an Ice Heat-Flux Buoy, and a nearby ring of 3 GPS Buoys
- 2 Ice Buoy Recoveries
- 6 Casts at 4 stations for in-situ pumping, with up to four pumps attached to the wire per cast.
- Ice Observations
  Hourly visual observations from bridge
  Opportunistic aerial observations during helicopter flights
  5 on-ice surveys
- Underway data collection of ship's meteorological, depth, sea surface, and navigation sensors.
- 99 XCTD (expendable temperature, salinity and depth profiler) Casts typically to 1100m depth
- 10 XCP (expendable current profiler) Casts, maximum depth 1000 m
- 27 XBT (expendable temperature and depth profiler) Casts, maximum depth 2000m.
- 58 Shallow CTD SBE19+ casts hand lowered from FRC, ice and ship
- 48 Vertical Net Casts, typically to 100m depth, at 24 selected Rosette stations
- 104 Drift Bottles Deployed
- Documentary filming by Japan's Asahi Broadcasting Corporation

Other:

- Passenger transfer at Barrow for medical reasons

- Fuel (1000m³ litres) loading by barge near Herschel Island
- Transfer of science samples and equipment to the *CCGS Sir Wilfrid Laurier* at Kugluktuk

4. PROGRAM COMPONENT DESCRIPTIONS

4.1 Rosette/CTD Casts: Fiona McLaughlin (IOS) PI, Sarah Zimmermann and Jane Eert

Figure 3. Rosette deployment.

The primary CTD system used on board was a Seabird SBE9+ CTD configured with a 24- position SBE-32 pylon and ice-strengthened rosette frame with 10L Niskin bottles fitted with internal stainless steel springs. The data were collected real-time using the SBE 11+ deckunit and computer running Seasave Win32 V 5.37d acquisition software. The CTD was set up with two temperature sensors, two conductivity sensors, two oxygen sensors, fluorometer, transmissometer, altimeter, a bottom contact switch and surface reference PAR. Early on during the cruise the secondary oxygen failed and was replaced by a secondary transmissometer. Casts shallower than 1000m typically also had nitrate (ISUS) and PAR sensors.

Figure 4. Rosette sampling

On all rosette casts we sampled Salinity, Dissolved Oxygen, Nitrate (NO3), Silicate (SiO4), Phosphate (PO4), Chlorophyll-a (filtered at 0.7 µm with chlorophyll-a and phaeopigment values for each), Coloured Dissolved Organic Matter (CDOM), Alkalinity, Oxygen-18 isotope (O18), Barium, Bacteria and Carbon-13 isotope (C-13). On selected casts we sampled Cesium-137, Iodine-129, Plutonium, Americium, Ammonium, Particulate Organic Carbon (POC), Total Suspended Solids (TSS), Dissolved Inorganic Carbon (DIC), RNA, DNA, Urea, and Biogenic Silica.

For a typical cast, the CTD was powered on while still on the deck. The transmissometer(s) windows and nitrate sensor window were wiped with deionized water soaked kimwipe or q-tip prior to each deployment. The PAR sensor was wiped periodically. The rosette package was lowered to 10m, the sensor pumps turned on and the package soaked for 3 minutes to equilibrate the oxygen sensor. The package was then raised to the surface and lowered at 30m/minute to 300m then at 60m/minute to within 15m of the ocean floor. After closing the first bottle at the bottom of the cast, the package was raised at 60m/minute then slowed to 30m/minute for the upper 400m. Bottles were closed on the upcast without changing the ascent speed with the thought that this will capture water with a uniform vertical offset (approximately 1 m) instead of stopping the package for bottle closures which can result in variable 0 to 5m offsets, depending on the flow dynamics around the bottles. The bottle flushing around a stopped package is dependant on the ship rock and relative drift, which are both less favourable for bottle flushing when a ship is in ice.

Figure 5. Motoyo Itoh operating the CTD computer in the new container lab.

In the upper 400m, the sample depths were chosen to match a set of salinity values. During the downcast, the depths of the salinity values were noted so that on the upcast the bottle could be closed at the pre-determined depths.

The instrumented sheave (Brook Ocean Technology) readouts to the winch operator, CTD operator and bridge allowed all three to monitor cable out, wire angle and CTD depth.

The PAR sensor cable connection leaked at the sensor end. It was removed, the bulkhead connector replaced and reinstalled. The CTD's six-pin bulkhead connectors were replaced prior to the cruise with wet-pluggable connectors with great results. For the first time, this CTD was used on an Arctic cruise with no leaking connections to the CTD body. Unlike last year, we had less trouble with Niskin bottles not closing. The reason may be to that there was less grease falling off the wire onto the CTD frame and that the pylons had been serviced prior to the cruise.

The 107 CTD/Rosette cast location are listed in the appendix.

Sampling took place immediately after each cast in the heated rosette room. The order of sampling was fixed, based on sampling water most susceptible to temporal changes first. Dissolved Oxygen, Nutrients, Salinity, Chlorophyll-a and Ammonium were analysed on board. All other samples were prepared and stored for analysis on shore.

Figure 6. Oxygen analysis in the new temperature controlled container lab by Mary Steel

Figure 7. Nutrient analysis in the main lab by Linda White.

In conjunction with the CTD/Rosette Casts, an acoustic doppler current profiler (ADCP) measuring currents of the upper 60m and two backscatter transducers looking for layers of zooplankton were lowered over the side. The package was lowered by crane from the boatdeck to approximately 5m beneath the surface and left in place until the completion of the CTD cast.

4.2 Anthropogenic Radionuclide sampling: John Smith (BIO) PI, Rick Nelson (BIO)

Recent investigations have revealed that the Arctic Ocean is undergoing major changes in contaminant concentrations and rates of water circulation on time scales of the order of years (Carmack *et al*., 1995; 1997; Morison *et al*., 1998; Steele and Boyd, 1998). Results from icebreaker cruises in 1993–1995 in the Western Arctic Ocean indicate that a major thermohaline disturbance was underway, characterized by an increase in the transport and/or temperature of Atlantic water flowing into the Eurasian Basin and a corresponding increase in flow past the Lomonosov Ridge into the Canada Basin (McLaughlin *et al*., 1996; Carmack *et al*., 1997; Swift *et al*., 1997). This direct intrusion of water from the North Atlantic along the continental margin of the Eurasian Basin into the Canada Basin is also carrying elevated inventories of the radioactive tracers, ^{129}I and ^{137}Cs, which during the past 30 years have been released in large quantities from the nuclear fuel reprocessing plants at Sellafield, UK and La Hague, France, which discharge into the Irish Sea and English Channel, respectively. Changes in the reprocessing plant release rates of ^{129}I and ^{137}Cs are propagated through the Norwegian and Atlantic Coastal Currents into the marginal seas and interior of the Arctic Ocean on time scales of 4–5 years (Livingston, 1988; Smith *et al*., 1990; Kershaw and Baxter, 1995) and measurements of these signals can be used to constrain water circulation time-scales throughout the Arctic Ocean (Smith *et al*., 1998). There are two basic tracer applications of these radionuclides in the Arctic Ocean: (1) measurements of ^{129}I and ^{137}Cs, separately provide evidence for Atlantic-origin water labeled by discharges from European reprocessing plants; and (2) measurements of ^{129}I and ^{137}Cs, together can be used to identify a given year of transport through the Norwegian Coastal Current (NCC) thereby permitting the determination of a transit time from the NCC to the sampling location (Smith *et al*., 1998).

Methods:

Samples were collected from 13 stations for ^{129}I (1 liter), 8 stations ^{137}Cs (40 liters) and 2 stations Pu/AM (80 liters). For ^{129}I, one liter samples were collected from selected depths (see attached spreadsheet) stored and returned to the laboratory analysis by Accelerator Mass spectrometry. Thirteen stations were sampled and 179 samples were collected. For ^{137}Cs, forty liter samples were collected at selected depths and ^{137} Cs was concentrated on 5 gram columns of KCFC coated silica gel. The KCFC was dried and returned to the laboratory for analysis. ^{137} Cs is determined using Gamma Spectrometry with HPGE detectors. Eight stations were sampled and 48 samples were collected. For Pu/Am, eighty liter samples were collected at selected depths for Pu/Am analysis. Pu/Am was precipitated from 80 liters with $FeCl_3$ at pH 8-10. The ppt was transferred to 1 liter nalgene bottles and transported to the laboratory for analysis. The Pu and Am are separated by ion exchange, platted on nickel disks and activities are determined using alpha spectrometry. Two stations were sampled and 14 samples were collected.

4.3 Dissolved organic carbon and colored dissolved organic matter in the Arctic Ocean: Céline Guéguen (Trent University) PI

Background

Dissolved organic carbon is (DOC) is an important component in global carbon budgets and marine carbon cycling. A portion of the total DOC pool, which absorbs lights in the UV and visible ranges, is referred to chromophoric (or colored) dissolved organic matter (CDOM). Recent studies have shown that CDOM may play an important role in radiative transfer of light in the ocean and remote sensing of primary production. Major sources of CDOM in the ocean are mostly from terrestrially derived humic substances from river runoff, especially in coastal regions, diagenetic processes in shelf sediment and phytoplankton production. In addition to tracing DOC concentrations in the water column, CDOM can be used as a potential tracer in water mass mixing, especially in the Arctic Ocean where there is a large share of global river discharge and terrigenous DOC. However, characteristics of CDOM and its distribution in the Arctic Ocean are poorly understood.

Objectives

1) To characterize the nature and origin of organic matter in the cold halocline
2) To assess the spatial distribution of DOC and CDOM in the Canadian Basin
3) To evaluate the potential of CDOM as water mass tracer (e.g. Pacific Summer Water vs. Atlantic Water) and to better understand the dynamic cycling of organic carbon in the Arctic Ocean
4) To investigate the nature and composition of DOM in multi-year ice in relation with seawater.

Method

680 seawater samples were collected at 12 depths (1000, 800, 500, Tpmax, 34.4, 34.0, 33.1, 32.9, 32.3, Chla, 20, 5) and 61 stations. Briefly, seawater was filtered on a precombusted glass fiber filter (GF/F, Whatman). Aliquots of filtrate were then sampled for DOC and CDOM analysis. DOC samples were immediately frozen whereas CDOM were stored in the dark at 4ºC. DOC concentrations will be measured on a TOC analyzer whereas the optical properties of CDOM will be investigated by absorbance and fluorescence spectroscopy. Three-dimensional fluorescence (3D-EEM) will be performed on selected samples to identify the main fluorophore moieties in relation with water mass origin.
Four ice cores and 12 melt pond waters were collected at 4 ice stations in collaboration with Jenny Hutchings (IARC, UAF). Ice temperature was measured directly on the field every 10 cm. Salinity, nutrients and chlorophyll of melted cores were measured onboard whereas DOC and CDOM will be measured at Trent University.

4.4 Studies continuing from prior leg: Canada's Three Oceans Program

Please see the Canada's Three Oceans Cruise Report for descriptions of the following three programs:

DNA and RNA sampling - Connie Lovejoy's lab (Connie Lovejoy, Karen Scarcella and Emilie Didierjean).

Phytoplankton Productivity and Nutrient Dynamics in Surface Waters of the Western Canadian Arctic-Diana Varela and Ian Wrohan (University of Victoria)

HPLC Pigments and Bacteria- Bill Li Bedford Institute of Oceanography.

4.5 Vertical Net Tows: John Nelson (IOS) and Russ Hopcroft (UA) PIs

Zooplankton sampling was performed using a modified Bongo net system. Two large bongo hoops were fitted with coarse mesh nets of 150µm and 236µm. A second set of smaller hoops were fitted perpendicular to the large hoops. These smaller hoops were fitted with finer 53µm mesh nets. The four nets were fitted with unidirectional flowmeters which measure the amount of water flowing through the hoops. Between cast the nets were stored on the foredeck in a box, built by the ship specifically to accommodate the bongo net.

Figure 8. Zooplankton nets

Figure 9. Helen Drost preserves zooplankton samples

Two casts, typically to 100m were performed per station to collect enough samples for identification, DNA analysis and biomass measurements. Samples from the first cast were preserved in formalin with samples from the nets with 53µm-sized mesh combined to form one sample. From the second cast, the samples from the nets with 236µm mesh and combined nets of 53µm mesh were preserved in 95% ethanol. The sample from the net with 150µm mesh was washed with 4% ammonium formate and dried at 50^{o}C for 24 hours for biomass measurements. 48 casts were performed at 24 stations. Locations are listed in the appendix.

4.6 XCTD, XBT and XCP Casts: Koji Shimada, Motoyo Itoh (JAMSTEC), F. McLaughlin, E. Carmack (IOS) PIs

XCTD

XCTD (expendable conductivity, temperature and depth profiler, Tsurumi-Seiki Co., Ltd.) probes were deployed into the ocean off the stern of the ship using a hand launcher LM-3A (Tsurumi-Seiki Co., Ltd.). The probes made vertical profiles of temperature and salinity to the bottom or a depth of 1100 m, whichever was shallower. The data were communicated back to a shipboard computer via a digital data converter MK-130 (Tsurumi-Seiki Co., Ltd.) connected to the probe by a fine copper wire which breaks when the probe reaches its maximum depth.

According to the manufacturer's nominal specifications, the range and accuracy of parameters measured by the XCTD are as follows;

Parameter	Range	Accuracy
Conductivity	0 ~ 60 [mS/cm]	+/- 0.03 [mS/cm]
Temperature	-2 ~ 35 [deg-C]	+/- 0.02 [deg-C]
Depth	0 ~ 1000 [m]	5 [m] or 2 [%] (either of them is major)

In this cruise, 99 XCTDs were successfully launched. Only 2 XCTD failed. In open water the probe was launched while the ship steamed at 12 knts. In heavy ice, the ship stopped before deployment due to the fragility of the conducting wire.

