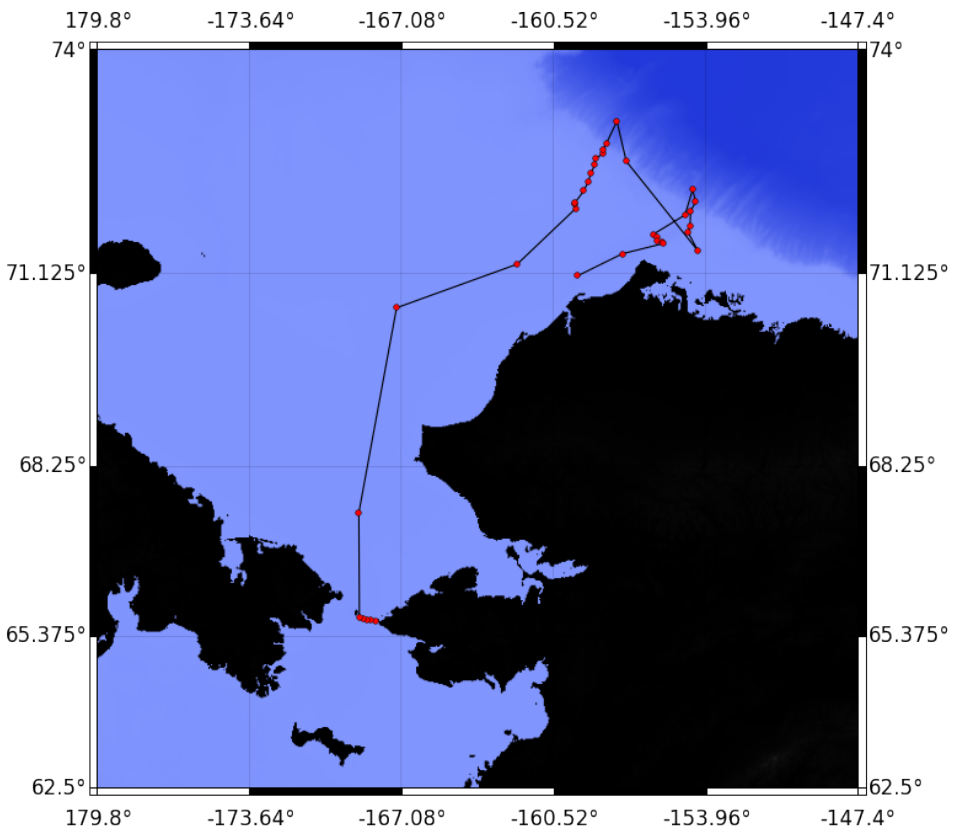
CRUISE REPORT: HLY0402

(Updated MAR 2014)



HIGHLIGHTS

CRUISE SUMMARY INFORMATION

WOCE Section Designation	**HLY0402**
Expedition designation (ExpoCodes)	**32H120040515**
Chief Scientists	**Jacqueline Grebmeier / UTenn**
Dates	2004 MAY 15 to 2004 JUN 23
Ship	*USCGC HEALY*
Ports of call	Nome, Alaska to Nome, Alaska
Geographic Boundaries	73° 8' 7" N 168° 54' 39" W 154° 18' 6" W 65° 39' 13" N
Stations	35 CTD/rosette stations; 11 XCTD stations
Floats and drifters deployed	0
Moorings deployed or recovered	0

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LINKS TO SELECT TOPICS

Shaded sections are not relevant to this cruise or were not available when this report was compiled.

Cruise Summary Information	Hydrographic Measurements
Description of Scientific Program	**CTD Data:**
Geographic Boundaries	Acquisition
Cruise Track (Figure): PI CCHDO	Processing
Description of Stations	Calibration
Description of Parameters Sampled	Temperature Pressure
Bottle Depth Distributions (Figure)	Salinities Oxygens
Floats and Drifters Deployed	**Bottle Data**
Moorings Deployed or Recovered	Salinity
	Oxygen
Principal Investigators	Nutrients
Cruise Participants	Carbon System Parameters
	CFCs
Problems and Goals Not Achieved	Helium / Tritium
Other Incidents of Note	Radiocarbon
Underway Data Information	**References**
Navigation Bathymetry	
Acoustic Doppler Current Profiler (ADCP)	
Thermosalinograph	
XBT and/or XCTD	
Meteorological Observations	**Acknowledgments**
Atmospheric Chemistry Data	
Data Processing Notes	

SBI HLY-04-02 Final Cruise Report

Final Report: Western Arctic Shelf-Basin Interactions (SBI) Spring Cruise HLY-04-02 (15 May-23 June 2004)

Edited by Jackie Grebmeier, Chief Scientist
University of Tennessee, Knoxville, TN 37932 USA;
email: jgrebmei@utk.edu

A. Introduction

The 2004 oceanographic field phase of the Western Arctic Shelf-Basin Interactions (SBI) project began on the USCGC Healy icebreaker on 15 May 2004. There are 18 research projects included in the ship-based program, ranging from hydrographic measurements to biochemical tracers and biological studies of various trophic levels. The goal of the SBI global change project is to investigate the production, transformation and fate of carbon at the shelf-slope interface in the Arctic as a prelude to understanding the impacts of a potential warming of the Arctic. We worked initially in ice-free stations on the southern Chukchi Sea shelf (Herald Valley [HV] transect), then moved into very heavy ice cover in the Chukchi outer shelf to Arctic Basin line (East Hanna Shoal [EHS] transect line). We terminated the EHS line at 2500m and proceeded SE past Barrow to occupy the East Barrow (EB) line. Extremely heavy ice precluded our occupation of the EB line and we moved over to the Barrow Canyon (BC) line via a shortened transect north of Smith Bay (SB) line in the nearshore Beaufort Sea.

The SBI project is an interdisciplinary program, where physical, biogeochemical and biological measurements are being made using a variety of sampling devices. CTD/rosette sampling collected physical and hydrochemical samples. Thirty-five stations were occupied during this cruise, with an additional 11 XCTD and 4 Video Plankton Recorder deployments. A total of 48 scientists from nineteen institutions in the United States, Bermuda, Canada, and Japan participated in this interdisciplinary scientific endeavor. In addition, a two-person BBC film crew joined us on June 11. Although an Alaskan community participant was scheduled to participate in the cruise, circumstances on land precluded that person joining the spring cruise.

In our sampling, we used a CTD/rosette system for collecting physical and hydrochemical samples. Subsamples from multiple CTD/rosette casts were used for primary production, chlorophyll content, nutrients, particulate carbon, inorganic carbon, biomarkers, microzooplankton, and radioisotopes. Various nets (vertical, bongo, multi-net) were used to collect size fractions of micro-macro- and meso-zooplankton for both population and experimental purposes. Benthic grabs and cores were used to collect benthic fauna and sediment samples for population, community structure, food web, chemistry and metabolism studies. In-situ pumps were also used to measure the activities of the particle-reactive radionuclide thorium-234.

Off-ship sampling by lowering personnel to the ice occurred to undertake ice measurements and to collect ice cores. Floating sediment traps were deployed and moored to an ice flow for 12-24 hrs. Limited helicopter operations were used for ice reconnaissance, river sampling and port logistics.

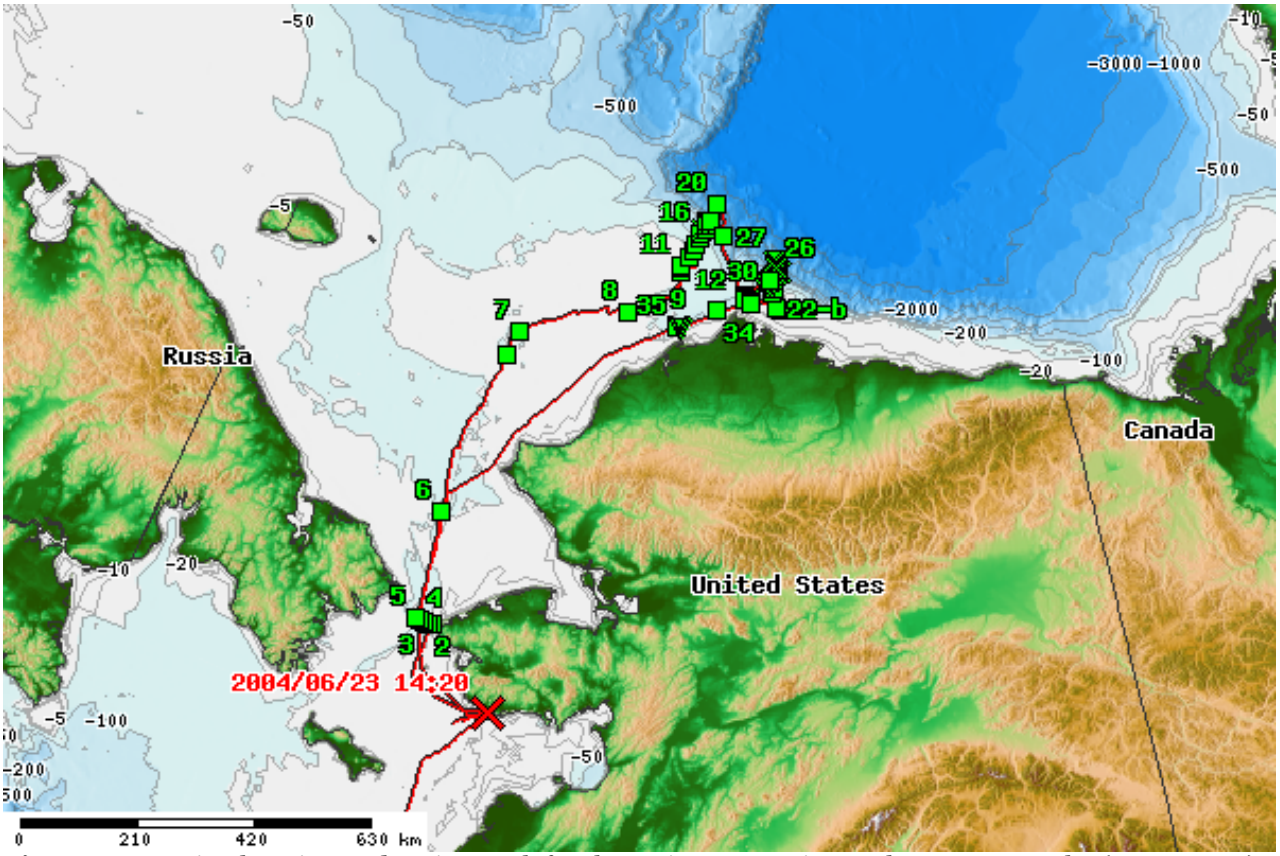

Figure 1. *Station location and cruise track for the spring SBI cruise on the USCGC Healy (HLY-04-02). Due to heavy ice conditions sampling was limited to the Chukchi Sea shelf, East Hanna Shoal (EHS) west line and Barrow Canyon (BC) east line).*

During the cruise, ice conditions were the main limiting factor for occupying only about half of the 5 transect lines outlined in the HLY-04-02 cruise plan. Heavy ice over the outer shelf of the Chukchi Sea made it slow going on the East Hanna Shoal (EHS) line, basically keeping the ship at a slow pace until the upper slope. We were in heavy ice past Icy Cape, only pulling into the northern limits of an open lead moving east past Barrow. The other factor to be resolved during the cruise was limitation on the availability of ambient seawater due to heavy ice conditions. The new USCG science seawater system (SSW) clogged in heavy ice, thus we reverted to the 2002 solution of filling and using the forcastle ballast tank. The USCG engineering division connected the SSW system to the E-O-W forward ballast tank and this tank was connected to the bow incubators through a spigot tree and hoses. When the seawater in the ballast tank warmed up due to daily heating, science requested a dumping of the water in transit and a subsequent refill on station, which occurred using SSW. This situation especially occurred on sunny days, and the "dump and pump" technique became standard operations between stations. As the amount of open water in ice increased, engineering rigged a fitting directly to the SSW system so that the ballast tank could be filled in transit. Note that keeping the tank at 30,000 gallons kept the water below the seawater line and thus cooled by the seawater surrounding the hull. It is anticipated that the summer cruise will be able to directly use the SSW system without the ballast tank support. Further information on the ambient seawater bow system is included in Appendix A.

The Joint Office of Science Support (JOSS) group of the University Corporation for Atmospheric Research group maintained a shipboard field catalog during the cruise that provided real-time data to scientists on the ship, which was mirrored to a land-based system in Colorado. The JOSS site incorporated all the service group datasets and preliminary analyses and acted as an instrument whereby scientists could share their observations and preliminary analyses. The SBI field catalog (with maps and event information at sea) can be found on the webpage: (http://www.joss.ucar.edu/sbi/catalog/). Full details on the SBI project, the field cruise program and results to date can be found on the SBI webpage http://sbi.utk.edu and associated links on that web site. A highlight summary from the PI findings for the spring SBI cruise will be posted on the SBI and JOSS webpages.

We were fortunate to have Patty Cie, a Yelm Middle School teacher from Washington State, onboard the Healy during the spring SBI cruise who provided daily updates on research and ship operations, including spotlights on individual research groups, explained in layperson's terms. She was sponsored through the NSF Research Experience for Teachers (RET) funding to Dr. Ken Dunton at the Marine Science Institute of the University of Texas at Port Aransas. These daily updates are accessible through the website and are linked to the SBI website (http://sbi.utk.edu/). While aboard the cruise, she also served as a team member with the Dunton/Schonberg food web sampling team. Outreach activities during the cruise included two INMARSAT telephone -aided Powerpoint presentations of cruise activities to her local Yelm school and via web connections through the ARCUS TREC program to schools both in Washington and Vermont.

The Captain, officers and crew of the USCGC Healy provided outstanding support that was essential to the success of the cruise goals. We appreciated the continued, professional support provided by Captain Dan Oliver, Operations Officer Daryl Peloquin, Executive Officer Bill Rall, Engineering Officer Greg Stanlick and Master Chief Navigator Joe Gispert. Valuable support for science was provided by the lead Marine Science Technicians Glen Hendrickson and Don Snider, and the other Marine Science Technicians (Suzanne Scriven, Chad Klinesteker, Eric Rocklage, and Josh Robinson), along with the Science Officer Neal Amaral. The Aviation Detachment under the direction of Ed Beale provided essential logistical support for ice surveys and limited science operations. In Nome and in Barrow, Andy Heiberg of the University of Washington made himself indispensable to meeting the logistical needs of the project as a whole. Also, in Barrow, we are grateful for the assistance of the Barrow Arctic Sciences Consortium (BASC), including Matt Irinaga and Glenn Sheehan, for their liaison activities with the Alaska Eskimo Whaling Commission, and for assisting us logistically in the transfer of personnel, equipment and samples to and from the ship. This work was financially supported by the U.S. National Science Foundation, the Office of Naval Research, and the U.S. Coast Guard.

C. Summary of Science Reports

Stations occupied during HLY-04-02 were on the Chukchi Sea shelf (HV transect), the Chukchi outer shelf to Arctic Basin lines (East Hanna Shoal: EHS transect), stations near Pt. Barrow, and the Barrow Canyon (BC) line. Table 1 provides a general summary of station location, target depth, and station duration during the cruise. Note that there is an interactive table with links to station maps and event logs for each station on the JOSS SBI webpage <http://www.joss.ucar.edu/sbi/catalog_hly-04-02/index.html>.

The following science summaries include sampling collection information and preliminary findings. There are also two appendices: Appendix A is the summary of the ballast tank procedures developed during the cruise and Appendix B is as report on the Healy science system. The complete SBI hydrographic service team final report can be found on the JOSS SBI website as a separate document in the shipboard reports section <http://www.joss.ucar.edu/sbi/catalog_hly-04-02/index.html>.

The following sequence provides a generic outline of the events undertaken at process stations. Modifications in sequence were made depending on arrival time to station and PI needs.

Event No.	Event
1	Ice team deployment
2	Sediment trap deployment
3	CTD-service cast (shallow and deep, depending on station depth)
4	Zooplankton hauls: ring nets (vertical and oblique)
5	CTD-productivity cast
6	Optics: active and passive, sometimes also surface optics
7	CTD-biomarkers
8	Video plankton recorder
9	CTD-zooplankton (every 2 days) coincident with 4 vs 2 zoop hauls
10	Bongo or multi-net
11	CTD-radium casts
12	Multi-corer
13	van Veen grabs
14	Multi-HAPS corer
15	Dredge

Station Summary

Station No. (Password Protected On Land)	Date	Time (Utc)	Latitude (N)	Longitude (W)	Depth (M)	Duration (Hrs)
HLY-04-02-001(BRS1)	05/17/04	20:51	65.673	-168.212	42m	0.6 hrs
HLY-04-02-002(BRS2)	05/17/04	23:00	65.678	-168.391	51 m	0.5 hrs
HLY-04-02-003(BRS3)	05/18/04	01:13	65.667	-168.553	53 m	1.8 hrs
HLY-04-02-004(BRS4)	05/18/04	04:16	65.682	-168.731	51 m	0.4 hrs
HLY-04-02-005(BRS5)	05/18/04	05:38	65.705	-168.883	50 m	0.3 hrs
HLY-04-02-006(HV1)	05/18/04	16:55	67.490	-168.928	50 m	21.2 hrs
Cota-2004_05-20-1	05/20/04	22:46	70.221	-167.635	51 m	0.2 hrs
HLY-04-02-007(HV2)	05/21/04	08:56	70.641	-167.288	56 m	11.7 hrs
HLY-04-02-008(productivity)	05/22/04	16:35	71.256	-162.089	47 m	2.2 hrs
HLY-04-02-009(EHS0)	05/24/04	15:55	72.007	-159.569	45 m	18.4 hrs
HLY-04-02-010(EHS0.5)	05/26/04	19:14	72.079	-159.590	48 m	16.3 hrs
HLY-04-02-011(productivity)	05/27/04	15:36	72.090	-159.583	48 m	1.5 hrs
HLY-04-02-012(EHS1)	05/28/04	07:52	72.244	-159.203	51 m	0.7 hrs
HLY-04-02-013(EHS2)	05/28/04	18:50	72.365	-159.006	52 m	4.9 hrs
HLY-04-02-014(EHS3)	05/29/04	13:15	72.479	-158.883	54 m	1.0 hrs
HLY-04-02-015(EHS3.1)	05/30/04	00:20	72.580	-158.741	74 m	0.9 hrs
HLY-04-02-016(EHS4)	05/30/04	09:22	72.637	-158.677	153 m	20.8 hrs
HLY-04-02-XCTD_01	05/31/04	12:42	72.726	-158.588	225 m	-
HLY-04-02-017(EHS5)	05/31/04	20:49	72.719	-158.401	247 m	19.1 hrs
HLY-04-02-018(EHS5.1)	06/01/04	19:15	72.774	-158.396	295 m	1.4 hrs
HLY-04-02-XCTD_02 (EHS5.2)	06/02/04	15:59	72.825	-158.271	410 m	-
HLY-04-02-VPR_01 (EHS5.2)	06/02/04	16:27	72.826	-158.274	~410 m	0.2 hrs
HLY-04-02-019(EHS6)	06/02/04	22:15	72.852	-158.207	689 m	27.0 hrs
HLY-04-02-020(EHS9)	06/04/04	16:28	73.134	-157.792	2400 m	23.0 hrs
HLY-04-02-021(EHSX)	06/06/04	14:23	72.629	-157.390	398 m	5.7 hrs
HLY-04-02-022(SB1)	06/08/04	16:38	71.439	-154.298	28 m	8.8 hrs
HLY-04-02-022-b(SB1)	06/10/04	18:05	71.465	-154.550	34 m	1.4 hrs
HLY-04-02-023(SB4)	06/11/04	20:47	71.691	-154.725	74 m	9.6 hrs
HLY-04-02-024(SB5)	06/12/04	12:46	71.776	-154.626	145 m	18.7 hrs
HLY-04-02-XCTD_03	06/13/04	09:17	71.821	-155.161	216 m	-
HLY-04-02-XCTD_04	06/13/04	10:37	71.868	-155.038	243 m	-
HLY-04-02-XCTD_05	06/13/04	12:35	71.918	-154.803	375 m	-
HLY-04-02-XCTD_06	06/13/04	13:48	71.969	-154.613	332 m	-
HLY-04-02-025(productivity)	06/13/04	14:15	71.975	-154.613	578 m	1.0 hrs
HLY-04-02-XCTD_07	06/13/04	16:44	72.016	-154.484	631 m	-
HLY-04-02-XCTD_08	06/13/04	19:16	72.063	-154.305	1396 m	-
HLY-04-02-026(BC5)	06/13/04	22:07	72.096	-154.370	1184 m	20.4 hrs
HLY-04-02-027(BC6)	06/15/04	07:31	72.252	-154.488	1898 m	17.4 hrs
HLY-04-02-XCTD_09	06/16/04	03:50	72.216	-154.554	~1500 m	-
HLY-04-02-XCTD_10	06/16/04	05:10	72.167	-154.520	~1500 m	-
HLY-04-02-XCTD_11	06/16/04	05:59	72.121	-154.524	~1500 m	-
HLY-04-02-028(BC4)	06/16/04	15:37	71.921	-154.867	545 m	32.6 hrs
HLY-04-02-029(BC3.1)	06/18/04	13:46	71.666	-156.204	~100 m	4.8 hrs
HLY-04-02-030(BC3.2)	06/18/04	19:20	71.625	-156.118	159 m	1.4 hrs
HLY-04-02-031(BC3)	06/19/04	02:24	71.583	-156.132	178 m	26.2 hrs
HLY-04-02-032(BC3.4)	06/20/04	06:03	71.548	-155.858	202 m	2.2 hrs
HLY-04-02-033(BC3.5)	06/20/04	08:53	71.532	-155.812	109 m	0.9 hrs
HLY-04-02-034(BC2)	06/20/04	15:53	71.397	-157.588	120 m	15.6 hrs
HLY-04-02-035(BC1)	06/21/04	12:50	71.085	-159.526	158 m	4.0 hrs
HLY-04-02-VPR_02 BC1.4)	06/21/04	18:40	71.044	-159.332	72 m	0.1 hrs
HLY-04-02-VPR_03 (BC1.2)	06/21/04	19:30	71.104	-159.517	68 m	0.1 hrs

Note: time, latitude, longitude and depth are for the start time of each station.

PI Reports (by sequence of events during standard process station):

1a. Service Hydrography Measurements

PI: Jim Swift, Dean Stockwell (both onboard), Andreas Muenchow (ADCP);
on board team members: Doug Masten, Robert Palomares, Kristin Sanborn, Dan Schuller, Jennifer Sheldon, Dave Huntley, and Dean Stockwell

The SBI Service Measurement Program was represented on HLY0402 by David Huntley (University of Delaware) working on ADCP, Dean Stockwell (University of Alaska, Fairbanks) working on chlorophyll and other pigments, and a six person group from the UCSD Scripps Institution of Oceanography working on CTD/rosette casts and salinity, dissolved oxygen, and nutrient analyses. The six persons were Doug Masten, Robert Palomares, Kristin Sanborn, Dan Schuller, Jennifer Sheldon, and James Swift. This report covers the activities of the SIO group.

The HLY0402 CTD package included a SeaBird 911+ CTD with dual conductivity and temperature sensors, an SBE43 dissolved oxygen probe, a fluorometer, a transmissometer, a Haardt fluorometer, a PAR sensor, and an altimeter. A SeaBird Carrousel was used to control closure of 12 30-liter Niskin bottles. The CTD operator sat next to the CTD winch operator, and also had visual access to the starboard staging bay (rosette room) and starboard A-frame launch area. This was a nearly ideal arrangement and it worked very well.