XBT

XBT (expendable bathy thermograph, Sippican Ltd.) T-5 probes were deployed into the ocean off the stern of the ship using the same method, equipment and software as the XCTDs. The probes made vertical profiles of temperature to the bottom or a depth of 2000 m, whichever was shallower. In open water the probe was launched while the ship steamed at 6 knts. In heavy ice, the ship stopped before deployment due to the fragility of the conducting wire.

In this cruise, 27 XBT probes were successfully launched. The failure rate was high, with approximately 50% failed probes, although this was not unexpected as the probes are approximately 20 years old and well past their expiration date.

XCP

10 Expendable Current Profilers, manufactured by Lockheed Martin were deployed for Jamie Morison, University of Washington, from the stern of the ship, the ice and from the FRC. The probe was launched along with a transmitter that is activated after contact with water. After a 40 second wait the probe was released and transmitted data to a handheld receiver via a radio link. The probe measured to a maximum depth of 1500m. Due to the disturbance in magnetic field caused by the ship, the probe was launched while the ship had a slight amount of way on so there would be some distance between the probe's compass and the ship. Another issue was that due to the minimal waves or the cold temperature, the probe would stick in its case and not deploy. The

ideal launching conditions were from the ice or the FRC where the probe could be shaken lose if necessary.

The deployment locations for the XCTD, XBT and XCP are listed in the appendix.

4.7 Beaufort Gyre Observing System (BGOS), Moorings, Buoys and Pump Casts: Andrey Proshutinsky (WHOI) PI BGOS, Tim Eglinton (WHOI) PI Particle flux, Rick Krishfield, Kris Newhall, Jim Dunn, Steve Manganini, and Luc Rainville

As part of the Beaufort Gyre Observing System (BGOS; http://www.whoi.edu/beaufortgyre), four bottom-tethered moorings (which were deployed in August 2006) were recovered, data was retrieved from the instruments, refurbished, and were redeployed at the same locations in August 2007 from the *CCGS Louis S. St. Laurent* during the JOIS 2007 Expedition. In addition, three Ice-Tethered Profiler (ITP; http://www.whoi.edu/itp) buoys were deployed, two in combination with Ice Mass Balance (IMB) and Arctic Ocean Flux Buoys (AOFB). Two previously deployed ITPs were also recovered.

Table 1. Summary of BGOS 2007 field operations.

Mooring Designation	Depth (m)	2006 Location	2007 Recovery	2007 Deployment	2007 Location
BGOS-A	3825	74° 59.975'N 149° 59.978'W	6-Aug 14:05 UTC	9-Aug 4:12 UTC	74° 59.945'N 149° 59.936'W
BGOS-B	3821	77° 59.6811'N 149° 58.105'W	10-Aug 15:20 UTC	13-Aug 18:52 UTC	77° 59.662'N 149° 58.167'W
BGOS-C	3722	76° 59.802'N 139° 55.026'W	15-Aug 16:11 UTC	18-Aug 17:54 UTC	76° 59.757'N 139° 54.321'W
BGOS-D	3518	74° 0.063'N 139° 59.480'W	22-Aug 18:45 UTC	23-Aug 19:14 UTC	74° 0.037'N 139° 54.989'W
ITP1			8-Aug 19:00 UTC		74° 40'N 151° 21'W
ITP8				11-Aug 22:00 UTC	78° 21' N 154° 1' W
ITP13/IMB/AOFB				13-Aug 23:15 UTC	78° 1'N 149° 12'W
ITP18/IMB/AOFB				16-Aug 20:45 UTC	78° 56'N 139° 58'W
ITP4			17-Aug		78° 30'N

21:00 UTC	139° 34'W

The mooring deployment and recovery operations were conducted from the foredeck using a dual capstan winch as described in WHOI Technical Report 2005-05 (Kemp et al., 2005). Before each recovery, an hour long precision acoustic survey was performed using a release deck unit connected to the ship's transducer in order to fix the mooring location to within ~20 m. When possible, the mooring top transponder (located beneath the sphere at about 45 m) was interrogated to locate the top of the mooring instead of the deep releases. However, effective communications with the top transponder were only available for two of the four moorings (B and D). Regardless, in every instance, the sphere surfaced in the open working pond created by the icebreaking and maneuvering skills of the Captain and officers.

All of the mooring recovery and deployment operations were conducted without incident. The actual recovery operations varied from between 2.25 and 3.5 hours. In every case, sometime after recovery of the MMP, the mooring wire was cut due to excessive tension, and the remainder of the mooring was recovered by retrieving the backup flotation and hauling in the rest of the instrumentation from the bottom. The deployment operations normally entailed an hour of deck preparation once on site, followed by a 3 to 4.75 hour anchor first deployment. Extra instrumentation on mooring A (3 sediment traps) and mooring D (devices clamped to a deep segment of the wire) added time to the operations.

Complete year long data sets with good data were recovered from nearly all instruments (3 out of 4 MMPs, and 4 out of 4 ULSs and BPRs). However, the MMP on Mooring A appears to have profiled for half of the year, and then the flash card memory became corrupted. The card will be hand carried back, and sent out to recover as much of the half year data set as possible. In addition, the ADCP on Mooring D exhausted its battery after 10 months.

Buoy operations consisted of the deployment of one ITP on a 3.5 m thick icefloe (ITP8), and two other ITPs (ITP13 and ITP18) deployed with IMBs and AOFBs to constitute Ice-Based Observatories (IBOs). The deployment operations were conducted according to procedures described in a WHOI Technical Report in press (Newhall et al., 2007). The IBOs were installed on 3.0 m icefloes. The deployment operations took about 6-7 hours each including the time to reconnaissance and drill holes in selected ice floes to determine the appropriate sites. Ice analyses and handheld CTD and XCP casts were also performed by others in the science party, while the ITP deployment operations took place. As of this writing, all of the buoys are functioning completely and sending good data back to their respective bases.

Furthermore, two previously deployed ITPs were recovered. ITP1 was deployed in 2005, and ITP4 was deployed in 2006 also as part of BGOS operations on the *CCGS Louis S. St. Laurent.* Based on information obtained during an unsuccessful ITP recovery operation last year (ITP3), a special motorized block apparatus was brought to haul the mooring after cutting the ice around the buoy with a hot water drill apparatus and removing the ice with chainsaws. Each recovery operation took about 5 hours. ITP1 had successfully transmitted 2042 profiles and completed its mission and was recovered for engineering redevelopment purposes, while ITP4 had trouble with the inductive modem circuit so information from the profiling unit was not being relayed to shore. Upon recovery 698 good profiles spanning the full year were retrieved from ITP4.

In addition to the mooring and buoy deployments and recoveries, 6 large volume pumping (LVP) stations were performed from the foredeck hydro wire to obtain suspended particles at multiple depths. The data will be used in conjunction with the sediment traps deployed on the moorings this year to understand particle fluxes through the water column. A summary of the LVP stations is included in the worksheet "BGFE LVP information Aug 2007.xls", and the sediment trap schedules are listed below.

Table 2. BGOS 2007 Sediment Trap Information

Mooring Location	Sediment Trap trap depth (m), *(approximate)*		Sediment Trap S/N	Start Date Local Time* Mm/dd/yy hh:mm	Close Date Local Time* mm/dd/yy hh:mm
BGFE-A	2050	upper trap	ML 12024-02	8/10/07 1:00	8/1/08 1:00
BGFE-A	3100	middle trap	ML 11649-06	8/10/07 1:00	8/1/08 1:00
BGFE-A	3745	deep trap	ML 11649-02	8/10/07 1:00	8/1/08 1:00
BGFE-B	3000	deep trap	ML 12024-01	8/15/07 1:00	8/7/08 1:00
BGFE-C	3000	deep trap	ML 11649-04	8/21/07 1:00	8/10/08 1:00
BGFE-D	3000	deep trap	ML 11649-03	8/28/07 1:00	8/12/08 1:00

* GMT = Local Time+ 6hrs

Also, four 700 m casts were conducted using the foredeck hydro wire with a Nortek Aquadopp and a RD Instrument DVS Acoustic Doppler Current Profilers (ADCPs) mounted horizontally to test their performance in the clear Arctic waters. The units are being evaluated to determine whether they could be integrated on future ITPs to obtain current measurements.

Information on the additional instruments deployed on Mooring D, description of aerosol optical measurements, and hand held CTD casts are described in "Cruise Report Rainville.doc." Dispatches of all aspects of the cruise work were also posted daily by Luc on the BGOS website at:
http://www.whoi.edu/beaufortgyre/dispatch2007/index2007.html, and on the ship's

public drive. Additional photos are also on the ship's public drive under the BGOS directory.

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Figure 10. Mooring Operation

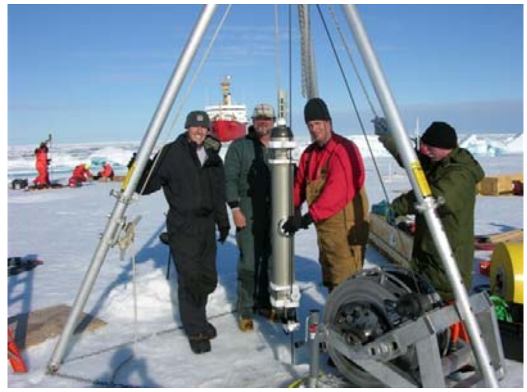


Figure 11. ITP Deployment

(photo Luc Rainville)

4.8 CABOS Mooring Recovery: I. Polyakov (IARC) PI, Mike Demspey

The Canadian Basin Observation System (CABOS) mooring has been deployed by on Institute of Ocean Sciences (IOS) Arctic cruises on behalf of the University of Alaska Fairbanks International Arctic Research Center (IARC) since 2003. The location of the mooring has varied due to ice conditions but has been continuously placed to monitor the flow of Atlantic water around the south east slope of the Canada Basin. The mooring is part of a string of moorings deployed by IARC to observe the movement of Atlantic water through the Arctic and measure the heat flux to upper waters. The Nansen/Amundsen Basin Observation System (NABOS) consists of a series of McLane Moored Profiler and conventional moorings located around the self break of the Laptev Sea. The CABOS mooring provides complementary data in the Canada Basin for this array. In 2007 it was decided to recover but not re-deploy the CABOS mooring in order to concentrate equipment resources in the Laptev Sea.

Table 1. 2007 Operations, CABOS mooring

Investigator	Recovery Depth (m)	Recovery Location	Recovery Time (UTC)	Deployment Depth (m)	Deployment Location	Deployment Time (UTC)
UAF/IARC I. Polyakov	1111	71 49.688'N 131 45.624' W	29-Aug 07 0205 (UTC)	Not re-deployed	Not re-deployed	Not re-deployed

The two acoustic releases were checked to see which one actually released. Contrary to what was originally suspected, the mooring was released by the first unit. Release 28388 was however hung up on a small burr on the release toggle and with a little effort on deck it dropped the link.

After the deck and equipment was cleaned up, the MMP 11474 was connected to a PC and the data checked. 350 record sets of similar size indicated that the profiler had worked for the whole period. The MMP clock was compared to GPS time and was found to be 26 minutes 42 seconds fast. (MMP clocks typically are 20 -30 minutes fast aver a year long deployment). Once opened and the PCMCIA memory card copied, it was verified that the profiler appeared to work well even during the recovery (last record 1846 local time).

Later analysis by Rick Krishfield of WHOI checked the whole data record using WHOI's MatLab tools. The MMP appeared to be nearly perfectly ballasted and apart from a couple of profiles where the profiler was momentarily stuck, all the records appear good.

TheSBE37 Microcat s/n 2368 was also connected to a PC and the memory checked. The Microcat clock was 3 minutes 7 seconds fast compared to GPS time. 33538 records had been recorded.

The recovery, the CABOS 2006 mooring was accomplished quickly with the help of many others. The assistance of a trained and motivated LSSL deck crew and bosun Bob Taylor was much appreciated. Also the station keeping of the ship during recovery and deployment was excellent. Many thanks to Rick Krishfield Kris Newhall and Jim Dunne of WHOI for their help on deck and for the use of their Lebus dual capstan traction winch. Also many thanks to Rick Krishfield for downloading the instruments and conducting the preliminary data analysis.

4.9 Ice Observations: Jennifer Hutchings (IARC) PI, Alice Orlich

Ice observations recording during the Louis S. St. Laurent 2007-20 cruise will provide detailed information for the interpretation of satellite imagery of the ice pack. Our objective was to identify the major sea ice zones in the Beaufort Sea and determine the types and state of ice in these zones. This information will be used to support a joint drifting-buoy, RADARSAT SAR, field and modelling campaign to investigate sea ice dynamics in the Beaufort Sea during winter 2006 to spring 2008. The project, "Sea ice tide-inertial interaction: Observations and Modelling" is funded by the National Science Foundation, with PIs Jenny Hutchings and Bill Hibler. The observations from this cruise will also support a field project "Detailed investigation of the dynamic component of the sea ice mass balance" performed spring 2007, with PIs Jenny Hutchings, Jackie Richter-Menge and Cathy Geiger. We anticipate that the observations will be useful for investigating the evolution of the ice cover over the last two years when used in conjunction with satellite and buoy data.

Observations from Bridge

Every hour, while the ship was steaming and light conditions allowed, an observation of ice conditions was recorded. Each observation was made from the bridge, and photos were taken from the monkey island to document ice regions. These are available on request from Jennifer Hutchings.