Except for the last two sites occupied during HLY0402, which were Video Plankton Recorder-only stations, and a handful of XCTD profiles collected underway, the CTD package was used at every station, with from 1-8 CTD casts per station. During a long mid-cruise traverse the CTD/rosette package received service, during which 6 springs were replaced due to rust developing on ends, and 12 end cap O-rings were replaced due to wear damage. Although all of the 30-liter bottles appeared to be in excellent condition, on most HLY0402 casts a good seal failed to develop on one bottle (typically), resulting in a leaking bottle. These were due in almost every case to a portion of an O-ring slipping from its groove. In every case the suspect O-ring was inspected, and replaced if necessary. In general a different bottle then leaked. Full inspections were frequent, and at least twice during the cruise all O-rings were. Care was used to measure O-rings to locate those least likely to slip out, but to no avail. This was the only notable deficiency in the hydrographic measurements program. Because no solution was found, it bears further thought and effort before the next SBI cruise with this package.

The Healy's Guildline AutoSal salinometer was used to analyze salinity samples. The salinometer ran fine. Bottle salt data quality was excellent, exceeding SBI data quality specifications.

An ODF oxygen autotitrator was used to run bottle oxygen samples from SBI productivity and service casts. The system ran well, with very few overtitrations or backtitrations. Oxygen data quality was excellent, exceeding SBI data quality specifications.

A six-channel nutrient autoanalyzer was used to analyze samples, including those from the main SBI stations as well as ancillary samples from 5 different shipboard science groups. The autoanalyzer ran well. Nutrient data quality was excellent, exceeding SBI data quality specifications.

Data processing went very well, with both CTD post-cast processing and bottle data examination up to date at nearly all times during the cruise. The placement of the CTD sensors and the design of the rosette as compared to 2002 yielded noticeably cleaner CTD profiles. Also, the winch speed controls were much smoother than in 2002, causing profiles with less "shed-wakes". WHP-Exchange format CTD and bottle data files were updated daily. Additionally, bottle data reports, available for each station and updated as

needed, provided both a quick tabular look at the data for each cast and an easy-to-use format for examining the data comments. (The data comments form the basis for assignment of data quality codes other than that for "good value".) Standardized CTD plots were generated for each profile and made available. All data, including raw values and comments, are archived by ODF.

Samples for pigment analyses were drawn from a subset of the rosette bottles at service casts and producitivity casts. The samples were analyzed on board by Dr. Dean Stockwell from the University of Alaska Fairbanks. Six to eight depths per cast were sampled and processed. In addition, samples were processed from some bio-optical stations and for Dr. David Kirchman. Data entry into the JOSS data server followed after quality control checks on spreadsheet information were concluded.

Interpretative activities related to the CTD/hydrographic data focused on preparation and distribution of short reports on HLY0402 observations. The titles of the .pdf versions:

Diomede_staplots_allyears.pdf
EHS_2002vs2003_discuss.pdf
East_Hanna_Shoals_discuss.pdf
HLY0402_22to26_discuss.pdf
HLY0402_22to27_CTDdiscuss.pdf
HLY0402_22to27_halocline.pdf
HLY0402_BC_discuss.pdf
HLY0402_BC3_CTDdiscuss.pdf
HLY0402_BeringStrCTD.pdf
HLY0402_CTD_27_28_discuss.pdf
HLY0402_CTD_27_discuss.pdf
HLY0402_CTD_TvsS_note.pdf
HLY0402_sta16CTDdiscuss.pdf
HLY0402_sta24and26_discuss.pdf
HV02_botdata_comparison.pdf
SBI_brinewaters_note.pdf
ShelfBottomCircNote.pdf
SummerWaterDiscuss.ppt

In general, hydrographic characteristics observed during HYL0402 are similar to those observed during the HLY0201 spring cruise, which took place at about the same time of year. There is a sense in the data that the winter shelf waters in 2004 are slightly less saline, and hence slightly less dense, than in 2002. Nutrient distributions versus salinity on the East Hanna Shoals section in 2004 were nearly the same as in 2002, though the vertical sections reveal a stronger sense of shelf-slope similarity (or connection) in 2004 than in 2002. One should recall, however, that the slope waters could be fed from the Herald Valley outflow, west of the section, and may not necessarily have "slid off the shelf". Thus the similarity may be coincidental. [Preliminary ADCP velocities in the layer just above (from Andreas Munchow) do, however, suggest off-shelf flow.] Halocline waters on the section just east of Barrow Canyon showed a major intrusion of better oxygenated, lower nutrient waters, splitting the low-oxygen, high-nutrient halocline waters into two layers. A somewhat similar feature was seen in the HLY0201 data, suggesting that this represents annual post-winter injection of new halocline waters into the slope region. The water mass structure in the outer Barrow Canyon region showed influences of both older and younger halocline waters. In mid- and upper-Barrow Canyon, the colder, higher-oxygen waters dominated, consistent with a view that there is outflow of the colder upper-canyon waters into the mouth of the canyon, where they mix with the warmer, lower-oxygen layers. These are highly preliminary observations and can be expected to change when more time is available to study the data.

The full SBI service final documentation is provided in Appendix A of this cruise report as well as can be found on the SBI JOSS website http://www.joss.ucar.edu/sbi/catalog_hly-04-02/index.html.

1b. ADCP

PI: Andreas Muenchow;
onboard team member: David A. Huntley, University of Delaware. ADCP

Introduction

The USCGC Healy has two acoustic Doppler current profilers (ADCP) mounted in its hull. One is an Ocean Surveyor 75 kHz phased-array system (OS75) and the other is a Broadband 153 kHz discrete-array system (BB153). Both systems are up and running, although the BB153 system is still being vetted to ascertain it's data collection reliability. The OS75 is functioning in both the broadband and narrowband modes. Both the OS75 and BB153 systems integrate acoustic data with the ship's gyro, the aft P-code Trimble Centurion GPS and the Ashtech attitude GPS data. All data are collected onto the local computer and then manually transferred to the archiving computer (SNAP1) for both systems.

The only change in system operation since the 2004 shakedown cruise was the installation of a new data/power cable connecting the BB153 transducer assembly to that unit's deck box. The success of that installation will be reported in a future system report.

Data Collection

The BB153 is setup to collect 50 6-meter bins and bottom track to 800 meters. Blanking is set to 4 meters.

The OS75 has four distinct data collection setups. They are designed for different depth requirements as follows:

Shallow - interleaved broad- and narrow-band pings plus bottom track to 100m.
    Broadband in 15 4m bins
    Narrowband in 8 8m bins
Mid-water- narrowband only plus bottom track to 400m
    Narrowband in 50 8m bins to 340m
Mid-water 250+ - narrowband only plus bottom track to 1100m
    55 8m bins to 375m
Deep water – narrowband only but no bottom track
    55 8m bins
All OS75 configurations have 10m blanking.

Data is collected onto the local machines and then transferred 'manually' to the archive system. The operator completes this file transfer each morning around 0730 via Windows Explorer copy and paste, this leaves a copy of the file on the host computer to facilitate file number advance. The manual transfer is necessary due to a buffer overflow problem and system hang-up that occurs when VmDas attempts to automatically write to the archival system at the same time as it is collecting and writing data locally. The system hang-up and buffer overflow do not occur when this feature is disabled in VmDas.

Performance

The OS75 has performed normally for most of the cruise, so far. Both systems have been affected by vibration from ice breaking, the intermittent power outages and some system instability primarily due to the Windows operating system. The BB153 has had more system instabilities than the OS75 including system lockup that could only be corrected by "hard reboot" or disconnecting the power supply, VmDas shutdown that was traced to the optical mouse, and the system computer restarting without any user input. Both systems have had numerous "ADCPCOMM timeout" errors, however this is simply a dropped ping and if it does not stop data collection it is not an issue. Consistent NMEA buffer overflows were occurring on both systems. The problem was traced to the Ashtech GPS, which was sending data too fast (twice per second). When the output was reduced to once per second, the buffer overflow condition was corrected. The OS75 has had intermittent operating system shut down without user input. The symptom of this is a blue screen and loss of data collection. The solution has been to reboot the computer and restart data collection. No indication as to why this is occurring.

Future Recommendations

Currently the system computers and the deck units for both ADCP's are not vibration isolated. This is suspect in causing intermittent hardware shutdown. I recommend that all ADCP system parts be mounted similarly to the SDN computer system, which is vibration isolated.

Both system computers are currently running Windows 2000 and should be upgraded to Windows XP. This may help with the system instability. VmDas will run acceptably with this operating system. All unnecessary programs should be removed from the computers during install.

A method of archiving the local data should be found that is invisible to the VmDas software. The current "dual drive" system in the software package does not function well and results in data loss when the operating system shuts down.

2. Sea ice working group:

PI: Rolf Gradinger;
onboard team members: Heike Merkel, Sarah Story, and Kazu Tateyama

The sea-ice working-group investigated the magnitude and the controlling factors of sea ice algal primary production in the SBI region. Our objectives for the spring 2004 expedition included: 1) continuous under-way measurements of ice thickness with an EM31 mounted to the ship's bow, 2) standardized ice observations in two-hour intervals, 3) sea ice core analysis for physical, chemical and biological properties, and 4) measurement of properties of the under-ice water layer.

Under-way measurements

Ice observations

A total of 213 ice observations were conducted in two-hour intervals between 5/17/04 and 6/21/04. Each observation consists of a detailed evaluation of ice conditions (ice concentration, type, sediment content, occurrence of ice algae) supplemented by digital photography. Ice observations are available on-line in the SBI/JOSS catalogue.

Continuous indirect ice thickness measurements

Sea ice thickness data were collected with an electro-magnetic inductive device (EM) starting May 19 until June 20. Equipped with a laser altimeter and a GPS, mounted on the port side of the bow, this instrument

measures continuously with a frequency of 10Hz the ice thickness and concentration, which will be averaged over 1 and 10 minutes intervals. Data were recorded over a time span of 422 hours in total. The average combined ice and snow thickness was 1.68m for this expedition. These data will be compared with data collected in the same region in August 2003 by the Chinese icebreaker Xuelon and with satellite microwave data.

Measurements at ice stations

Eleven ice stations were conducted between May 21 and June 16. Ice thickness and snow depth measurements were carried our by EM and with a snow stick (Table 1). The combined distance of the survey line is 5,065 m with measurements being conducted every 5m.

For objectives 3 and 4, three to eight ice cores were taken at each station and used to determine the vertical distribution of ice temperature and salinity, POC/PON, stable isotope ratios (d13C, d15N), algal pigments, nutrient concentrations and algal species composition in relation to the permeability of the sea ice.

Ice thicknesses of the collected cores ranged between 0.7 to 2.1 m. The sea ice in the study area was dominated by first year (FYI) sea ice with bulk salinities mostly above 3 as typical for FYI. Along the EHS transect, the algal pigment concentrations varied greatly with a remarkable decrease towards the north, also supported by the ice observation record. The maximum algal pigment content of 439 μg Chl a/l occurred in the bottom layer of the first ice station, where also nutrient levels within the ice were highest. The bottom concentration at the second ice station was by a factor of 100 lower at similar ice nutrient levels. The algal pigment levels in the cores collected along the Barrow Canyon line remained low. The regional differences are related to changes in ice and snow thickness, light and latitudinal gradients. Primary production measurements were conducted at nine stations using stable isotope tracers (13C, 15N). Ice core sections (5cm thickness each) were collected in the field and centrifuged at 1200 rpm in the laboratory for porosity and permeability measurements to be conducted with X-ray tomography and a specifically developed permeameter at UAF. The sections were taken in continuous 5-cm increments for the bottommost 30 cm (6 sections) and every other section was taken for the core sections above 30 cm (another 6 sections).