A combination of ASPECT (Worby & Alison 1999), Standard Russian and Canadian Ice Service codes were used to describe ice conditions. During each observation period we estimated the total ice coverage within 3km of the ship (when visibility allowed), the types of ice present and the state of open water. For each ice type we estimate the coverage of that type, thickness, flow type, topography, sediment coverage, algae presence, snow type, snow thickness and stage of melt. There was space for detailed observations of three ice types (primary, secondary and tertiary) in the log sheets. We also recorded the codes for any other types of ice present that was at lower concentration than the three main types. We recorded basic meteorological phenomena of cloud coverage and type, visibility and precipitation.

Webcam Imagery

Two cameras were installed on the monkey island. Back on land, we will investigate whether the images from the cameras are useful for mapping ice types and concentration by an ice expert who does not attend the cruise. My inclination is that a lot of information is lost by the cameras, as they can not provide 360^o vision, and can not be focused on a variety of ice features as the human eye can.

Camera 1 pointed forward on the port side of the ship, and took an image every 10 minutes. This provided a wide field view of the ice pack the ship was heading into. The second camera was trained on the “ice thickness pole” to observed overturning ice. In order to get a representative sample of overturned ice, this camera took pictures every 10 seconds. Both cameras were linked into the ship’s local area network (LAN), and images can be stored on any computer on this LAN that is running an FTP server. The NOAA server will be used in future for image storage. On this cruise Jenny Hutchings downloaded the images directly to my laptop. Anyone who is interested in these may contact Jenny.

We had a couple of small issues in setting up the camera system. First, the image size needs to be not too large, as the ships LAN can not support large file transfer. We found that images over 100 kbytes would become pixilated in file transfer. Second the netcam cameras do not have a small enough aperture for bright summer time pack ice photos. Hence most images from camera 1 are slightly blurry as they were over exposed. The fix to this problem would be a filter on the webcam lens.

Aerial Ice Observations

At various times during the cruise we had the opportunity to observe the ice cover from helicopter. In flying conditions when visibility was good, and the helicopter could travel at an altitude of 2000 feet, these flights were very helpful in extrapolating ship based observations to the wider field. During flights, notes were taken of ice coverage, distribution of types and state of melt. Photographs were taken as a record of ice conditions.

During future cruises it would be advantageous to have a camera mounted on the helicopter, pointing downwards with a coincident record of geodetic location and altitude. This could provide a record of ice conditions that could be used to estimate scale of features on the ice and would not take up a seat on the helicopter. The camera which has been used on the Louis helicopter was designed to mount in the cargo hold, and can only be used when there is no load in the hold. This is not an optimal situation for the work we do. It would be better to design a camera that is affixed to the exterior of the helicopter. However, this will require extensive flight testing.

Ice Stations

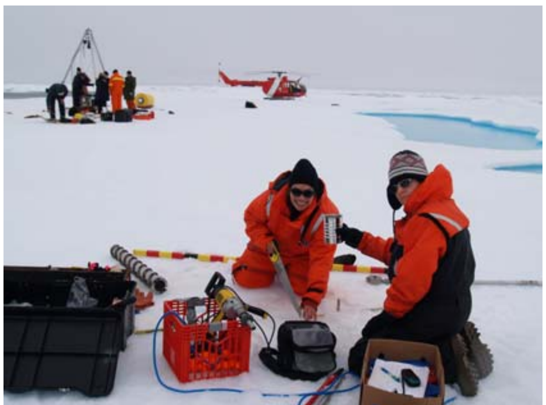


Figure 12. Ice sampling by Celine Gueguen and Alice Orlich (photo J Hutchngs)

Transects of ice thickness, snow depth and melt pond depth can provide additional information about ice conditions that is not possible to gauge with shipboard methods. Ice cores were taken to provide temperature and salinity profiles through the ice. We had two objectives for ice station work: (1) to determine the mean level ice thickness and variability at point locations during the cruise, and (2) to investigate surface melt conditions and to provide information about the progress of this summers melt. An important component of our ice station work was to compliment the deployment of a cluster of three ice drifting buoys that will monitor ice deformation (the IARC GPS drifters) around an Ice Mass Balance Buoy (in collaboration with Cold Regions Research and Engineering Laboratory and Woods Hole Institute) that will monitor the thermodynamic evolution of the multi-year ice in the center of the buoys array.

Table 1: Measurements and samples at each ice stations.

Ice Station	**Date**	**Lat (N)**	**Lon (W)**	**# Cores**	**# thickness**	**Thickness transects**	**Melt Pond Depths**	**Other Samples**
1	9-Aug	74 40	151 21	1	8	1	no	none
2	11-Aug	78 21	154 02	2	7	1	no	melt pond temp
3	13-Aug	78 11	150 05	2	20	1	yes	Celine: Melt pond
4	16-Aug	78 56	139 58	2	11	2	yes	Celine: Melt pond
5	17-Aug	78 30	139 29	1	30	4	yes	Biota

Sampling Dirty Ice

During the two legs between (76 09N, 133 03W), (75 49N, 127 08W) and (75 42N, 133 18W) dirty ice was recorded during each observation period. Arial estimates of the amount of ice affected were 1/10 during the helicopter flight on August 20th. We collected samples from two dirty ice floes on August 20th at 75 46N, 129 51W using the ship's zodiac.

GPS Buoy Deployment

The deployment of a GPS buoy ice deformation array was successfully completed. This buoy array will monitor pack ice strain rate of a 10mile square region which includes autonomous buoy site with Ice Mass Balance Buoy. The three IARC GPS drifters provide GPS position with 10 minute frequency.

On August 13th, 3 ice drifting GPS buoys were deployed in a 10 mile side square with an Ice Tethered Profiler, Ice Mass Balance Buoy and Heat Flux Buoy joint site comprising one corner of the square. The region of deployment, around 78N 150W, was covered with greater than 90% multi-year and young multi-year ice. All ice in the region was in an advanced stage of melt. In fact, there were relatively few multi-year floes without thaw holes to choose for deployment sites.

All buoys were placed on the most substantial multiyear floes we could find within one mile of the planned deployment location. It took 1 1/2 hours to deploy the array, roughly ½ hour per buoy. We spent 15-25 minutes on the ice at each buoy site, drilling two holes to measure ice thickness and anchor the buoy.

Table 1: Deployment locations of buoys in deformation array, with depth and freeboard of holes drilled to anchor each buoy.

Buoy ARGOS ID	Relative location	latitude	longitude	depth (cm)	freeboard (cm)
53538	**North West**	78 10.363	149 59.603	356	40
				>400	
IMB/ITP	**South East**	77 59.99	149 08.761	235	42
				239	44
53537	**North East**	78 10.527	149 10.428	287	31
				270	28
53526	**South West**	77 58.380	150 00.883	271	47
				268	46

4.9 Underway Measurements: Svein Vagle (IOS) PI

Seawater Loop

A seawater loop system, drawing seawater from below the ship's hull to the main lab ("aft lab") was installed for the 2007 field season. This system allows measurements to be made of the sea surface water without having to stop the ship for sampling. The water is as uncontaminated as possible coming directly from outside of the hull through stainless steel piping without recirculation in a sea-chest. The flow rate is controlled for systematic measurements, and allows for continuous autonomous sampling. Measurements were taken by installing sensors in-line, and by diverting water through a manifold to run through various sensors.

Autonomous measurements were made using:

- SBE38: Temperature.
  Sensor was installed in-line, approximately 4m from pump at intake. This is the closest measurement to actual sea-temperature.
- SBE21 Seacat Thermosalinograph: Temperature and Conductivity.
  5 second sample rate, run off the manifold in the main lab (Eddy Carmack, DFO)
- Blue Cooler: Total gas (Gas Tension Device), Oxygen.
  15 (?) second sample rate, run off the manifold in the main lab
  (Svein Vagle, DFO)
- Black Box: Methane, Oxygen, pCO2.
  Hourly sample, run off the manifold in the main lab
  (Patricia Ramlal, DFO)

Part of the system, but not attached to the seawater loop:

- SBE48: Temperature was also measured through the hull using a temperature sensor mounted on the ship's hull, inside, aft of the pump approximately 15m, starboard side.

Discreet Water Samples drawn for analyses on other instruments

- Salinity, Barium, O-18, Alkalinity

Other

- Water was taken from the manifold to the hangertop by approximately 50m of garden hose to support an incubation study requiring sea surface water temperature.

Figure 13. Seawater loop system providing uncontaminated seawater from 9m depth to the science lab for underway measurements.

Figure 14. Pump for seawater loop at intake in engine room.

The seawater loop was operational beginning July 16th after the installation of pump, plumbing, manifold, variable flow control that uses feedback between the main lab and the pump, 3 flow control valves, and finally the science instruments. Some of the instruments were self-contained; others were connected to a single data storage computer. The data storage computer provided a means to pass ship's GPS for integration into sensor files, to pass the SBE38 data from the engine room to the TSG instrument, and to pass the TSG and SBE48 data to the ship's data collection system (SCS).

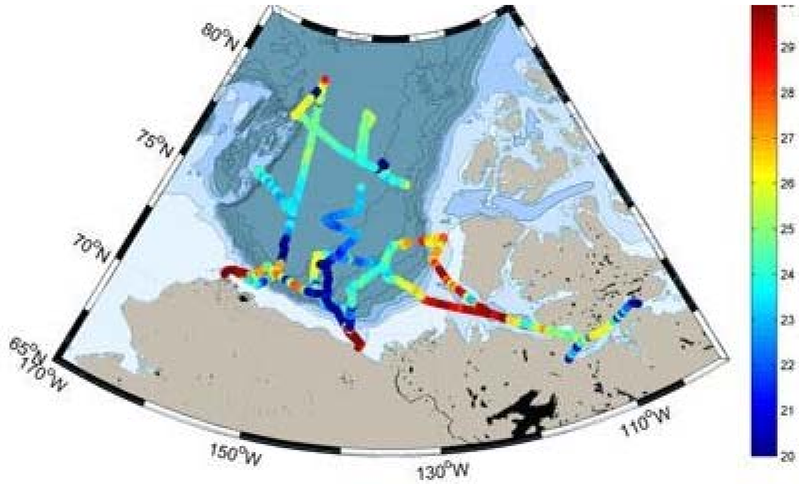


Figure 15. Underway sea surface salinity.

SCS Data Collection System

The ship uses the Shipboard Computer System (SCS) written by the National Oceanographic and Atmospheric Administration (NOAA), to collect and archive underway measurements. This system takes data arriving via the ship's network (LAN) in variable formats and time intervals and stores it in a uniform ASCII format that includes a time stamp. Data saved in this format can be easily accessed by other programs or displayed using the SCS software.

The SCS system on a shipboard computer called the "NOAA server" collects:

- Location from the ship's GPS (GPGGA and GPRMC sentences)
- Heading from the ship's gyro (HEHDT sentences)
- Depth sounding from the ship's Knudsen sounder (SDDBT sentences)
- Air temperature, apparent wind speed, apparent and relative wind direction, barometric pressure, relative humidity, and apparent wind gusts from the ship's AVOS weather data system (AVRTE sentences). SCS derives true wind speed.
- Sea surface temperature and salinity from the ship's SBE 21 and SBE38 thermosalinograph
- Sea surface temperature from the SBE48 hull mounted temperature sensor
- SCS derives speed over ground and course over ground

The RAW files were set to contain a day's worth of data, restarting around midnight. The ACO and LAB files grew until they wee moved out of the datalog/compress directory for archiving.

We were still experiencing some problems this year with the system losing data strings due to communication errors, sensor reconfigurations or sensors having stopped. The SCS system required regular checks to confirm data was being collected, requiring stopping and restarting the software to solve the majority of communication problems.

4.10 Drift-Bottle Deployments: Eddy Carmack (IOS) PI

Figure 16. Drifter deployment by Steve Romaine (photo Paul Galipeau)

Numbered bottles with messages inside were tossed over the side, typically with each CTD cast. In two years we expect to start hearing back as people find these bottles washed up on shore. From the returned information, the starting and ending positions, probable route and a maximum transit time can be determined.

Two sets of bottles were tossed. The first set was a put together by Bonita Leblanc, an 8th grade student, for a school science fair project. She chose toss locations throughout the ship's transit from Dartmouth NS into the Canada Basin. The second set was put together by Helen Drost to fill in around Bonita's toss locations. Empty bottles were donated by Sleeman Breweries Ltd. and Labatt Breweries.

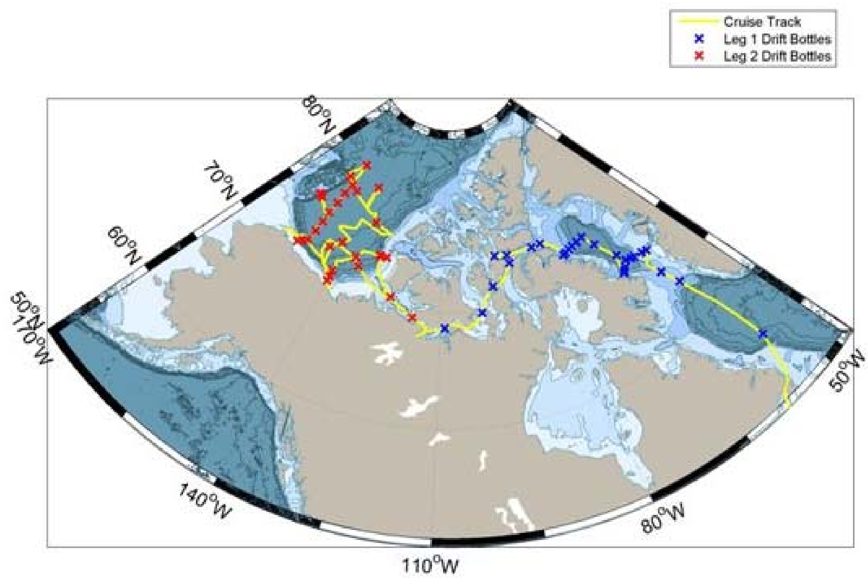


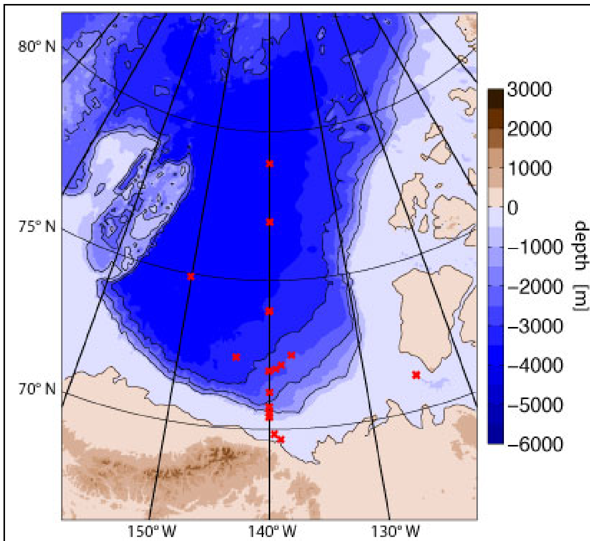
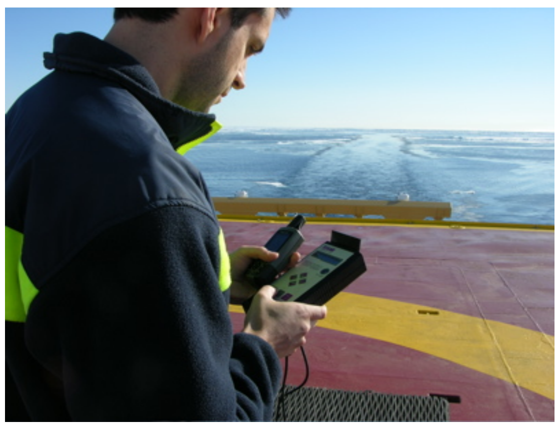
Figure 17. Drift bottle locations. Red x marks deployment locations during the JOIS cruise.

4.11 Opportunistic Study

Aerosol optical depth measurements (Luc Rainville, WHOI)

During the cruise, Luc Rainville made aerosol optical depth measurements for Alexander Smirnov (Goddard Earth Sciences and Technology Center, University of Maryland, Baltimore County, asmirnov@aeronet.gsfc.nasa.gov). Dr. Smirnov provided me with a hand-held sunphotometer (Microtops II) that was used to acquire 152 solar scans. This instrument is specifically designed to measure columnar optical depth and water vapor content. To obtain the time and position of the measurements, the sunphotometer was connected to a hand-held GPS. The measurements were made only when the sun disk was completely free of clouds or fog.

Those measurements are important for several reasons: lack of knowledge on aerosol optical properties over the oceans; satellite remote sensing validation needs them; global aerosol transport models need the data; radiative forcing computations. We expect very little or no aerosol in the Arctic, but this is the first time direct measurements were taken from the Arctic Ocean. Filling the data gaps is the major point. Verifying the satellite aerosol estimates in the Arctic is crucial. These measurements will be important for comparison in the future.

	
Map of the locations (red dots) of the aerosol optical depth measurements taken during the 2007 cruise.	Luc Rainville taking the aerosol measurements with the Microtops connected to the GPS unit.

Upper Ocean CTD casts using a SBE19Plus: Fiona McLaughlin (IOS) PI

Jennifer Jackson (UBC) and Luc Rainville collected 58 CTD profiles of the upper ocean were recorded using a small SBE19+ from the zodiac, the ship, and the ice. These measurements were conducted to measure spatial variability in the near-surface temperature and salinity and asses the ship's mixing of the upper water column.

5. COMMENTS ON OPERATION

5.1 Ice conditions

Ice thickness was greatest in the northeast and parts of the southeast region of our study area. Ice was light in the northwest region, likely an effect of the polynya in the area to the south the year before. At the start of the cruise the ice was far enough off Banks Island to begin our sampling there and carried on in a clockwise path around the Canada Basin.

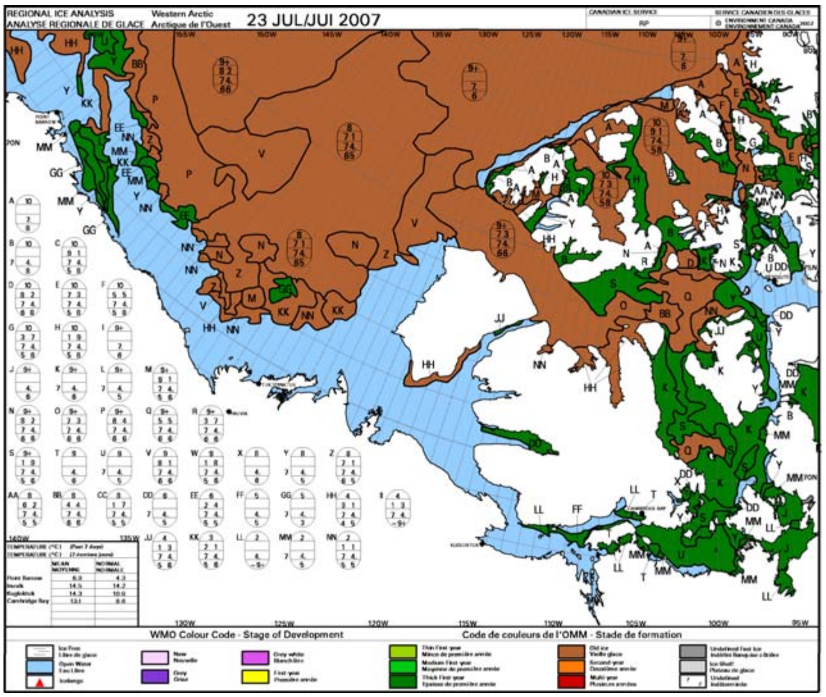


Figure 18. Ice concentration at the start of the program

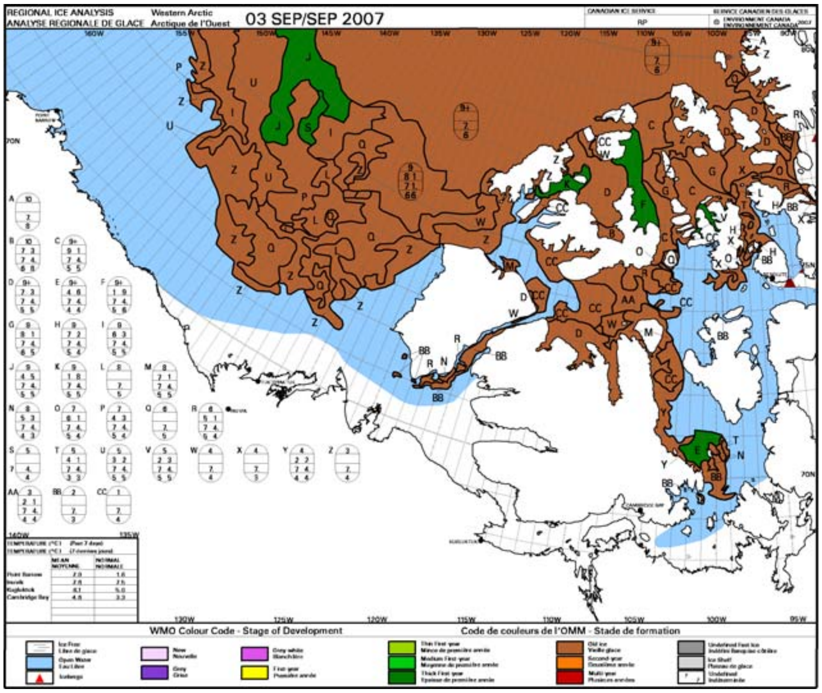


Figure 19. Ice concentration at the end of the program

5.2 Planned activities that were not completed

All objectives were met.

5.3 Ship improvements completed for 2007

Items critical for this year's Canada's Three Oceans and JOIS-2007 programs were addressed as well as other improvements made possible with funding for the International Polar Year. Some of the highlighted outcomes of last winter's efforts are listed below. Additionally, we were glad to have the ship's fifth engine back in operation.

- Fume hood and vent installation in the main lab with chemical locker below. This system allows for the safe use of chemicals in the lab. The fume hood worked well. Understanding how to set and operate the alarm system was not intuitive although this could be fixed with posting of the instruction manual.

- New temperature controlled container lab (within 2 deg), suited for salinity and oxygen analysis.

- New container lab divided into CTD operation section and a section with a fumehood (suitable for solvents) and explosion proof refrigerator.

- An uncontaminated seawater supply, delivered to the main lab, in which sensors (i.e. Seabird SBE 21 thermosalinograph) were installed and water samples drawn.

- Repair to the rosette container lab door.

- Removing and rewinding the CTD conducting wire on to the drum to solve the bad-wrap problem.

- Forward container lab was removed and replaced with repaired container lab from boatdeck previously used for CTD operation.

- Sink, counter and floor on outboard side of main lab replaced and/or repaired.

- Anti-fatigue mats, chairs and stools added to labs

- Foredeck container to be completed in time for the 2008 field program.

5.4 Suggestions for 2008

The following is a list of suggested improvements to and comments about the ship's equipment and lab spaces. The lists are written in order of priority and depend on unidentified funding.

General Ship:

- Add air conditioning to the forward science lab for performance and operation of ship's network servers, sounder equipment and computers as well as to make a more comfortable work space.

- Network speed is variable by location and at some areas takes too long to move or open files put on public drive. Boardroom, 301 and other port side 300 level cabins are slow places, to mention a few.

Science:

- Pivot pins on rosette A-frame need examination/ service. The A-frame "clunks" as the rosette is deployed and recovered.

- Wooden deck outside rosette lab needs repair as the pallet jack sinks into the wood when the rosette is moved.

- Add drain to the rosette container, diagonally in 1-m from aft outboard corner. The existing drain in the same corner (next to the wall) is good but not sufficient.

- Inspect plumbing from main lab double sink: has leak been fixed (i.e. can. both basins be used)? This is the sink next to the fume hood.

- Step from the lab containers to the deck need to be deeper (~>12 inches) – i.e. extend out from the door farther. Step from the temperature controlled lab to cover the bolt on deck as it is often tripped over.

- Add coat hooks to all lab spaces, specifically, add hooks for mustang suits/ hats/ gloves to rosette lab and main lab.

- Insulate sea water loop manifold and hoses running out of lab (if there are hoses) to prevent condensation.

- Brooks Ocean Instrumented Block software experienced intermittent communication interruptions between the block, CTD computer and winch display which required turning the system off and on. To be discussed with Brooks Ocean.

- Add shelves to the lab attached to main lab (aft most lab), some at 4.5 feet, some at 5 feet.

- Add tie down points below benches to secure boxes (nutrient lab and main lab)

- Addition of a speed control valve on the winch to ease operation during the long 3 hour casts.

- If possible, move the GPS antenna so that it is mounted directly over the ship's 12kHz transducer

For discussion (not required for Canada Basin work in 2008)

- Options for making a dedicated chemical storage in ventilated, temperature controlled room (maintained above freezing and less than ~25ºC).

- Personnel on science legs to attend to ship's network, data collection from ship's sounder and underway instruments, as well as handle the additional networking and email demands from the science group.

- New access to Aft Lab area through new door (in way of window) into Aft Lab A from exterior alleyway

- Add sinks to outboard after labs.

- Add a second seawater supply from the small sea chest aft and port side of ship (sea chest does not receive recirculated water and stays ice-free more readily than the forward intake). This system could be used when more water is needed or when forward intake is clogged with ice.

- Winch on the foredeck for mooring work.

- Winch with non-conducting wire for foredeck operation and block

- Spare conducting wire for CTD winch

Science to purchase:

- Mylar blinds to windows and fan to temperature controlled lab.

- Fan for aft-most lab adjoining main lab.

- Stand-up freezer (22 cu Ft) for programs requiring little freezer space so that ship's large walk-in freezer is not used.

6. ACKNOWLEDGMENTS

The science team would like to thank the Coast Guard for their support and particularly Captains McNeill, Klebert and Potts, and the Crew of the *CCGS Louis S. St-Laurent*. In addition to everyone's assistance at sea, a substantial number of projects were completed by the ship in preparation for the summer science season resulting in very successful International Polar Year programs. We'd also like to thank the Canadian Ice Service for their assistance with ice images and weather information as well as the helicopter pilots and mechanics for their valuable help with ice observations and transport. Thanks to the *CCGS Sir Wilfrid Laurier* for transferring and transporting equipment and samples back to Victoria. Importantly, we'd like to acknowledge DFO, NSF and JAMSTEC for their continued support of this program.