Under-ice measurements

Under-ice light intensities were determined with a LICOR 4pi sensor. PAR values under the ice were between 0.1 to 20% of the incoming radiation, measured simultaneously with a 2pi sensor. Under-ice temperature and salinity gradients were assessed with a hand-held CTD system down to a water depth of 10 to 20m. We also measured under-ice currents with two current meters in close proximity to the biological coring site for later correlation of current speeds and directions to biological activity. While an Acoustic Doppler Current Profiler (ADV) was deployed close to the ice-water interface at depths between 0.50 and 1.80 meters and time intervals between 1 and 18 hours, the second current meter was deployed at a depth of 4 meters below the ice-water interface for the duration of the station. Ship positions and drift speeds were downloaded from the ship's server for adjustment of the local currents.

Table 1: *Measurements conducted during ice stations in spring 2004*

Date	Ice temp.	Ice salinity	Under-ice T/S	Under-ice currents	Light (PAR)	Algal pigments	POC/ PON	EM transect	comments
40521	x	x	x	-	x	x	x	x	FYI
40524	x	x	x	x	x	x	x	x	MYI
40526	x	x	-	-	x	x	x	x	FYI
40530	x	x	x	x	x	x	x	x	FYI
40531	x	x	x	x	x	x	x	x	FYI
40602	-	-	x	x	-	-	-	x	-
40604	x	x	x	x	x	x	x	x	FYI
40611	x	x	x	x	x	x	x	x	FYI
40612	-	-	-	-	-	-	-	-	bear encounter
40614	x	x	x	x	x	x	x	x	FYI
40616	x	x	x	x	x	x	x	x	FYI

3. Primary Production, Bio-optics, and Remote Sensing of Ocean Color

PI: Glenn Cota;
onboard sampling team: David Ruble, Victoria Hill and Xiaoju Pan

3.1 Objectives

Characterization of bio-optical properties, the development of relationships between biological properties of the water column and optical measurements. Collection of validation points for SeaWiFS and MODIS.

3.2 Observations

Measurement of primary productivity using c14 and nutrient uptake (nitrate and ammonium) experiments at 6 light depths 100%, 50%, 30%, 15%, 5%, 1%. Discrete optical measurements of absorption of particulate and soluble material, continuous profile measurements of absorption, attenuation, backscatter, upwelling radiance, and downwelling irradiance. Samples filtered for later analysis of total suspended material and pigments (HPLC). Surface measurement of incidence irradiance and surface reflectance, sunphotometer and ozone.

3.3 Progress

We experienced setup problems with the new passive optical instruments, this has been resolved, however data for the first week was unobtainable. Due to heavy ice conditions and almost continuous cloud cover there have been no validation points for SeaWiFS or MODIS.

Experimental Observations

Experimental observations have included primary production as well as nitrogen uptake. Simulated in situ deck incubations continue to be problematic. The uncontaminated seawater system has been out of service due to the ice conditions. The Coast Guard set up an alternative flow-thru system using the forward ballast tank to hold water, which is then pumped through the incubators. Temperature regulation in this system remains a challenge, warming occurring as the ballast tanks can only be filled whilst on station or in light ice conditions. Several production stations have been missed, as the ship was unable to find open water within the time window.

Date	SBI Station	Secchi (m)	HPLC	Cell counts	Primary Production	15NO3	15NH4
5/18/2004	06 HV-1	4.6	+	+	+	+	+
5/21/2004	07 HV-2	6.4	+	+	+	+	+
5/22/2004	08 Prod	6.6	+	+	+	+	+
5/24/2004	09 EHS-0	10.9	+	+	+	+	+
5/27/2004	11 prod	7.2	+	+	+	+	+
6/01/2004	17 EHS-5	17.5	+	+	+	+	+
6/03/2004	19 EHS-6	20.5	+	+	+	+	+
6/04/2004	20 EHS-7	32.5	+	+	+	+	+
6/08/2004	22 SB-1	12.9	+	+	+	+	+
6/12/2004	24 SB-5	7.7	+	+	+	+	+
6/13/2004	25 Prod	8.9	+	+	+	+	+
6/14/2004	26 BC-5	8	+	+	+	+	+
6/15/2004	27 BC-6	15.3	+	+	+	+	+
6/16/2004	28 BC-4	8.7	+	+	+	+	+
6/18/2004	29 BC-3.1	8.1	+	+	+	+	+
6/19/2004	31 BC-3	7.8	+	+	+	+	+
6/20/2004	34 BC-2	7.9	+	+	+	+	+

Phytoplankton pigment (HPLC) and cell count sample samples have been collected from the surface and the subsurface chlorophyll maximum at experimental and optical stations. At several stations samples were also filtered through a 5um pore size in addition to the usual 0.7um to provide size fractionated HPLC data. At Barrow Canyon, deep chlorophyll peaks at ~100-150m were found these were also sampled for HPLC and cell counts.

Optical Observations

Active optical observations have been very successful, with data also collected at times when experimental stations were unobtainable. Discrete absorption spectra of particulate and soluble material have been made to compare with the active profiles. Passive optics measurements at four stations were missed due to instrumentation problems.. This has included surface optics (SO) and passive optics profiles (PO), these problems have now been solved and it is hoped that the high spectral resolution data now available will yield interesting results. Few SO observations have been made due to $10/10^{th}$ ice cover or wrong ship – sun alignment.

				SfcOpt	Sun	PassOpt	ActOpt	ActOpt
ORCA Station #	SBI Station #	Secchi depth	Water Depth	SAS	Micro Tops	Pro/Ref	AC9	HS6
200405181	06 HV-1	4.6	51				+	+
200405201	06.5 bio-opt.		50				+	+
200405211	07 HV-2	6.4	50				+	+
200405221	08 Prod	6.6	47			+	+	+
200405241	09 EHS-0	10.9	45			+	+	+
200405261	10 EHS-0.5		49		+	+	+	+
200405271	11 Prod	7.2	47					
200405281	13 EHS-2		52			+	+	+
200405301	16 EHS-4	12.2	164			+	+	+
200406011	17 EHS-5	17.5	243	+		+	+	+

200406031	19 EHS-6	20.5	1379			+	+	+
200406041	20 EHS-7	32.5	2386		+	+	+	+
200406081	22 SB-1	12.9	39.1	+	+	+	+	+
200406111	23 SB-4	7.0	75.3	+	+	+	+	+
200406121	24 SB-5	7.7	167		+	+	+	+
200406131	25 Prod	8.9	577					
200406141	26 BC-5	8	1122		+	+	+	+
200406151	27 BC-6	15.3	1656	+	+	+	+	+
200406161	28 BC-4	8.7	545				+	+
200406162	28 BC-4		583	+	+	+		
200406181	29 BC-3.1	8.1	106			+	+	+
200406191	31 BC-3	7.8	142					
200406201	34 BC-2	7.9	122	+		+	+	+
200406211	35 BC-1		70				+	+

Additional Sunphotometer readings (done at times other than a prod or bio-optics station)

Station	Ship Station	McrTops	Station	Ship Station	McrTops
20040524A	09 EHS-0	+			
20040601A	18 EHS-5.5	+	20040614A	26 BC-5	+
20040605A	underway	+	20040614B	Underway	+
20040609A	underway	+	20040614C	underway	+
20040610A	beset in ice	+	20040615A	27 BC-6	+
20040610B	beset in ice	+	20040615B	27 BC-6	+
20040611A	23 SB-4	+	20040615C	27 BC-6	+
20040612A	24 SB-5	+	20040616A	28 BC-4	+
20040612B	24 SB-5	+	20040616B	28 BC-4	+
20040613A	26 BC-5	+	20040617A	28 BC-4	+
20040613B	26 BC-5	+	20040618A	Underway	+

Specialty experiments

Several experiments have been run to characterize the optical properties of arctic sediment and also material that is trapped in "dirty ice". A sediment re-suspension tank has been used in which the active optics package was placed, additions of material were then made. In this way absorption, attenuation, scattering and backscattering can be observed.

4. Carbon and Nitrogen Cycling Group

PIs: Nick Bates and Dennis Hansell;
on-board team members: Christine Pequignet and Jeremy Mathis

The group we sampled 32 stations, ie. every service casts. This represents 320 samples for DIC, Total Alk., DOC/DON, and POC/PON. The goal was to process all 37 service casts, so I guess we did it. DIC and Alk are sampled in 250ml bottles, preserved with mercuric chloride and will be analyzed in Bermuda. POC samples are filtered from 1 to 3 liters of water through a GF/F filters, which will be processed in Bermuda. 60ml DOC samples are filtered at the rosette, and stored frozen to be processed in Miami.

5. Heterotrophic Prokaryotes

PI: Dave Kirchman;
at sea support: Rex Malmstrom

Project Objectives

The objectives of this project are: 1) to estimate rates of net community production and respiration; 2) to examine the flux of dissolved organic material (DOM) through the microbial loop by estimating biomass and biomass production and respiration of heterotrophic prokaryotes; 3) to determine the phylogenetic composition of the prokaryotic communities; and 4) to examine the use of DOM components by select prokaryotic groups.

Samples collected

Profiles of prokaryotic biomass, biomass production, and community structure: 17
Profiles coupled with primary production measurements: 14
Net oxygen and respiration measurements: 26
Experiments to examine DOM use: 4

Preliminary results

Standing stocks of heterotrophic prokaryotes and rates of prokaryotic biomass production (mainly bacteria) appear to be lower than what was observed for the same season in 2002. Prokaryotic production seems to be also lower at the deep stations (>500 m) than on the shelf, and tended to be higher at the chlorophyll (fluorescence) maximum when present. Net community (oxygen) production was generally high, especially relative to community respiration.

Experiments were conducted in collaboration with Rachael Rearick (Rodger Harvey lab) to examine use of ice-rafted debris, algal detritus and peat by prokaryotic assemblages. Prokaryotic growth (leucine incorporation and changes in prokaryotic abundance over time) was used as a bioassay for the lability of organic material in the three treatments. Not surprising, prokaryotic growth was higher with the addition of the ice-rafted debris and algal detritus than in a no-addition control. What was surprising was the stimulation of prokaryotic growth in the peat-amended treatment, although the response was lower than in the other two treatments.

Additional experiments were conducted in collaboration with Ron Benner to examine the microbial response to and degradation of DOM in Ikpikpuk River water. As with the experiment described above, prokaryotic growth was used as a bioassay for the lability of riverine DOM and was compared with changes in concentrations of inorganic nutrients and various DOM components. Although expected to be dominated by refractory compounds, nevertheless, riverine DOM stimulated bacterial growth by several fold over a control receiving distilled water.

6. Dissolved Organic Carbon

PI: Ron Benner;
team member Richard Daw

Project objectives

Our primary objective is to characterize the origins, transformations and fates of dissolved organic matter (DOM) in the SBI study region. Within this broad objective, we will determine the abundances and distributuions of terrigenous and marine DOM and characterize their biological reactivies. We will explore the export of DOM from shelves to the Canada Basin and it's fate in basin waters.

Samples and data collected

A list of the samples collected to date is shown in Table 1. In addition to these samples, we are collecting data on every CTD cast with a flash fluorometer that provides a measure of the chromophoric component of DOM (CDOM).

Results to date

The CTD and fluorometer data indicate a brine layer at the bottom at most of the shelf stations. This indicates 2004 is a year of halocline renewal.