APPENDIX A: Participants

Table 3. Cruise Participants

Person	Affiliation	Role
Sarah Zimmermann	DFO	Chief Scientist
Jane Eert	DFO	Co-Chief Scientist / CTD
Linda White	DFO	Nurtrient Analysis
Kristina Brown	DFO	Ammonium Analysis
Michael Dempsey	DFO	Chief Technician /CTD
Mary Steel	DFO	Oxygen Analysis
Hugh Maclean	DFO	CTD
Helen Drost	DFO	Zooplanktion/ CTD
Jennifer Jackson	UBC	POC Analysis
Celine Gueguin	Trent University	CDOM Analysis
Timothy Kane	DFO	CTD
Emile Didierjean	ULaval	Microbial DNA+RNA
Karen Scarcella	ULaval	Microbial DNA+RNA
Ian Wrohan	UVIC	Phytoplankton Filteration + Productivity Studies
Rick Nelson	DFO	Isotope Analysis
Motoyo Itoh	JAMSTEC	CTD/ XCTD
Richard Krishfield	WHOI	Moorings and Buoys
Kris Newhall	WHOI	Moorings and Buoys
Luc Rainville	WHOI	Moorings and Buoys
Steven Manganini	WHOI	Moorings and Buoys
Jim Dunne	WHOI	Moorings and Buoys
Jennifer Hutchings	IARC	Ice Observation
Alice Orlich	IARC	Ice Observation
Toshio Nagashima	ABC, Japan TV	Media
Yuko Mukahira	ABC, Japan TV	Media
Masakazu Nagata	ABC, Japan TV	Media

Table 4. Principal Investigators on Shore

Name	Affiliation	Program
Fiona McLaughlin	DFO	CTD and chemistry
Eddy Carmack	DFO	CTD and chemistry
Andrey Proshutinsky	WHOI	WHOI moorings
Koji Shimada	JAMSTEC	XCTD
Chris Guay	OSU	Barium samples
Bill Li	DFO	Bacteria samples
John Smith	DFO	Cs-137, I-129, Pu/Am samples
Russ Hopcroft	UAF	Zooplankton net tows
John Nelson	UVic/DFO	Zooplankton net tows
Igor Polyakov	IARC	CABOS mooring

Connie Lovejoy	ULaval	Micorbial RNA/DNA samples
Diana Varela	UVic	Productivity samples

Affiliation Abbreviation

DFO	Department of Fisheries and Oceans, Canada
IARC	International Arctic Research Center, Alaska
JAMSTEC	Japan Agency for Marine-Earth Science Technology, Japan
OSU	Oregon State University, OR
UAF	University of Alaska Fairbanks, Alaska
UBC	Univerisity of British Columbia, BC
UVic	University of Victoria, BC
WHOI	Woods Hole Oceanographic Institution, Massachusetts
ABC	Asahi Broadcasting Company

APPENDIX B: Science Station Locations

Table 5. Rosette/CTD Casts

Cast #	Station	Cast Start Time (UTC)	Latitude (N)	Longitude (W)	Water Depth (m)	Cast Depth (m)	Sample #'s
1	AG5	2007/07/28 14:16	70.547	122.903	634+9	150	1-20
2	AG5	2007/07/28 15:47	70.546	122.888	614+9	618	21-43
3	BI-1	2007/07/29 10:56	73.858	127.345	188+9	189+5	44-53
4	BI-3	2007/07/29 16:49	73.812	129.591	1007+9	1011+15	54-70
5	BI-4	2007/07/29 19:51	73.777	129.973	1537+9	1487+10 m	71-91
6	BI-5	2007/07/29 23:00	73.797	130.434	2000+9	2008+9 m	92-104
7	BI-2	2007/07/30 02:50	73.851	129.174	490+9m	491 dbar	105-126
8	BI-2	2007/07/30 05:19	73.834	129.171	485+9m	232	
9	BI-2	2007/07/30 07:13	73.824	129.197	511+9	232	127-149
10	BI-6	2007/07/30 12:02	73.757	130.938	2499+9	2496+7	150-173
11	BI-7	2007/07/31 00:31	73.681	134.813	3036+9	2995+10 m	174-197
12	CB23a	2007/07/31 08:38	72.897	136.009	2729+9	2742+7 m	198-221
13	CB29	2007/07/31 21:09	71.992	140.039	2675+9m		222-233
14	CB29	2007/07/31 22:13	71.990	140.048	2675+9m		234-257
15	CB28b	2007/08/01 08:51	70.965	140.032	2033+9m	653	258-280
16	CB28b	2007/08/01 11:06	70.965	140.089	2038+9m	2039+6	281-304
17	MK-4	2007/08/01 15:25	70.814	140.053	1527+9m	1487+7 m	305-328
18	MK-3	2007/08/01 18:42	70.576	140.010	753+9m	815+9m	329-352
19	MK-3	2007/08/01 20:16	70.577	140.033	814+9m		
20	MK-3	2007/08/01 21:10	70.582	140.048	861+9		353-376
21	MK-3	2007/08/01 23:15	70.572	140.000	780+9		377-329
22	MK-2	2007/08/02 01:25	70.401	139.973	500+9		400-423
23	MK-1	2007/08/02 05:29	70.230	140.002	242+9		424-446
24	CB28aa	2007/08/02 08:36	70.003	140.009	49+9m	53	447-451
25	BL-1	2007/08/04 03:41	71.326	152.218	unknown	51	456-461
26	BL-2	2007/08/04 04:43	71.400	152.031	144+9m	146+9m	462-473
27	BL-2	2007/08/04 05:39	71.401	152.040	153+9m	149	474-492
28	BL-3	2007/08/04 07:27	71.465	151.798	557+9	567+10	493-515
29	BL-4	2007/08/04 10:19	71.502	151.657	992+9	1000+9	516-538
30	BL-6	2007/08/04 13:11	71.657	151.232	2010+9	2000+11	539-562
31	BL-8	2007/08/04 17:37	71.965	150.230	2986+9	2992+9	563-585
32	BL-8	2007/08/04 19:50	71.984	150.307	2986+9		586-609
33	CB-2a	2007/08/05 00:55	72.499	150.044	3681+9	80	610-621
34	CB-2a	2007/08/05 02:12	72.510	150.071	3682+9		622-645
35	CB-2	2007/08/05 07:42	72.998	149.979	3736+9m	3737+10	646-669
36	CB-3	2007/08/05 16:56	73.985	149.976	3815+9m	3815+19	670-693
37	CB-4	2007/08/06 04:25	74.924	150.133	3818		694-717
38	CB-4	2007/08/06 09:05	74.920	150.147	3822+9m	76	718-729
39	CB-4	2007/08/06 10:09	74.918	150.158	3819+9m	800	730-750
40	RS-6	2007/08/07 08:16	75.513	155.268	3839+9m	3830	751-773
41	RS-4	2007/08/07 13:32	75.615	156.057	2354+9m	2330	775-79
42	RS-1	2007/08/07 17:26	75.747	157.097	979+9m	304	799-821
43	RS-1	2007/08/07 17:26	75.747	157.097	983+9m	971	822-844
44	RS-2	2007/08/07 23:31	75.665	156.299	1452+9m	1000	845-856
45	RS-2	2007/08/08 01:02	75.666	156.302	1452+9m	1406	857-880
46	CB-5	2007/08/08 01:02	75.200	156.288	3838+9m	1001	881-898

47	CB-7	2007/08/09 09:31	75.985	149.958	3820+9m	3819	899-922
48	CB-8	2007/08/09 18:23	76.999	150.001	3819+9m	3816	923-946
49	CB-9	2007/08/10 04:00	77.933	149.832	3816+9m	5	947-950
50	CB-9	2007/08/10 04:14	77.935	149.827	3816+9m	800	951-972
51	CB-9	2007/08/10 05:53	77.940	149.807	3817+9m	1000	973-996
52	CB-9	2007/08/10 07:20	77.943	149.772	3816+9m	3813	997-1020
53	RN-6	2007/08/11 04:03	78.354	152.615	3513+9m	3446	1021-1044
54	RN-4	2007/08/11 08:20	78.343	153.130	2564+9m	2614	1045-1068
55	CB-10a2	2007/08/11 11:58	78.341	153.490	1840+9m	1000	1069-1092
56	CB-10a2	2007/08/11 13:47	78.351	153.469	1912+9m	1880	1093-1116
57	CB-10a	2007/08/11 17:09	78.322	154.044	1014+9m	1000	1117-1139
58	CB-10a	2007/08/11 19:35	78.329	154.012	1051+9m	1037	1140-1163
59	CB10aa	2007/08/11 21:43	78.337	154.323	915+9m	917	1164-1186
60	CB11b	2007/08/12 14:13	79.989	150.012	3811+9m	107	1187-1198
61	CB11b	2007/08/12 15:24	79.992	149.990	3811+9m	1001	1199-1221
62	CB11b	2007/08/12 20:28	79.915	150.153	3813+9m	3801	1222-1245
63	CB11	2007/08/13 07:04	78.999	150.031	3822+9m	1000	1246-1264
64	CB9a	2007/08/14 00:53	78.038	149.240	3817+9m	1000	1265-1288
65	CB-12	2007/08/14 06:44	77.705	146.806	3806+9m	3803	1289-1312
66	CB-12	2007/08/14 08:06	77.713	146.823	3807+9m	3771	1313-1336
67	CB-13	2007/08/14 16:28	77.307	143.239	3779+9m	5	1337-1341
68	CB-15	2007/08/15 01:36	76.998	140.186	3725+9m	1000	1342-1363
69	CB-15	2007/08/15 01:52	76.999	140.187	3725+9m	1001	1364-1387
70	CB-15	2007/08/15 08:31	77.033	140.247	3728+9m	3722	1388-1411
71	CB-15	2007/08/15 09:55	77.041	140.254	3728+9m	3742	1412-1435
72	CB-16	2007/08/16 02:52	77.994	140.016	3747+9m	3742	1412-1435
72	CB-16	2007/08/16 04:10	77.998	140.023	3747+9m	3742	1412-1435
73	CB-16N	2007/08/16 13:00	78.952	139.942	3763+9m	3761	1436-1459
74	CB-16N	2007/08/16 20:29	78.938	139.950	3763+9m	1000	1460-1483
75	TK-1	2007/08/17 02:35	78.734	138.904	3749+9m	3747	1484-1507
76	CB-15	2007/08/18 12:49	76.968	140.074	3717+9m		1508-1531
77	LS-28	2007/08/19 02:05	77.012	136.514	3605+9m	3630	1532-1555
78	PP-7	2007/08/19 10:42	76.438	135.338	3543+9	1502	1556-1575
79	PP-6.5	2007/08/19 14:06	76.259	133.883	3333+9m	5	1576-1599
80	PP-6	2007/08/19 17:16	76.123	132.482	3030+9m	3015	1600-1623
81	PP-4	2007/08/20 00:02	75.953	130.013	1980+9m	1956	1624-1647
82	PP-2	2007/08/20 05:22	75.845	128.642	996+9m	999	1648-

								1670
83	PP-2	2007/08/20 07:22	75.837	128.708	1020+9m	1025	1671-1693
84	PP-1	2007/08/20 10:39	75.846	127.793	420+9m	436	1694-1710
85	CB-17	2007/08/21 09:17	75.992	139.980	3704	301	1711-1722
86	CB-17	2007/08/21 10:58	75.984	139.986	3688	3686	1723-1746
87	CB-17.5	2007/08/21 15:34	75.650	139.717	3693+9m	5	1747-1770
88	CB-18	2007/08/21 19:58	75.001	140.004	3621+9m	3616	1771-1794
89	CB-19W	2007/08/22 06:57	74.504	144.977	3731+9m	3729	1795-1818
90	CB-21	2007/08/22 22:32	73.974	140.062	about	3494	1819-1842
91	CB-21	2007/08/23 06:12	73.956	140.101	3490+9m	3483	1843-1866
92	CB-21	2007/08/23 11:24	73.981	140.036	3506+9m	1000	1867-1886
93	CB-21	2007/08/23 13:02	73.966	140.093	3492+9m	5	1887-1890
94	CB-21	2007/08/23 13:21	73.967	140.088	3493+9m	1000	1891-1912
95	STA-A	2007/08/24 05:35	72.687	144.706	3498+9m	3000	1913-1936
96	STA-A	2007/08/24 08:00	72.674	144.747	3498+9m	1000	1937-1960
97	STA-A	2007/08/24 09:08	72.670	144.783	3456+9m	401	1961-1984
98	STA-A	2007/08/24 10:46	72.687	144.701	3463+9m	1000	1985-2008
99	STA-A	2007/08/24 12:05	72.688	144.697	3463+9m	3458	2009-2032
100	STA-A-E	2007/08/24 16:26	72.646	143.828	3426+9m	3408	2033-2056
101	STN-A95-CH	2007/08/26 15:43	73.000	145.351	3561+9	1000	2057-2080
102	STN-A95-CH	2007/08/26 17:13	73.011	145.368	3567+9	3562	2081-2104
103	CB-27	2007/08/27 03:42	73.000	139.993	3211+9	3203	2105-2128
104	CB-23a	2007/08/27 11:38	72.905	136.001	2757+9	1200	2129-2150
105	CB-31b	2007/08/27 18:08	72.271	134.297		1201	2151-2171
106	CABOS	2007/08/28 02:41	71.831	131.798	1111	1000	
107	CABOS	2007/08/28 03:46	71.834	131.836	1152+9m	1141	2172-2195

Table 6. XCTD Casts

Type	Cast	Time (UTC)				Latitude (N)		Longitude (W)		Water Depth (m)	Comment
XCTD	23	2007	7	29	05:35	73	01.13	129	08.55	645	
XCTD	24	2007	7	29	06:34	73	11.61	128	44.74	480	
XCTD	25	2007	7	29	08:36	73	32.37	127	53.68	197	
XCTD	26	2007	7	29	13:01	73	50.56	128	13.15	331	
XCTD	27	2007	7	30	16:01	73	45.35	132	27.11	2809	data error below