Table 1: *Benner - HLY-04-02 Sample Log (May 17 to June 21, 2004).*

Date	Station	Cast	Bottle	Sample Code	Alternative Code	Latitude N	Longitude W	Depth (m)	DOM Sample	C18 SPE Sample	C18 volume (L)
17-May	1	1	10	1-1-10	BRS1	65.683	-168.217	13	2	2	10
	2	1	10	2-1-10	BRS2	65.685	-168.387	12	1	1	10
	4	1	9	4-1-9	BRS4	65.689	-168.728	13	1	1	10
	5	1	10	5-1-10	BRS5	65.708	-168.879	13	1	1	10
18-May	6	1	7	6-1-7	HV1	67.508	-168.900	4	1	-	-
21-May	7	3	1	7-3-1	HV2	70.696	-167.205	48	-	-	-
	7	3	6	7-3-6	HV2	70.696	-167.205	6	-	-	-
	7	3	7	7-3-7	HV2	70.696	-167.205	6	1	1	10
	7	3	11	7-3-11	HV2	70.696	-167.205	2	1	-	-
22-May	8	1	2	8-1-2	PROD	71.256	-162.088	19	-	-	-
	8	1	3	8-1-3	PROD	71.256	-162.088	19	1	1	10
	8	1	8	8-1-8	PROD	71.256	-162.088	6	1	1	10
24-May	9	1	1	9-1-1	EHS0	72.007	-159.572	38	1	1	10
	9	1	6	9-1-6	EHS0	72.007	-159.572	9	-	-	-
	9	1	7	9-1-7	EHS0	72.007	-159.572	9	1	1	10
	9	4	3	9-4-3	EHS0	72.007	-159.668	37	1	1	10
26-May	10	2	1	10-2-1	EHS0.5	72.080	-159.634	43	-	1	25
	10	2	2	10-2-2	EHS0.5	72.080	-159.634	43	1	-	-
	10	2	3	10-2-3	EHS0.5	72.080	-159.634	43	-	1	25

	10	2	4	10-2-4	EHS0.5	72.080	-159.634	43	1	1	10
	10	2	5	10-2-5	EHS0.5	72.080	-159.634	43	-	-	-
	10	2	6	10-2-6	EHS0.5	72.080	-159.634	43	-	2	50
27-May	12	1	1	12-1-1	EHS1	72.245	159.206	46	-	-	-
	12	1	2	12-1-2	EHS1	72.245	-159.206	46	1	-	-
	12	1	9	12-1-9	EHS1	72.245	-159.206	12	1	-	-
29-May	15	1	2	15-1-2	EHS3.1	72.581	-158.742	70	1	1	10
	15	1	10	15-1-10	EHS3.1	72.581	-158.742	13	1	-	-
30-May	16	4	2	16-4-2	EHS4	72.673	-158.767	153	-	-	-
	16	4	11	16-4-11	EHS4	72.673	-158.767	7	1	1	10
	16	4	12	16-4-12	EHS4	72.673	-158.767	7	-	-	-
	16	5	2	16-5-2	EHS4	72.681	-158.784	154	1	1	10
31-May	17	1	2	17-1-2	EHS5	72.720	-158.403	238	1	1	10
	17	1	10	17-1-10	EHS5	72.720	-158.403	102	1	1	10
	17	2	5	17-2-5	EHS5	72.724	-158.414	28	1	1	10
3-Jun	19	6	3	19-6-3	EHS6	72.881	-158.260	171	1	1	10
	19	6	4	19-6-4	EHS6	72.881	-158.260	121	1	1	10
	19	6	6,7	19-6-6,7	EHS6	72.881	-158.260	121	-	-	-
	19	6	8	19-6-8	EHS6	72.881	-158.260	81	1	1	10
	19	6	9,10	19-9,10	EHS6	72.881	-158.260	81	-	-	-
	19	6	11	19-6-11	EHS6	72.881	-158.260	22	1	1	10
	19	6	12	19-6-12	EHS6	72.881	-158.260	22	-	-	-
4-Jun	20	3	2	20-3-2	EHS7	73.143	-157.786	1503	1	1	10
	20	5	1	20-5-1	EHS7	73.157	-157.815	196	1	1	10
	20	5	2,3	20-5-2,3	EHS7	73.157	-157.815	196	-	-	-
	20	5	4	20-5-4	EHS7	73.157	-157.815	152	1	1	10
	20	5	5,6	20-5-5,6	EHS7	73.157	-157.815	152	-	-	-
	20	5	7	20-5-7	EHS7	73.157	-157.815	122	1	1	10
	20	5	8	20-5-8	EHS7	73.157	-157.815	82	1	1	10
	20	5	11	20-5-11	EHS7	73.157	-157.815	22	1	1	10
	20	5	12	20-5-12	EHS7	73.157	-157.815	22	-	-	-
5-Jun	21	1	2	21-1-2	EHS-x	72.629	-157.392	281	1 D/L AA	-	-
	21	1	5	21-1-5	EHS-x	72.629	-157.392	151	1 D/L AA	-	-
	21	1	8	21-1-8	EHS-x	72.629	-157.392	76	1 D/L AA	-	-
	21	1	11	21-1-11	EHS-x	72.629	-157.392	12	1 D/L AA	-	-
8-Jun	22	1	2	22-1-2	SB1	71.439	-154.299	31	1	1	10
	22	1	11,12	22-1-11	SB1	71.439	-154.299	1	2	1	10
	22	2	10	22-2-10	SB1	71.440	-154.315	11	1	1	10
11-Jun	23	1	2	23-1-2	SB4	71.690	-154.730	70	1	1	10

	23	1	11	23-1-11	SB4	71.690	-154.730	2	1	1	10
12-Jun	24	2	1	24-2-1	SB5	71.778	-154.701	152	1	1	10
	24	2	3	24-2-3	SB5	71.778	-154.701	21	1	1	10
13-Jun	25	1	2	25-1-2	BC4.1	71.975	-154.617	101	1	-	-
	25	1	5	25-1-5	BC4.1	71.975	-154.617	25	1	-	-
	26	5	1	26-5-1	BC5				1	1	10
	26	5	5	26-5-5	BC5				1	1	10
	26	5	7	26-5-7	BC5				1	1	10
	26	5	9	26-5-9	BC5				1	1	10
	26	5	11	26-5-11	BC5				1	1	10
	26	5	12	26-5-12	BC5				1	1	10
15-Jun	27	8	2	27-8-2	BC6				1	1	10
	27	8	4	27-8-4	BC6				1	1	10
	27	8	6	27-8-6	BC6				1	1	10
	27	8	7	27-8-7	BC6				1	1	10
	27	8	9	27-8-9	BC6				1	1	10
	27	8	11	27-8-11	BC6				1	1	10
16-Jun	28	5	1	28-5-1	BC4				1	1	10
	28	5	4	28-5-4	BC4				1	1	10
	28	5	7	28-5-7	BC4				1	1	10
	28	5	10	28-5-10	BC4				1	1	10
19-Jun	31	5	1	31-5-1	BC3				1	1	10
	31	5	4	31-5-4	BC3				1	1	10
	31	5	7	31-5-7	BC3				1	1	10
	31	5	10	31-5-10	BC3				1	1	10
20-Jun	32	2	2	32-2-2	BC2				1	1	10

7. Biomarkers

PI: Rodger Harvey;
at sea team member: Laura Belicka

Project Objectives

This project aims to determine the inputs and transport of organic carbon in the Western Arctic Ocean. Through the analysis of molecular organic markers (fatty acids, sterols, hydrocarbons, etc.) in conjunction with bulk and compound-specific carbon isotopic composition, we can obtain information on the sources and diagenetic fate of carbon in the water column and sediments. These compounds also provide an understanding of how carbon is exchanged between the shelves and basins.

In order to achieve these goals, biomarkers will be analyzed in multiple types of samples. We are collecting particulate organic carbon (POC) in vertical profiles throughout the water column along shelf to basin transects to examine community structure, quantify marine and terrestrial carbon sources, and evaluate particulate transport pathways. To better characterize the inputs and transport of terrigenous organic matter into the Arctic, we plan to collect sediments and POM from a major river along the north slope of Alaska. The sampling of ice rafted debris will enable us to examine how sea-ice acts to redistribute organic carbon in the Arctic. Obtaining four sediment cores in the Basin (~3700m) will complete our 2002 collection of sediments and provide invaluable data on both the sequestration of carbon in the Arctic Basin and on variations in carbon sources over long time scales.

In addition, we are currently examining bacterial utilization of various sources of carbon using regrowth experiments. These experiments will be analyzed for bacterial growth, cell abundances and sizes, lipid composition and community structure analysis using fluorescent in situ hybridization as well as DNA cloning. All lipid and DNA sample analyses will be conducted upon our return to the Chesapeake Biological Laboratory.

Sample Collection

To date, POM samples have been collected at 26 stations in the Bering Strait, Herald Valley, Smith Bay, East Hannah Shoal and Barrow Canyon regions of the western Arctic Ocean, as well as from the Ikpikpuk River, snow-suspended sediments from the Ikpikpuk River and ice rafted sediments from two separate ice stations. At station 031.2, a small boat deployment was used to collect ice rafted sediments, which proved to be an ideal platform for sample collection. One shallow box core was also taken as a test for the deep coring process. Regrowth experiments were also conducted. The stations and sampling depths for POM, Sediment Cores, and Ice Rafted Debris are as follows:

Station Number	Station Name	Sampling Depths (m)
Station 001	BRS-1	10
Station 002	BRS-2	10
Station 003	BRS-3	10
Station 004	BRS-4	10
Station 005	BRS-5	10
Station 006	HV-1	3.2
Station 007	HV-2	4
Station 008	Prod cast	4.6, 17.6
Station 009	EHS-0	7.8, 43
Station 010	EHS-0.5	10, 41
Station 012	EHS-1	10, 43
Station 015	EHS-3.1	68
Station 016	EHS-4	5, 153
Station 017	EHS-5	25, 100, 245

Station 019	EHS-6	20, 80, 120, 800
Station 020	EHS-9	20, 80, 150, 195, 1500
Station 022	SB-1	0, 10, 31
	Ikpikpuk River	Surface
	Ikpikpuk River Dirty Snow	Surface
Station 023	SB-4	0, 69
Station 024	SB-5	20, 152
Station 026	BC-5	25, 80, 130, 190, 340, 1200
Station 027	BC-6	20, 85, 120, 190, 210, 355
Station 028	BC-4	20, 65, 120, 190, 550
	Ice Rafted Sediment	Surface
Station 031	BC-3	28, 79, 175, 220
Station 031.2	Ice Rafted Sediment	Surface
Station 034	BC-2	35, 110
Station 035	BC-1	8.3, 73

Results

Sample analysis must be completed upon our return to the Chesapeake Biological Laboratory. Data will be sent to the JOSS website data archive as it is available.

8. Evaluation of Shelf-Basin Interaction in the Western Arctic by Use of Radium Isotopes

PI: David Kadko;
on-board team member: Mark Stephens

Project Objectives

We are measuring concentrations of radium isotopes in the upper water column in order to evaluate processes and timescales of shelf-basin exchange. The source of dissolved radium is sedimentary thorium. Radium diffuses out of the sediments, and thus its concentration is elevated in shallow shelf waters and decreases due to transport, mixing and radioactive decay off-shelf. Two isotopes of radium are appropriate for the timescales of shelf-basin interaction, and are of greatest interest to this study: Ra-224 (3.6 day half-life) and Ra-228 (5.8 year half-life).

Summary of Data Collections

We have collected 55 large volume (200L) water samples from the upper water column (0 to 250m depth). Each sample has been filtered through manganese-coated fibers (which absorbs the radium), and analyzed for initial Radium-224 concentrations.

Transects sampled include: Bering Strait (3 surface samples), Harold Valley (4 samples from 2 shallow stations), East Hanna Shoal (19 samples from 6 locations), and the Barrow Canyon / Smith Bay transect (29 samples from 9 locations). Station depths on the EHS section ranged from 45 to 2500m. On the BC/SB transect station depths were 85 to 1900m.

Preliminary Results

All samples have been analyzed for initial total Radium-224 content. A second analysis is required to determine the fraction of excess Ra-224. To date, we have performed the second analysis on 14 of the samples. The results from those 14 samples are as follows:

Bering Strait: Excess Ra-224 concentrations range from 1.1 to 1.7 dpm/100L (3 samples)
Harold Valley: Excess Ra-224 concentrations range from 0.75 to 1.4 dpm/100L (4 samples)
East Hanna Shoal (100m station): Excess Ra-224 concentrations range from 0.0 to 0.9 dpm/100L (7 samples)

Analysis on the remaining EHS transect stations is expected to be completed before the Summer SBI cruise, and the BC/SB samples will be completed later in the Summer.

All samples will later be analyzed with a gamma detector for the longer-lived radium isotopes (Ra-228 and Ra-226) upon our return to Miami.