											500m
XCTD	28	2007	7	30	19:30	73	45.25	133	29.13		
XCTD	29	2007	7	31	05:37	73	20.23	135	22.17		
XCTD	30	2007	7	31	13:12	72	35.26	137	14.71	2604	
XCTD	31	2007	7	31	16:03	72	17.82	138	33.27	2585	
XCTD	32	2007	8	01	03:29	71	36.73	140	00.82	2490	
XCTD	33	2007	8	01	05:50	71	17.51	139	59.95	2294	data error below 500m
XCTD	34	2007	8	01	14:21	70	45.29	140	00.58	1470	
XCTD	35	2007	8	02	11:35	70	25.99	140	52.86	443	
XCTD	36	2007	8	02	12:19	70	34.11	141	07.03	775	
XCTD	37	2007	8	02	13:43	70	50.63	141	35.97	2200	
XCTD	38	2007	8	02	15:24	71	01.49	142	37.63	2105	
XCTD	39	2007	8	02	17:48	71	28.79	143	42.58	3037	
XCTD	40	2007	8	02	19:28	71	28.08	144	57.12	2983	
XCTD	41	2007	8	02	20:59	71	31.25	146	08.72	3004	
XCTD	42	2007	8	02	22:31	71	37.34	147	19.74	2942	
XCTD	43	2007	8	03	00:21	71	45.69	148	36.03	2916	
XCTD	44	2007	8	03	01:57	71	54.52	149	50.30	2973	
XCTD	45	2007	8	03	04:26	72	09.81	151	42.80	2975	
XCTD	46	2007	8	03	05:39	71	56.36	152	18.51	2050	
XCTD	47	2007	8	03	06:40	71	47.22	152	45.41	1200	
XCTD	48	2007	8	03	06:57	71	45.05	152	51.36	800	
XCTD	49	2007	8	03	07:21	71	41.00	152	58.38	171	
XCTD	50	2007	8	03	07:49	71	38.28	153	09.13	67	
XCTD	51	2007	8	04	06:55	71	26.65	151	53.23	250	
XCTD	52	2007	8	04	12:21	71	33.97	151	28.09	1460	
XCTD	53	2007	8	04	17:36	71	48.66	150	48.15	2543	
XCTD	54	2007	8	05	13:29	73	29.24	150	04.63		
XCTD	55	2007	8	05	00:00	74	29.13	151	23.51		
XCTD	56	2007	8	06	22:42	74	45.05	150	08.80		
XCTD	57	2007	8	06	01:24	74	59.72	151	23.51		
XCTD	58	NA									
XCTD	59	2007	8	07	04:53	75	20.14	154	22.40		
XCTD	60	2007	8	07	19:19	75	47.00	157	30.31		
XCTD	61	2007	8	08	02:51	75	38.01	156	07.82	2076	
XCTD	62	2007	8	08	04:04	75	34.76	155	56.06	3000	
XCTD	63	2007	8	09	07:01	75	30.18	149	59.26	3831	
XCTD	64	2007	8	09	15:12	76	29.87	149	57.39	3832	
XCTD	65	2007	8	10	01:05	77	29.21	149	57.39		
XCTD	66	2007	8	11	01:08	78	9.593	151	04.84		
XCTD	67	2007	8	11	07:48	78	20.84	153	02.25	2900	
XCTD	68	2007	8	11	10:56	78	20.84	153	46.56	2361	
XCTD	69	2007	8	11	16:10	78	20.93	153	46.56		

XCTD	70	2007	8	12	00:22	78	28.42	153	45.25	1964
XCTD	71	NA								
XCTD	72	2007	8	12	01:57	78	37.77	153	24.08	3294
XCTD	73	2007	8	12	04:18	78	57.76	152	36.54	3632
XCTD	74	2007	8	12	07:36	79	19.08	151	35.54	3830
XCTD	75	2007	8	12	07:36	79	19.74	151	35.33	3830
XCTD	76	2007	8	12	10:00	79	39.41	150	54.59	3820
XCTD	77	2007	8	13	02:37	79	30.01	150	05.24	3826
XCTD	78	2007	8	13	04:59	79	16.67	150	02.61	3828
XCTD	79	2007	8	13	10:34	78	40.45	150	02.66	3832
XCTD	80	2007	8	13	13:04	78	20.71	150	02.77	3827
XCTD	81	2007	8	14	04:12	77	54.14	148	19.00	3826
XCTD	82	2007	8	14	13:41	77	28.75	145	02.88	3802
XCTD	83	2007	8	14	22:50	77	09.13	141	38.58	
XCTD	84	2007	8	15	22:53	77	30.24	140	00.68	
XCTD	85	2007	8	16	08:51	78	29.02	140	01.01	3771
XCTD	86	2007	8	17	21:25	76	49.48	138	15.38	
XCTD	87	2007	8	19	07:01	76	42.46	135	52.92	3614
XCTD	88	2007	8	19	14:24	76	31.64	136	28.64	3430
XCTD	89	2007	8	19	22:10	76	01.00	132	02.00	2535
XCTD	90	2007	8	20	03:30	75	50.48	129	21.10	1506
XCTD	91	2007	8	20	09:42	75	49.08	128	15.73	548
XCTD	92	2007	8	20	17:42	75	38.26	130	16.54	1881
XCTD	93	2007	8	20	18:16	75	38.06	130	40.94	2111
XCTD	94	2007	8	20	20:06	75	35.02	131	31.32	2557
XCTD	95	2007	8	20	22:44	75	42.15	132	38.82	3006
XCTD	96	2007	8	21	00:20	75	42.35	133	18.87	3183
XCTD	97	2007	8	21	01:06	75	45.52	134	16.82	3379
XCTD	98	2007	8	21	02:19	75	47.81	135	06.07	3459
XCTD	99	2007	8	21	04:16	75	53.32	136	40.25	3577
XCTD	100	2007	8	21	06:25	75	54.91	138	12.75	3638
XCTD	101	2007	8	21	16:42	75	30.74	139	49.38	3693
XCTD	102	2007	8	22	01:22	74	52.97	141	40.30	
XCTD	103	2007	8	22	04:05	74	43.38	143	23.59	
XCTD	104	2007	8	22	12:09	74	18.34	143	22.74	3704
XCTD	105	2007	8	22	14:55	74	10.42	141	42.55	3645
XCTD	106	2007	8	23	21:41	73	37.90	141	10.80	
XCTD	107	2007	8	24	00:04	73	17.13	142	12.90	3526
XCTD	108	2007	8	24	02:23	72	56.81	143	20.25	3453
XCTD	109	2007	8	24	16:14	72	38.78	143	49.97	3427
XCTD	110	2007	8	24	20:39	72	09.47	143	21.93	3221
XCTD	111	2007	8	24	23:32	71	40.81	143	13.14	
XCTD	112	2007	8	25	02:40	70	58.66	142	33.60	1897
XCTD	113	2007	8	25	04:03	70	50.36	141	37.50	1980
XCTD	114	2007	8	25	05:05	70	37.90	141	06.22	1052

XCTD	115	2007	8	25	23:38	70	25.67	140	00.43	550	
XCTD	116	2007	8	26	01:49	70	56.79	140	00.21	2018	
XCTD	117	2007	8	26	11:26	71	58.76	145	17.96	3340	
XCTD	118	2007	8	27	01:39	73	02.61	138	04.91	3387	
XCTD	119	2007	8	27	08:15	72	56.67	138	04.91	2878	
XCTD	120	2007	8	27	16:22	72	18.27	135	12.00		
XCTD	121	2007	8	27	21:23	72	00.74	132	48.60		
XCTD	122	2007	8	28	06:39	71	35.35	131	05.90	605	
XCTD	123	2007	8	28	07:18	71	27.90	130	44.69	267	

Table 7. XBT Casts

Type	Cast	Time (UTC)				Latitude (N)		Longitude (W)		Water Depth (m)	Comment
XBT	50	2007	8	01	3:40	71	36.73	140	00.82	2480	bad data
XBT	51	2007	8	01	3:40	71	36.73	140	00.82	2480	bad data
XBT	52	2007	8	01	3:47	71	36.73	140	00.82	2480	bad data
XBT	53	2007	8	01	3:48	71	36.73	140	00.82	2480	
XBT	54	2007	8	01	5:50	70	55.44	140	10.36	1861	failed 500m
XBT	55	2007	8	01	13:25	70	39.48	140	00.81	1297	bad data
XBT	56	2007	8	01	17:39	70	38.97	140	00.98	1297	
XBT	NA										
XBT	58	2007	8	02	0:39	70	28.29	139	59.94	650	
XBT	59	2007	8	02	4:40	70	18.94	139	59.98	450	bad data
XBT	60	2007	8	02	4:47	70	18.94	139	59.98	450	failed 500m
XBT	NA										
XBT	62	2007	8	02	7:05	70	08.56	140	00.47	110	
XBT	NA										
XBT	64	2007	8	02	7:05	70	08.56	140	00.47	110	
XBT	NA										
XBT	66	2007	8	02	7:33	70	05.23	140	00.34	80	
XBT	67	2007	8	02	7:36	70	05.23	140	00.34	80	
XBT	NA										
XBT	69	2007	8	24	14:47	72	41.56	144	35.42		failed 150m
XBT	70	2007	8	24	14:59	72	40.80	144	29.00		failed 300m
XBT	71	2007	8	24	15:09	72	40.79	144	23.04		failed 200m
XBT	72	2007	8	24	15:28	72	40.32	144	11.33		failed 150m
XBT	73	2007	8	24	15:43	72	39.69	144	02.60		failed 300m
XBT	74	2007	8	24	16:20	72	38.77	143	49.76		
XBT	75	2007	8	25	07:13	70	09.56	139	59.93		
XBT	76	2007	8	25	21:57	70	10.20	140	00.00	58	

XBT	77	2007	8	25	22:01	70	16.80	140	00.00	58
XBT	78	2007	8	25	22:50	70	13.80	140	00.00	270
XBT	79	2007	8	25	23:10	70	14.92	140	00.13	300
XBT	80	2007	8	26	00:17	70	34.36	140	00.39	771
XBT	81	2007	8	26	01:00	70	44.88	140	00.08	1479
XBT	82	2007	8	26	20:29	73	01.92	144	52.05	
XBT	83	2007	8	26	21:51	73	05.30	144	07.87	
XBT	84	2007	8	26	21:56	73	05.27	144	04.57	1675
XBT	85	2007	8	26	23:00	73	00.45	143	28.64	
XBT	NA									
XBT	87	2007	8	27	07:30	71	24.87	130	39.96	377
XBT	88	2007	8	27	07:46	71	23.71	130	32.23	84

Table 8. XCP Casts

TIME (UTC)	CAST TYPE	EVENT No.	Latitude (N)		Longitude (W)		BOTTOM DEPTH	COMMENTS
2007/07/29 21:20	XCP	CP-1	73	46.777	129	59.294	1976m	Serial #07011002; from ship; FAILED
2007/08/01 16:03	XCP	CP-2	70	48.889	140	4.46	1528m	Serial #07011008; from FRC
2007/08/04 06:32	XCP	CP-3	71	24.54	152	2.659	174m	Serial #07011005; from ship; slip-line caught
2007/08/04 11:58	XCP	CP-4	71	33.071	151	28.9	1453m	Serial #07011009; from ship
2007/08/04 22:09	XCP	CP-5	72	0.089	150	21.725	3052m	Serial #07021003; from ship
2007/08/05 19:02	XCP	CP-6	73	59.504	150	1.911	3827m	Serial #07031002; from FRC
2007/08/07 23:39	XCP	CP-7	75	39.97	156	17.859	1448m	Serial #07031004; from FRC
2007/08/13 21:13	XCP	CP-8	78	1.313	149	12.067	3825m	Serial #07031006; from ice
2007/08/16 21:05	XCP	CP-9	78	55.841	139	58.603	3772m	Serial #07031007; from ice
2007/08/20 15:15	XCP	CP-10	75	45.978	129	51.981	1680m	Serial #07031024; from FRC

Vertical Net Tows

Table 9. Sampling locations. Key to net operators are HD (Helen Drost) and HM (Hugh Maclean).

Vertical Net Casts 2007									
Net event	**Station Name**	**CTD cast #**	**Date (UTC)**	**Time (UTC)**	**Approx. Max Net Depth (m)**	**Approx. Water Depth (m) +9**	**Biomass Sample**	**Cast done by**	**Notes**
1	**BI-2**	7	7/30/07	4:30	100	491		HM	
2	**BI-2**	7	7/30/07	5:00	100	491	6a	HM	Flow meter #4 (53um) broken (see log book
3	**BI_6**	10	7/30/07	12:50	100	2504		HD	
4	**BI_6**	10	7/30/07	13:03	100	2504	6b	HD	no wash down and 150 codend had a crack in top (replaced it)
5	**CB28b**	16	1/08/07	10:20	100	2046		HD	
6	**CB28b**	16	1/08/07	10:35	100	2046	6c	HD	
7	**MK-2**	22	2/08/07	2:35	100	524		HM	
8	**MK-2**	22	2/08/07	2:50	100	524	6f	HM	
9	**MK-1**	23	2/08/07	6:15	100	243		HD	
10	**MK-1**	23	2/08/07	6:30	100	243	3a,3b	HD	
11	**BL-2**	27	4/08/07	4:53	100	160		HM	
12	**BL-2**	27	4/08/07	5:15	100	160	3c, 3d	HM	
13	**BL-4**	29	4/08/07	10:43	100	1002		HD	
14	**BL-4**	29	4/08/07	10:57	100	1002	3e, 3f	HD	
15	**BL-8**	32	4/08/07	20:16	100	2995		HM	
16	**BL-8**	32	4/08/07	20:30	100	2995	4a	HM	
17	**CB-2**	35	5/08/07	14:30	100	3745		HD	
18	**CB-2**	35	5/08/07	14:38	100	3745	4b	HD	
19	**CB-4**	37	6/08/07	5:00	100	3829		HM	
20	**CB-4**	37	6/08/07	5:15	100	3829	4c	HM	
21	**RS-4**	41	7/08/07	14:42	100	2349		HD	
22	**RS-4**	41	7/08/07	15:00	100	2349	4d	HD	
23	**CB-8**	48	9/08/07	21:45	100	3828		HM	
24	**CB-8**	48	9/08/07	22:00	100	3828	4e	HM	
25	**CB-9**	50	10/08/07	7:30	100	3829		HD	
26	**CB-9**	50	10/08/07	7:45	100	3829	4f	HD	
27	**RN-6**	53	11/08/07	4:35	100	3517		HM	
28	**RN-6**	53	11/08/07	4:47	100	3517	2a	HM	
29	**CB-10a2**	55	11/08/07	12:02	100	1832		HD	
30	**CB-10a2**	55	11/08/07	12:40	100	1832	2b	HD	
31	**CB-15**	71	15/08/07	11:15	100	3728		HD	
32	**CB-15**	71	15/08/07	11:30	100	3728	2c	HD	
33	**CB-16**	72	16/08/07	3:38	100	3749		HD	
34	**CB-16**	72	16/08/07	3:50	100	3749	2d	HD	
35	**CB-15**	76	18/8/07	12:16	500	3728		HD	
~~36~~	-	-	-	-	-	-	-	-	this event number was skipped
37	**PP-4**	81	20/8/07	103	100	1981		HM	