9. Microzooplankton: biomass, rates of herbivory, and food for mesozooplankton

PI: Ev Sherr;
team member Sybille Pluvinage (both onboard)

Data summary:

Microzooplankton Grazing Experiments (dilution assays)

We completed 10 dilution assays during the Spring 2004 cruise - data below:

Dates of experiment	Station	Sample depth m	Light level % of incident	Initial Chl-a ug/l	Treatment	Growth rate day^-1	Grazing mortality day^-1
24-26 May	9	6.8	5	1.47	Dilution series	0.30	-0.09
26-28 May	10	5	5	2.21	Dilution series	0.37	-0.16
30-32 May	16	7.8	5	1.52	Dilution series	0.07	0.04
				0.48	40%	-0.28	
				0.53	10 um	-0.28	
3-5 June	19	45	0.06	3.3	Dilution series	0.06	-0.12
				1.3	40%	-0.39	
				0.53	10 um	-0.21	
4-6 June	20	30	0.06	0.57	Dilution series	0.03	-0.03
8-10 June	22	10	5	4.68	Dilution series	0.19	-0.03
				0.32	10 um	-0.22	
12-14 June	24	10	5	7.15	Dilution series	0.31	-0.04
				7.15	100% no nuts	0.06	
				0.79	10 um	-0.29	
15-17 June	27	24	5	1.31	Dilution series	0.28	-0.01
				1.31	100% no nuts	-0.03	
				0.47	10 um	-0.10	
16-18 June	28	32	5	5.3	Dilution series	0.03	0.01
				0.62	10 um	-0.20	-0.17
					10% 10 um	-0.04	
18-29 June	29	28	5	7.32	Dilution series	0.20	-0.11
				1.17	10 um	-0.14	

A striking difference between the Spring 2002 and Spring 2004 cruise was that the phytoplankton stocks, as measured by chl-a concentrations in the initial samples of the dilution assays, were much higher during 2004 (up to 7.3 ug chl-a/liter, compared to a maximum of 0.53 ug chl-a/liter in our experiments during spring 2002). During the first part of the cruise, microscopic inspection of samples suggested most of the phytoplankton were large and chain-forming diatoms that resembled the ice algal diatom assemblage. During the last two weeks, the phytoplankton were dominated by a mixed species assemblage that included pelagic diatoms, e.g. *Chaetocerous* and *Thallasiosira* spp. However, there were abundant smaller phytoplankton, phytoflagellates and some smaller diatoms, in the samples. The dilution assay results during this cruise suggest that microzooplankton had only a slight grazing impact on total phytoplankton stocks. In two experiments (Stations 24 and 27), we found that the phytoplankton appeared to be nutrient limited, i.e. the growth rate of phytoplankton in undiluted (100%) water with no added nutrients was lower than the growth rate of phytoplankton in 100% water with added nutrients (5 uM of ammonium nitrate and 0.25 uM of sodium phosphate are added to all bottles except for two of the undiluted, 100% water treatments).

However, the results of the 10 um screened water treatments suggested that the smaller phytoplankton do experience significant grazing mortality from protists that pass through the 10 um mesh netting. We also found a much higher mortality in the 40% whole water treatment in two of the earlier dilution experiments. Inspection of the 10 um screened water showed abundant smaller heterotrophic dinoflagellates and other heterotrophic flagellates which had ingested small phytoplankton cells. These results suggest that there may be a two-tiered food web in the microzooplankton assemblage, in which possibly the larger protists are consuming the smaller protists as well as phytoplankton, and the smaller protists have the biggest grazing impact on the < 10 um sized phytoplankton. Flow cytometric analysis of change in abundance of the smaller phytoplankton, and quantitative analysis of the protist community in the experiments, will hopefully provide a clearer picture of what was going on.

1) **Microzooplankton biomass and analysis of phytoplankton community composition:** Samples have been collected at the 6 depths of the primary production assays for 16 primary production casts during the cruise. Three types of samples are collected: for flow cytometric analysis of phytoplankton and heterotrophic bacteria, for epifluorescence microscopy, and for inverted microscopy (Lugol fixed samples). Preliminary inspection of prepared epifluorescence filters showed that most of the phytoplankton biomass in shelf waters appeared to be large sized and chain forming diatoms, many of which appeared to be ice algal-like pennates: *Nitschia* – type cells or *Fragilariopsis* – type chains, plus some pelagic species: *Thalassiosira*, *Chaetocerous* and *Cocinodiscus*. The striking chl-a maximum found at outer slope station 19 was composed of these large shelf diatom species, while the phytoplankton in the upper water column at this station were mainly smaller phytoflagellates and a smaller sized centric diatom. There were abundant heterotrophic dinoflagellates and some ciliates in the samples examined so far.

2) **Mesozooplankton grazing experiments:** We have sampled the Time 0 and Time Final bottles for the 10 mesozooplankton grazing assays carried out to date on the cruise. These samples will be analysed for change in protist abundance and biomass to evaluate the grazing rate of microzooplankton on heterotrophic protists.

10. Exchange of Plankton and Particles between the Shelf and Basin; Carin Ashjian

PI: and Stephane Plourde;
on-board team member; Scott Gallager (PI) and Mark Benfield (PI)

The purpose of this project is to document shelf-basin exchange of plankton and particles. The project is composed of two components: shipboard estimates of plankton and particle abundance from a Video Plankton Recorder during the two process cruises and long-term observations of particle/plankton abundance from moored acoustic Doppler current profilers. Only the first component is conducted on the present cruise.

The Video Plankton Recorder (Seascan Inc. mfg.) is an underwater microscope that images plankton in a known volume illuminated by a strobe. Coincident environmental (e.g., temperature, salinity, depth) data are collected using CTDs and other sensors. This project uses the AutoVPR, a self-contained instrument that logs data (images, environmental information) internally to a hard drive during deployment. The AutoVPR is equipped with a SeaBird SBE 49 CTD. During this cruise, the VPR was deployed off of the stern from the 3/8" hydro wire using a stainless steel cage. The VPR typically is deployed during a period while the bottles on the CTD rosette are emptied between CTD deployments, resulting in no extra ship time for the VPR casts. The VPR is deployed to 10 m off the bottom or to 300 m, depending on the bottom depth. We deployed the VPR at all process station locations as well as at extra, "high-resolution" locations between the major stations in order to provide higher-spatial resolution descriptions of hydrographic and plankton/particle distribution. Either the CTD or an XCTD was deployed also at these locations with the exception of locations near the Weingartner Barrow Canyon mooring where only the VPR was deployed. Twenty-eight casts with the VPR were conducted during the cruise.

Table 1. *Locations and times of VPR Casts*

Station	Station	VPR	Date		Time		Lat.	Long.	Tow	Bottom
Name	#	#	Local	GMT	Local	GMT	°N	°W	Depth (m)	
HV-1	6	1	5/18/04	5/19/04	1620	20	67.47	168.9	40	51
HV-2	7	2	5/21/04	5/21/04	402	1202	70.66	167.3	40	53
EHS1	9	3	5/24/04	5/24/04	1229	2029	72.01	159.7	32	42
EHS0.5	10	4	5/26/04	5/27/04	2052	452	72.08	159.7	40	47
EHS2	13	5	5/28/04	5/28/04	1402	2202	72.37	159.1	40	52
EHS3.1	15	6	5/29/04	5/30/04	1707	107	72.58	158.7	62	72
EHS4	16	7	5/30/04	5/30/04	729	1529	72.66	158.7	130	~140
EHS5	17	8	5/31/04	5/31/04	1540	2340	72.73	158.5	235	245
EHS5.1	18	9	6/1/04	6/1/04	1218	2018	72.77	158.4	284	295
	xctd_02	10	6/2/04	6/1/04	826	1626	72.83	158.3	200	240
EHS6	19	11	6/2/04	6/3/04	2301	2323	72.87	158.2	300	1170
EHS9	20	12	6/4/04	6/5/04	1730	130	73.15	157.8	300	2510
SB1	22	13	6/8/03	6/9/04	1327	2127	71.44	-154.31	25	38
SB4	23	14	6/11/04	6/12/04	1607	7	71.69	-154.82	82	91
SB5	24	15	6/12/04	6/12/04	554	1354	71.78	-154.65	140	153
SB5	24	16	6/12/04	6/13/04	1615	15	71.78	-154.97	270	280
BC5	26	17	6/13/03	6/14/04	1625	25	72.10	-154.42	300	1398
BC6	27	18	6/15/04	6/15/04	316	1116	72.26	-154.53	300	1780
BC4	28	19	6/16/04	6/17/04	1731	131	71.92	-154.90	300	550

BC3.1	29	20	6/18/04	6/18/04	722	1522	71.67	-156.22	90	106
BC3.2	30	21	6/18/04	6/18/04	1236	2036	71.63	-156.05	140	151
BC3	31	22	6/18/04	6/19/04	1916	316	71.58	-156.06	170	181
BC3.4	32	23	6/19/04	6/20/04	2258	658	71.56	-155.83	145	159
BC3.5	33	24	6/20/04	6/20/04	137	937	71.54	-155.79	110	121
BC2	34	25	6/20/04	6/20/04	1142	1942	71.40	-157.50	110	127
BC1	35	26	6/21/04	6/21/04	840	1640	71.12	-159.32	70	89
BC1.4		27	6/21/04	6/21/04	1041	1841	71.04	-159.32	56	66
BC1.2		28	6/21/04	6/21/04	1130	1930	71.10	-159.52	50	61

Hydrographic data (temperature, salinity) from the VPR were compared with data from the service CTD and the xCTD when collected at the same station. The VPR CTD compared very favorably with the service CTD and somewhat less so with the xCTD. We plan to sample using all three instruments at a single location to obtain a three-way comparison.

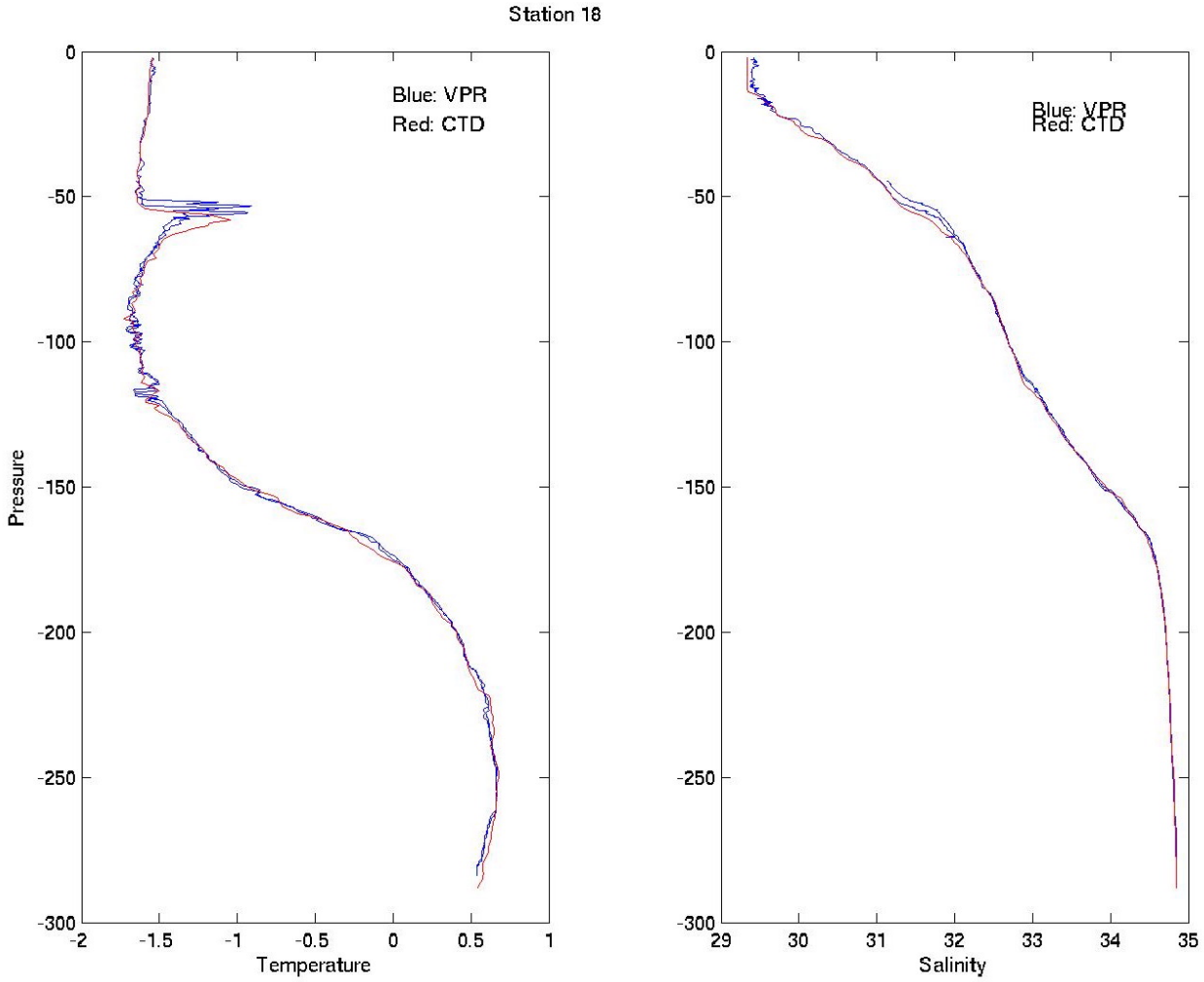

Figure 1. *Comparison between temperature (left) and salinity (right) from service CTD (red) and VPR CTD (blue). Service CTD data averaged into 1-m bins. No post-processing conducted on VPR CTD data.*