38	**PP-4**	81	20/8/07	123	100	1981		HM	
39	**PP-4**	81	20/8/07	137	100	1981	**2e**	HM	
40	**PP-1**	84	20/8/07	1100	100	438		HD	
41	**PP-1**	84	20/8/07	1117	100	438	**2f**	HD	
42	**CB-18**	88	21/8/07	2037	100	3621		HM	
43	**CB-18**	88	21/8/07	2049	100	3621	**5a**	HM	
44	**CB-21**	91	23/8/07	643	100	3490		HD	15-20 knot wind and stopped at 40meters going up as net was under ship for approx. 2 mins.
45	**CB-21**	91	23/8/07	648	100	3490	**5b**	HD	no angle on 2nd cast - wind dropped.
46	**Stn A.**	99	24/8/07	1225	100	3498		HD	
47	**Stn A.**	99	24/8/07	1242	100	3498	**5c**	HD	
48	**CABOS**	107	27/8/07	412	100	1167		HM	
49	**CABOS**	107	27/8/07	427	100	1167	**5d**	HM	

Table 10. Large Volume Pump Casts

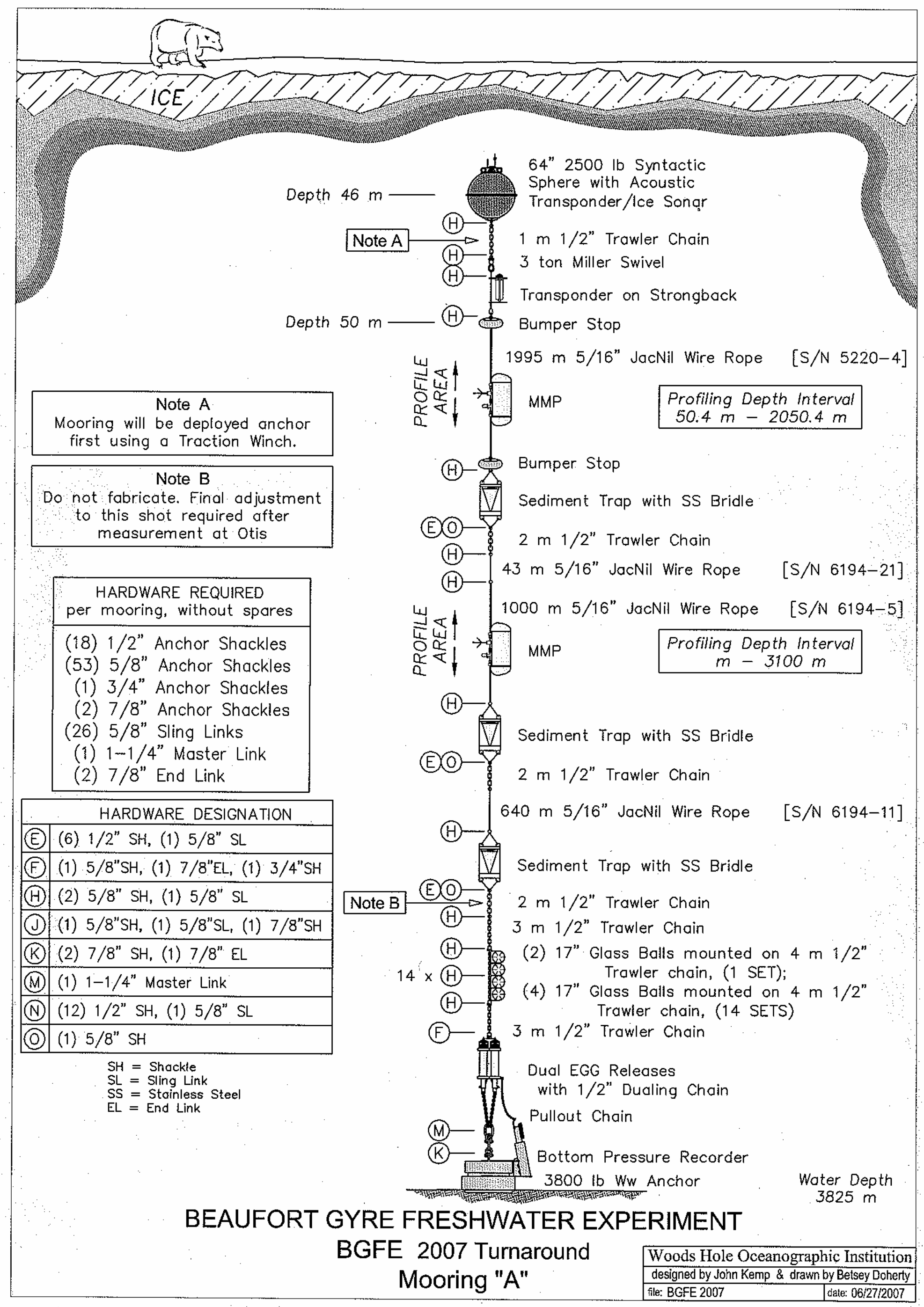
LVP Cast #	LVP Location ID	LVP date	LVP LAT. (N)	LVP LON. (W)	Filter Type (142mm)	LVP Depth	Vol. gal.	Note
1	BGFE-A	06/08/2007	74° 55.22	150° 08.83	GFF	2000	104.7	ok
1	BGFE-A	06/08/2007	74° 55.22	150° 08.83	Versapore (0.4u)	1980	70.8	ok
2	BGFE-B	10/08/2007	77° 56.61	149° 46.30	GFF	2000	111.3	ok
2	BGFE-B	10/08/2007	77° 56.61	149° 46.30	Versapore (0.4u)	1980	90.0	ok
3	BGFE-C	15/08/2007	77° 02.47	140° 15.26	GFF	2920	208.0	ok
3	BGFE-C	15/08/2007	77° 02.47	140° 15.26	Versapore (0.4u)	2900	165.5	ok
3	BGFE-C	15/08/2007	77° 02.47	140° 15.26	GFF	1900	211.2	ok
3	BGFE-C	15/08/2007	77° 02.47	140° 15.26	Versapore (0.4u)	1880	129.7	ok
4	BGFE-C	18/08/2007	76° 58.06	140° 04.03	GFF	1020	224.0	ok
4	BGFE-C	18/08/2007	76° 58.06	140° 04.03	Versapore (0.4u)	1000	143.5	ok
4	BGFE-C	18/08/2007	76° 58.06	140° 04.03	GFF	520	81.0	2 GFF filters
4	BGFE-C	18/08/2007	76° 58.06	140° 04.03	Versapore (0.4u)	500	103.7	ok
5	BGFE-D	22/08/2007	73° 58.523	140° 03.685	GFF	2920	212.5	ok
5	BGFE-D	22/08/2007	73° 58.523	140° 03.685	Versapore (0.4u)	2900	160.5	ok

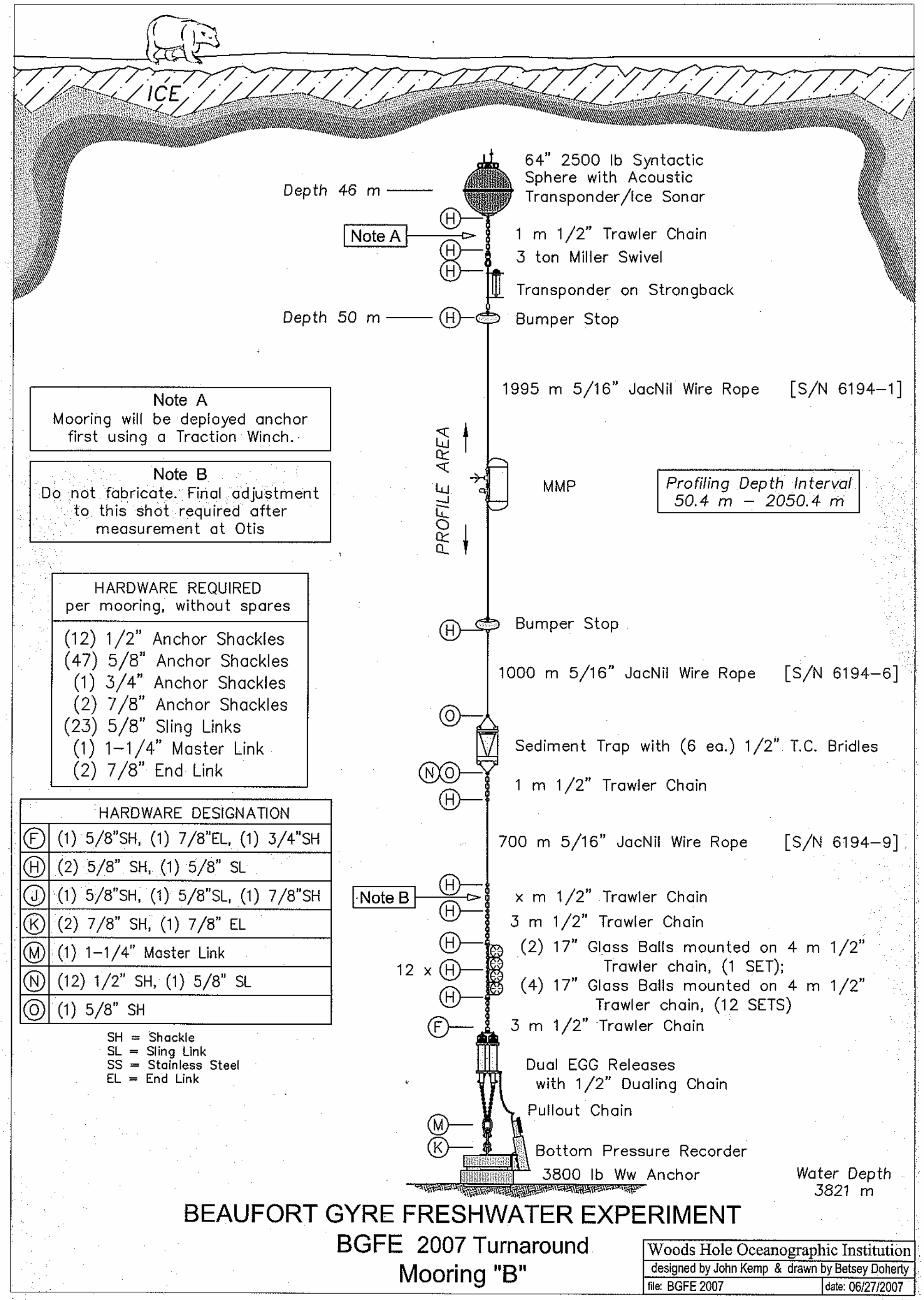
5	BGFE-D	22/08/2007	73° 58.523	140° 03.685	GFF	1900	67.0	sudden pressure release
5	BGFE-D	22/08/2007	73° 58.523	140° 03.685	Versapore (0.4u)	1880	128.0	ok
6	BGFE-D	23/08/2007	73° 57.43	140° 05.97	GFF	1020	202.0	ok
6	BGFE-D	23/08/2007	73° 57.43	140° 05.97	Versapore (0.4u)	1000	168.0	ok
6	BGFE-D	23/08/2007	73° 57.43	140° 05.97	GFF	520	22.0	sudden pressure release
6	BGFE-D	23/08/2007	73° 57.43	140° 05.97	Versapore (0.4u)	500	121.0	ok