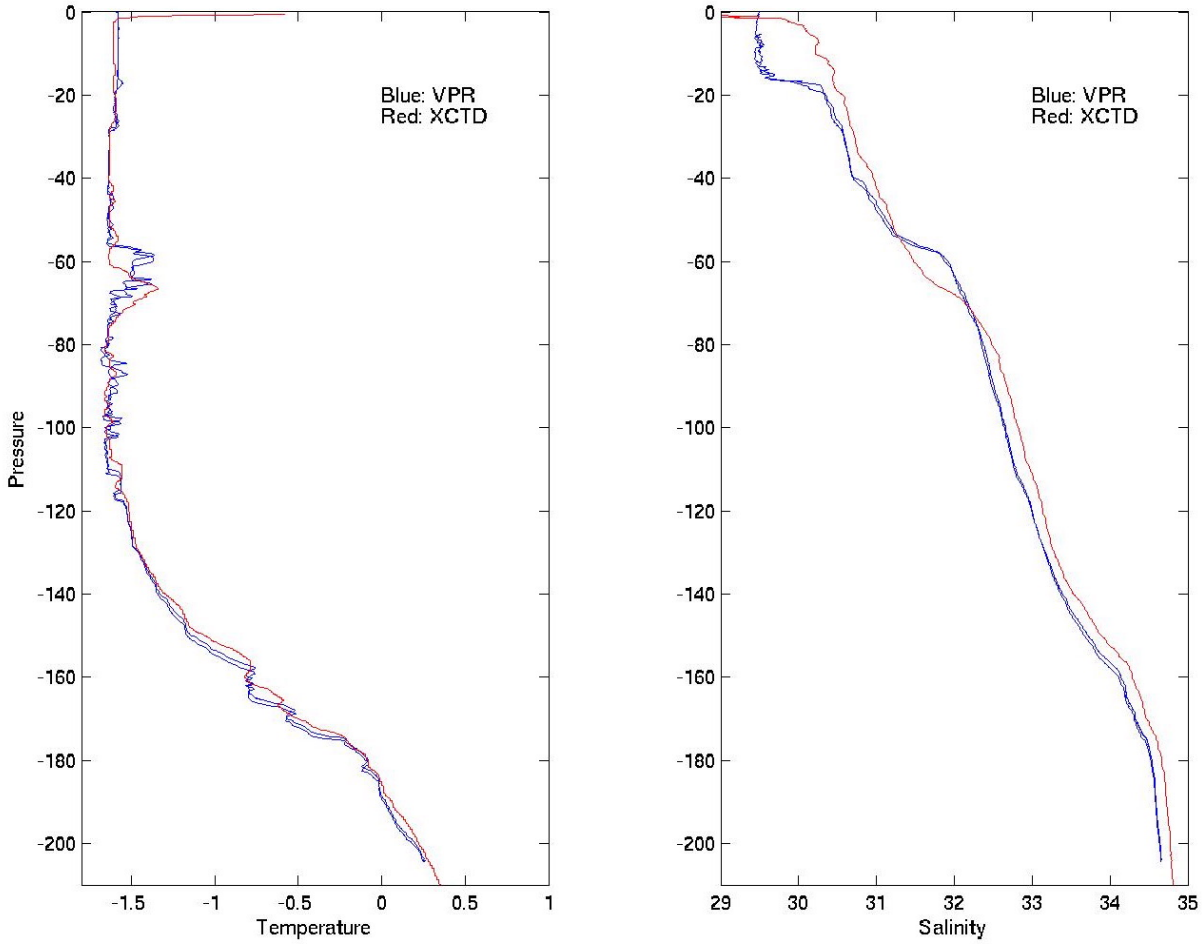

Figure 2. *Comparison between temperature (left) and salinity (right) from xCTD (red) and VPR CTD (blue). No post-processing conducted on VPR CTD data.*

As during the summer of 2002, the greatest number of images was recorded at locations in and offshore of Barrow Canyon. Particles in the canyon were composed of (presumably) decaying ice algae at depth and, along the eastern side of the canyon, colonies of Chaetoceros socialis. The most abundant plankton type was radiolarians. Copepods and chaetognaths also were observed. Qualitatively, abundances vary vertically and regionally, with greater abundances over the shelf and reduced abundances over the basin.

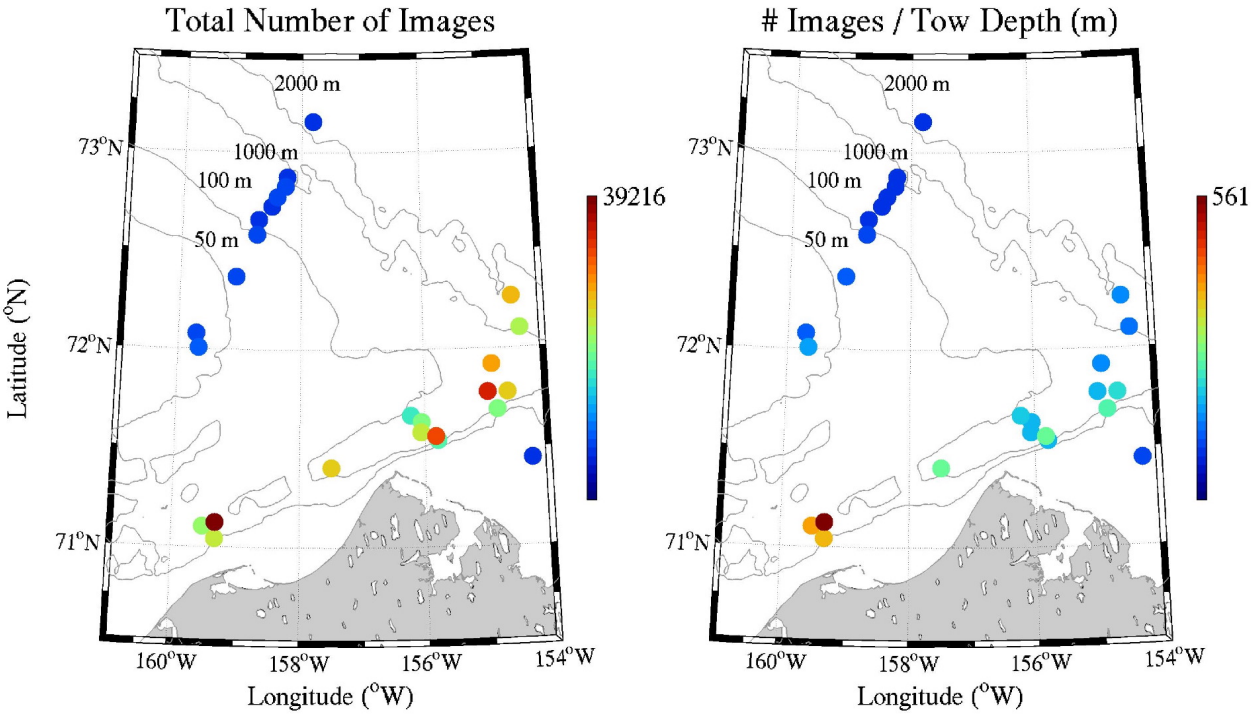

Figure 3. *Total number of images (left) and number of images standardized to tow depth (right) for 26 stations sampled along the northern portion of the cruise track.*

The VPR records will be analyzed post cruise to determine the plankton and particle concentrations and coincident temperature and salinity for each profile. These data then will be merged with ADCP velocity records obtained by the ship's hull mounted ADCPs to obtain estimates of instantaneous flux (magnitude and direction). From these measurements, we will obtain high-resolution descriptions of the vertical distributions of plankton and particles in association with hydrography, comparative estimates of abundance and vertical distributions between regions and along transects, and an estimate of how much and in which direction material is advected between shelf and basin.

11. Mesozooplankton Process Studies

PIs: Carin Ashjian and Robert Campbell;
onboard team member: Stephane Plourde

The purpose of this project is to determine the grazing rates of the dominant copepod species/life stages on phytoplankton and microzooplankton food at locations both on the shelf and in the basin. The ultimate goal is to couple these measurements with estimates of total abundance and food availability to describe the role of mesozooplankton in processing carbon (both primary production and microzooplankton) in the two regions. The relative condition of the plankton populations in the two regions also is assessed through measures of carbon and nitrogen content (CN), RNA/DNA (an indicator of metabolic activity), and, for actively reproducing species, egg production rates (EPR). The shelf and basin should contain different zooplankton species compositions, with the shelf being and admixture of endemic species and those advected in to the region from both the Pacific Ocean through Bering Strait and from the Beaufort Sea across the shelf-basin interface. In order to better understand and model the potential consequences of

climate variability on these ecosystems, it is important to understand how these ecosystems function and how changing the relative proportions of different species may impact the food web in the two regions.
A total of 10 grazing and 17 egg production experiments for the dominant species at each location were carried out (see table 1 for experimental and sample inventories). Grazing and egg production rates were higher on average than those observed in spring, 2002. This is most likely due to much higher chlorophyll at many locations that may have resulted from advection rather than in-situ production because heavy ice and snow cover was present at many locations. Advection of chlorophyll offshelf was most evident on the Barrow Canyon section where a prominent subsurface chlorophyll maximum and strong offshelf velocities were observed. The rates at the outer most station (EHS9) were much lower and more typical of what was observed in the basin in spring, 2002, but this was the only station that showed the basin station characteristics typical of spring, 2002.

Table 1. *Summary of sampling and analysis activities. Stations/locations where each type of sampling or analysis was conducted are indicted by a "1".*

Date	Station #	Transect Location	Net Tow	Grazing	EPR	RNA/DNA	CN
5/18/04	6	HV1	1		1	1	1
5/21/04	7	HV2	1		1	1	1
5/24/04	9	EHS0	1	1	1	1	1
5/26/04	10	EHS0.5	1	1	1	1	1
5/28/04	13	EHS2	1		1	1	1
5/30/04	16	EHS4	1	1	1	1	1
5/31/04	17	EHS5	1		1	1	1
6/2/04	19	EHS6	1	1	1	1	1
6/4/04	20	EHS9	1	1	1	1	1
6/8/04	22	SB1	1	1	1	1	1
6/11/04	23	SB4	1		1	1	1
6/12/04	24	SB5	1	1	1	1	1
6/13/03	26	BC5	1		1	1	1
6/15/04	27	BC6	1	1	1	1	1
6/16/04	28	BC4	1	1			1
6/18/04	29	BC3.1	1	1	1	1	1
6/18/04	30	BC3	1		1	1	1
6/20/04	34	BC2	1				
6/21/04	35	BC1	1		1	1	1

12. Shelf-Basin Exchange of Large Bodied Zooplankton

PI: Sharon Smith;
on-board team members: Peter Lane, Leo Llinas, Tina Senft

Introduction.

In the course of the PROBES study of the Bering Sea, we discovered that spring storms could alter the food web of the Alaskan continental shelf. If the winds were from the "right" direction, subsurface basin water was forced onto the shelf. In spring, some copepods migrate upward from their winter depths around 1000 meters in the basin to the surface of the ocean. When their upward migration coincided with the "favorable" winds, they ended up in a much richer food environment over the shelf than exists over the deeper adjacent

ocean, and their response was to grow to twice the size of the same animals that remained at the surface above the deeper basin waters. When this happened, the birds found this enhanced food supply and congregated in the shelf area where the copepods were located. These copepods cannot complete their life cycle on the shelf; they must spend the winter in deep water. So, although they grew to a large size and supported the birds, fish and mammals of the Bering Sea shelf, they were unable to survive and reproduce on the shelf. Hence, they must be reintroduced to the shelf environment each year by the water movements of the region. Subsequently, this phenomenon was found on other shallow shelves such as the Barents Sea, where the abundance of capelin was tied to physical transport of their copepod food supply from the deeper North Atlantic Ocean onto the shallow Barents shelf. These two observations were the basis for our conceptual model of possible climate change outcomes in the Chukchi and Beaufort Seas. The Chukchi shelf is broad and shallow, and supports large populations of birds, walrus, seals, polar bears and whales, and one of the bases of the food web that supports these charismatic organisms are the copepods transported from the deep adjacent Arctic Ocean onto the Chukchi and Beaufort shelves. By measuring the abundances of various copepods on the shelves and in the deep adjacent basin, and by identifying the early juvenile stages of the copepods, we can say which species of copepod are reproducing on the shelves. Such identification cannot be done with normal taxonomic characters; it must be done using new molecular probes under development now.

For many years, global models of climate have shown us that warming associated with increased carbon dioxide emissions will appear first - and be most intense - in the Arctic. Warming will reduce ice cover, exposing the shallow shelves to different current regimes than they experience presently. If climate change produces less transport of Arctic basin organisms onto the shelves, there will be reduced food for the birds, fish and baleen whales (the fish in turn support the seals and polar bears). If climate change instead produces increased transport onto the shelves (upwelling), then the food available for the upper levels of the food web could increase. Recent models show that the upwelling/no upwelling "switch" driven by ice cover could be very sensitive in this region. Ice cover changing by as little as ten or twenty kilometers from the shelf break could dictate the strength and extent of upwelling onto the shelves, and in turn the food web of the region.

Objectives.

Quantify abundances and depth-stratified distributions of pelagic zooplankton over the shelf, slope and basin of the Chukchi and Beaufort seas

Quantify distribution of copepod nauplii at the surface in the study area using molecular techniques

Quantify egg production by dominant copepods in the study area

Table of Data Collected.

Vertical Bongo Tows:	8
MultiNet® Tows:	11
Surface Map Samples:	250

Preliminary Results.

Heavy ice and other priorities prevented us sampling the Arctic Basin. The stratified samples in slope water show that the large Arctic copepod *Calanus hyperboreus* is predominantly in the upper 300 meters. Deeper samples contain predators (chaetognaths, *Pareuchaeta*) and the omnivore *Metridia longa*. The vertical distribution of the actively reproducing copepod *Calanus glacialis* could not be discerned with the naked eye, but it was common in the live tows from 100 meters to the surface.

A preliminary surface map showing values of fluorescence voltage from the SCUFA fluorometer suggests that the highest surface chlorophyll was in the region of station HV-1 near Pt. Hope (Figure 1). Fluorescence along the East Hanna Shoal section was highest at the southwestern end of the section (ca. 50 isobath) and lowest at the northeastern end of the section (ca. 2000 m isobath; Figure 1). In Barrow Canyon, chlorophyll concentrations were highest near the 200 m isobath, and lower both offshore and near the coast at Barrow (Fig. 1).

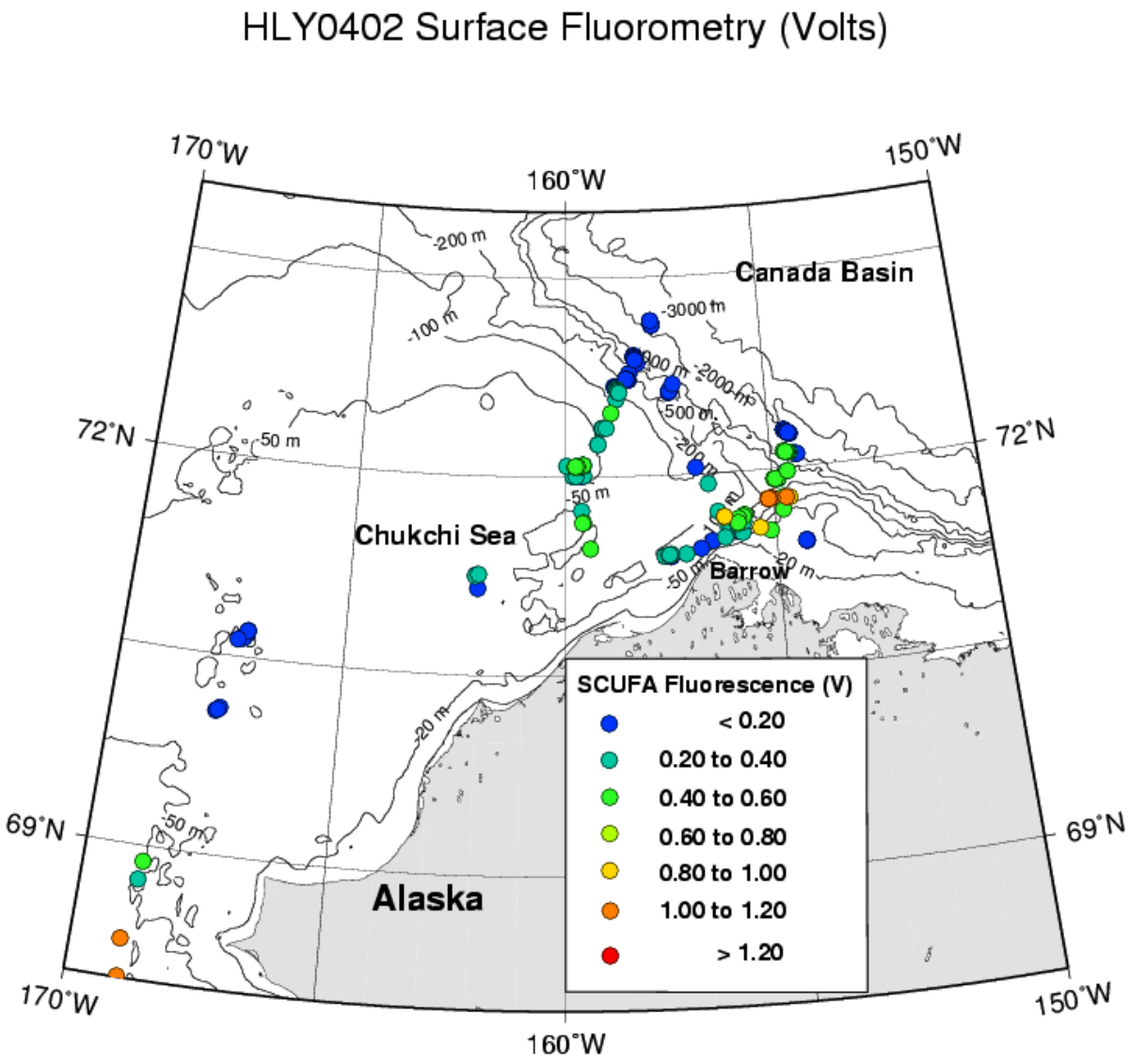

Figure 1. *Fluorescence, expressed as volts, from the SCUFA fluorometer plumbed in the aft TSG system during the first half of cruise HLY0402, 18 May – 6 June 2004.*

Date (local)	Station number	Station name	Latitude (N)	Longitude (W)	Haul type	Tow number	Number of samples per tow
18-May-04	6	HV1	67 32.52	168 50.52	Bongo	BG01	2
21-May-04	7	HV2	70 39.38	167 14	Bongo	BG02	2
24-May-04	9	EHS0	72 00.6397	159 69.5283	MultiNet	MN01	3
26-May-04	10	EHS0.5	72 04.7860	159 37.1132	Bongo	BG03	2
28-May-04	13	EHS2	72 21.9809	159 03.6152	Bongo	BG04	2
30-May-04	16	EHS4	72 39.3310	158 42.9858	MultiNet	MN02	3
31-May-04	17	EHS5	72 43.3307	158 24.5713	MultiNet	MN03	5
2-Jun-04	19	EHS6	72 51.8168	158 14.3105	MultiNet	MN04	5
4-Jun-04	20	EHS7	73 08.6984	157 47.3724	MultiNet	MN05	5
8-Jun-04	22	SB1	71 26.4082	154 18.3087	Bongo	BG05	2
8-Jun-04	23	SB4	71 41.4859	154 48.7477	Bongo	BG06	2
12-Jun-04	24	SB5	71 46.6062	154 38.7976	Bongo	BG07	2
12-Jun-04	24	SB5	71 46.75	154 57.08	MultiNet	MN06	5
13-Jun-04	26	BC5	72 06.27	154 28.03	MultiNet	MN07	5
15-Jun-04	27	BC6	72 16.1915	154 34.2670	MultiNet	MN08	5
16-Jun-04	28	BC4	71 55.323	154 52.50	MultiNet	MN09	5
18-Jun-04	31	BC3	71 34.7290	155 52.90	MultiNet	MN10	4
20-Jun-04	34	BC2	71 24.255	157 27.2275	MultiNet	MN11	3
21-Jun-04	35	BC1	71 07.0766	159 21.4010	Bongo	BG08	2

Note: During the SBI process cruise HLY0402, 8 Bongo and 11 MultiNet tows were carried out for a total of 64 samples collected. In addition over 250 underway samples were collected from the aft TSG system.

13. Particulate Organic Carbon (POC)

PI: Brad Moran;
on-board team members: Pat Kelly and Kate Hagstrom

Project Objectives:

1) Quantify the flux of particulate organic carbon (POC) from the surface water to the deep waters of the Chuckchi Sea using ^{234}Th as a tracer of particle export.
2) Determine POC/^{234}Th ratio values for multiple size fractions of particles, and different types of particles at specific depths
3) Compare ^{234}Th-tracer derived POC fluxes w/ sediment trap derived fluxes of POC.
4) Compare ^{234}Th export from surface water with ^{234}Th accumulation in sediments.
5) Improve ^{234}Th sample resolution from HLY-02-0X using newly developed small volume technique.

Samples Collected

In-situ Pumps

Station	Depths	LPOC sizes (µm)	Notes
6-HV1	10, 25, 40	100, 53, 10	10m; 53 µm only Heavy loading on 10µm
7-HV2	10, 25, 35	200, 100, 53	10m; 53 µm only
9-EHS0	10, 20, 30	200, 100, 53	10m; 53 µm only
16-EHS4	10, 30, 40, 50, 60	100, 53, 20	10m; 53 µm only
17-EHS5	10, 30, 50, 100, 150	100, 53, 20	10m; 53 µm only
19-EHS6	10, 30,50,75,125,300	100, 53, 20	10m; 53 µm only
20-EHS7	10, 30, 50, 75, 100, 125, 300, 1000	100, 53, 20	10, 300, 1000 m,; 53µm only
24-SB5	10, 30, 50, 75, 100, 125, 225	100, 53, 20	10, 225; 53µm only