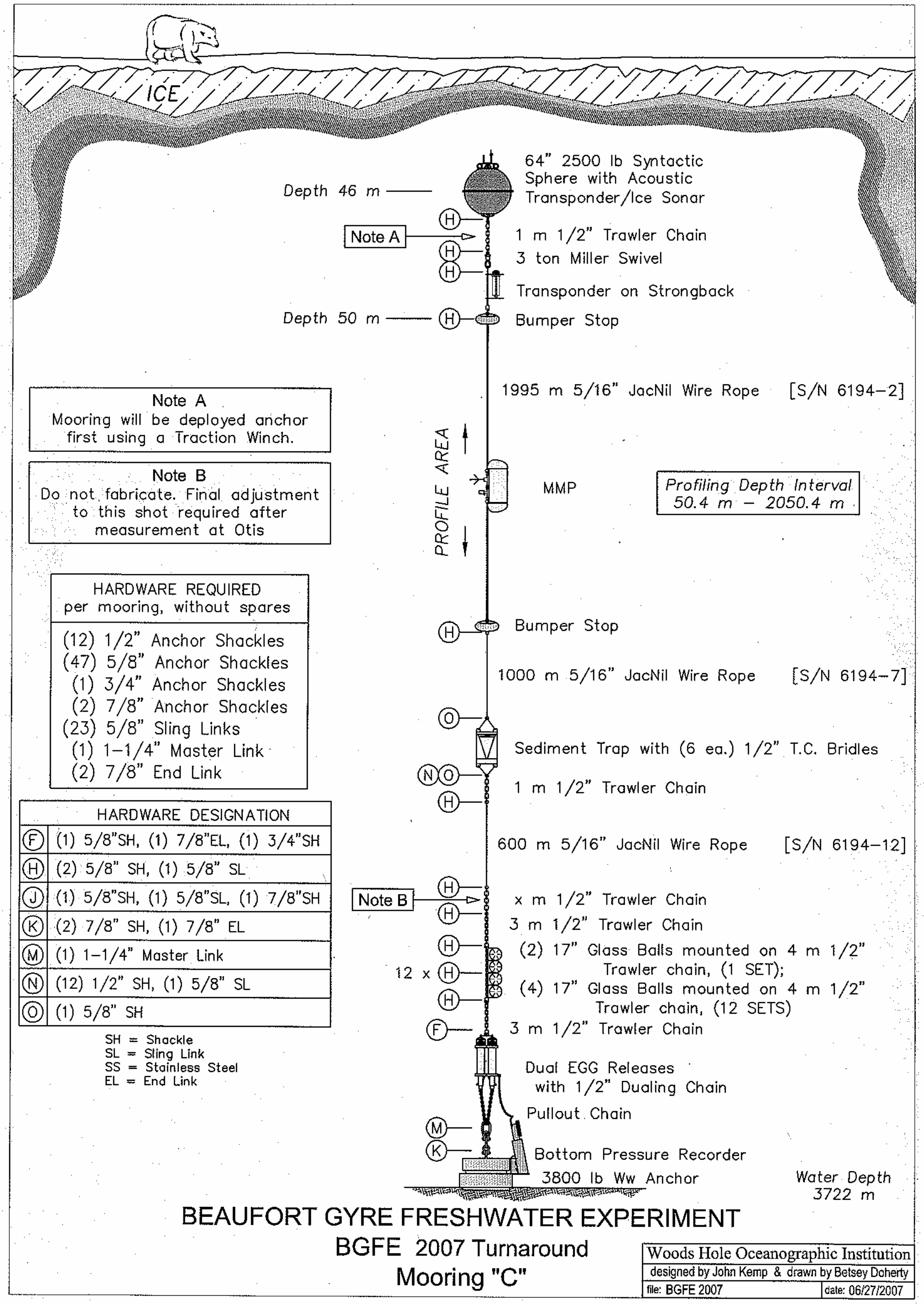
Mooring and Buoy Sites – Please see descriptions in sections above for
BGOS Moorings and Buoys (WHOI)
CABOS Mooring (IARC)
Ice Observation GPS Buoys (IARC)

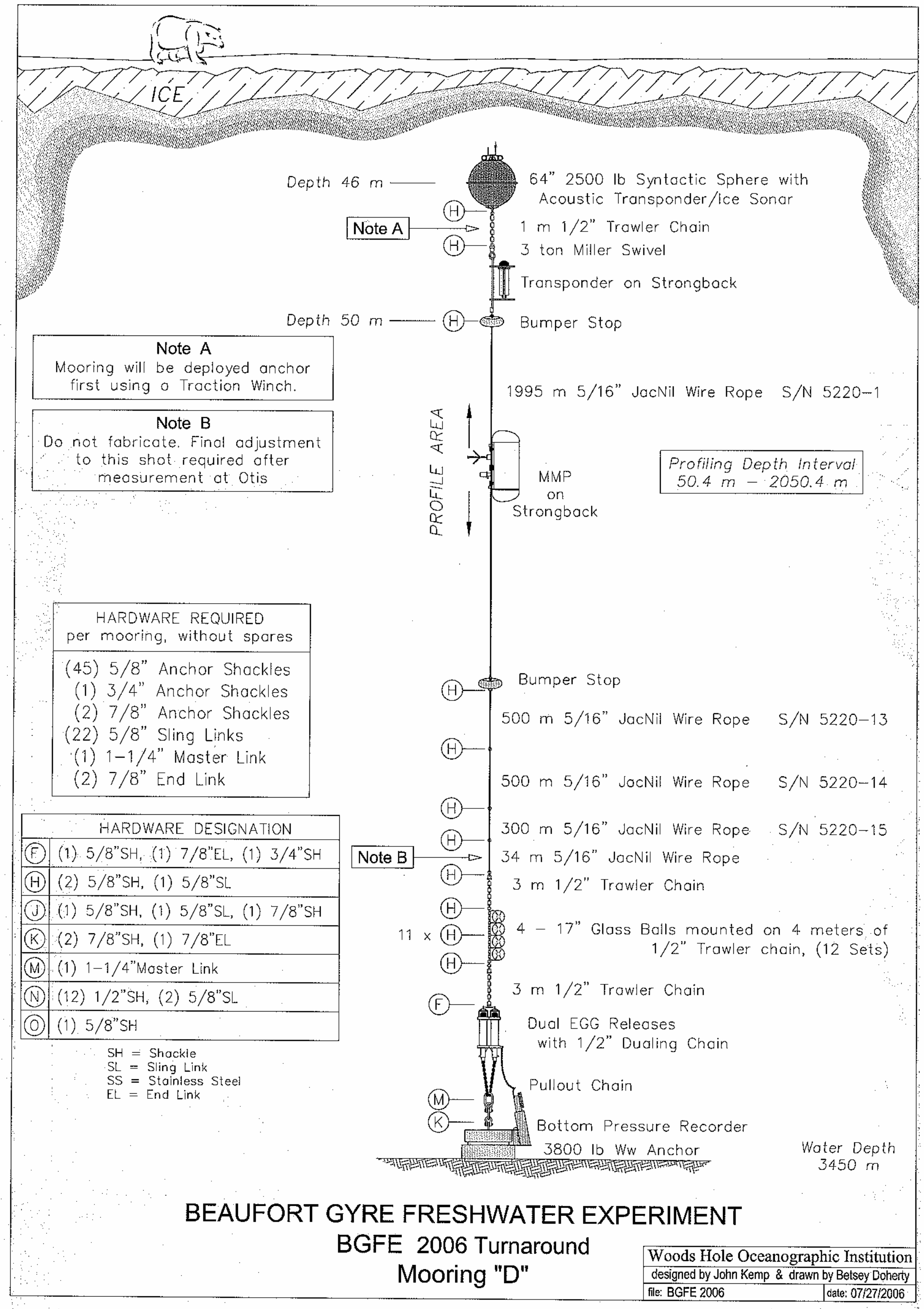
BGOS Mooring Diagrams for 2007 Deployment and the CABOS mooring recovery diagrams are shown below.

BGOS Mooring Diagrams for 2007 Deployment (Moorings A, B, C and D):




ICE
64" 2500 lb Syntactic Sphere with Acoustic Transponder/Ice Sonar
Depth 46 m
Note A
1 m 1/2" Trawler Chain
3 ton Miller Swivel
Transponder on Strongback
Depth 50 m
Bumper Stop
1995 m 5/16" JacNil Wire Rope [S/N 6194–1]
Note A
Mooring will be deployed anchor first using a Traction Winch.
Note B
Do not fabricate. Final adjustment to this shot required after measurement at Otis
PROFILE AREA
MMP
Profiling Depth Interval 50.4 m – 2050.4 m
HARDWARE REQUIRED per mooring, without spares
(12) 1/2" Anchor Shackles
(47) 5/8" Anchor Shackles
(1) 3/4" Anchor Shackles
(2) 7/8" Anchor Shackles
(23) 5/8" Sling Links
(1) 1-1/4" Master Link
(2) 7/8" End Link
Bumper Stop
1000 m 5/16" JacNil Wire Rope [S/N 6194–6]
Sediment Trap with (6 ea.) 1/2" T.C. Bridles
1 m 1/2" Trawler Chain
HARDWARE DESIGNATION
F (1) 5/8"SH, (1) 7/8"EL, (1) 3/4"SH
H (2) 5/8" SH, (1) 5/8" SL
J (1) 5/8"SH, (1) 5/8"SL, (1) 7/8"SH
K (2) 7/8" SH, (1) 7/8" EL
M (1) 1-1/4" Master Link
N (12) 1/2" SH, (1) 5/8" SL
O (1) 5/8" SH
SH = Shackle
SL = Sling Link
SS = Stainless Steel
EL = End Link
700 m 5/16" JacNil Wire Rope [S/N 6194–9]
Note B
x m 1/2" Trawler Chain
3 m 1/2" Trawler Chain
(2) 17" Glass Balls mounted on 4 m 1/2" Trawler chain, (1 SET);
12 x
(4) 17" Glass Balls mounted on 4 m 1/2" Trawler chain, (12 SETS)
3 m 1/2" Trawler Chain
Dual EGG Releases with 1/2" Dualing Chain
Pullout Chain
Bottom Pressure Recorder
3800 lb Ww Anchor
Water Depth 3821 m
BEAUFORT GYRE FRESHWATER EXPERIMENT
BGFE 2007 Turnaround
Mooring "B"
Woods Hole Oceanographic Institution
designed by John Kemp & drawn by Betsey Doherty
file: BGFE 2007
date: 06/27/2007


ICE
64" 2500 lb Syntactic Sphere with Acoustic Transponder/Ice Sonar
Depth 46 m
Note A
1 m 1/2" Trawler Chain
3 ton Miller Swivel
Transponder on Strongback
Depth 50 m
Bumper Stop
1995 m 5/16" JacNil Wire Rope [S/N 6194-2]
Note A
Mooring will be deployed anchor first using a Traction Winch.
PROFILE AREA
MMP
Profiling Depth Interval 50.4 m – 2050.4 m
Note B
Do not fabricate. Final adjustment to this shot required after measurement at Otis
HARDWARE REQUIRED per mooring, without spares
(12) 1/2" Anchor Shackles
(47) 5/8" Anchor Shackles
(1) 3/4" Anchor Shackles
(2) 7/8" Anchor Shackles
(23) 5/8" Sling Links
(1) 1-1/4" Master Link
(2) 7/8" End Link
Bumper Stop
1000 m 5/16" JacNil Wire Rope [S/N 6194-7]
Sediment Trap with (6 ea.) 1/2" T.C. Bridles
1 m 1/2" Trawler Chain
HARDWARE DESIGNATION
(F) (1) 5/8"SH, (1) 7/8"EL, (1) 3/4"SH
(H) (2) 5/8" SH, (1) 5/8" SL
(J) (1) 5/8"SH, (1) 5/8"SL, (1) 7/8"SH
(K) (2) 7/8" SH, (1) 7/8" EL
(M) (1) 1-1/4" Master Link
(N) (12) 1/2" SH, (1) 5/8" SL
(O) (1) 5/8" SH
600 m 5/16" JacNil Wire Rope [S/N 6194-12]
Note B
x m 1/2" Trawler Chain
3 m 1/2" Trawler Chain
12 x
(2) 17" Glass Balls mounted on 4 m 1/2" Trawler chain, (1 SET);
(4) 17" Glass Balls mounted on 4 m 1/2" Trawler chain, (12 SETS)
3 m 1/2" Trawler Chain
SH = Shackle
SL = Sling Link
SS = Stainless Steel
EL = End Link
Dual EGG Releases with 1/2" Dualing Chain
Pullout Chain
Bottom Pressure Recorder
3800 lb Ww Anchor
Water Depth 3722 m
BEAUFORT GYRE FRESHWATER EXPERIMENT
BGFE 2007 Turnaround
Mooring "C"
Woods Hole Oceanographic Institution
designed by John Kemp & drawn by Betsey Doherty
file: BGFE 2007
date: 06/27/2007


ICE
Depth 46 m
64" 2500 lb Syntactic Sphere with Acoustic Transponder/Ice Sonar
Note A
1 m 1/2" Trawler Chain
3 ton Miller Swivel
Transponder on Strongback
Depth 50 m
Bumper Stop
Note A
Mooring will be deployed anchor first using a Traction Winch.
1995 m 5/16" JacNil Wire Rope S/N 5220-1
Note B
Do not fabricate. Final adjustment to this shot required after measurement at Otis
PROFILE AREA
MMP on Strongback
Profiling Depth Interval 50.4 m – 2050.4 m
HARDWARE REQUIRED per mooring, without spares
(45) 5/8" Anchor Shackles
(1) 3/4" Anchor Shackles
(2) 7/8" Anchor Shackles
(22) 5/8" Sling Links
(1) 1-1/4" Master Link
(2) 7/8" End Link
Bumper Stop
500 m 5/16" JacNil Wire Rope S/N 5220-13
500 m 5/16" JacNil Wire Rope S/N 5220-14
HARDWARE DESIGNATION
F (1) 5/8"SH, (1) 7/8"EL, (1) 3/4"SH
H (2) 5/8"SH, (1) 5/8"SL
J (1) 5/8"SH, (1) 5/8"SL, (1) 7/8"SH
K (2) 7/8"SH, (1) 7/8"EL
M (1) 1-1/4"Master Link
N (12) 1/2"SH, (2) 5/8"SL
O (1) 5/8"SH
300 m 5/16" JacNil Wire Rope S/N 5220-15
Note B
34 m 5/16" JacNil Wire Rope
3 m 1/2" Trawler Chain
11 x
4 – 17" Glass Balls mounted on 4 meters of 1/2" Trawler chain, (12 Sets)
3 m 1/2" Trawler Chain
Dual EGG Releases with 1/2" Dualing Chain
SH = Shackle
SL = Sling Link
SS = Stainless Steel
EL = End Link
Pullout Chain
Bottom Pressure Recorder
3800 lb Ww Anchor
Water Depth 3450 m
BEAUFORT GYRE FRESHWATER EXPERIMENT
BGFE 2006 Turnaround
Mooring "D"
Woods Hole Oceanographic Institution
designed by John Kemp & drawn by Betsey Doherty
file: BGFE 2006
date: 07/27/2006

CABOS Recovered Mooring: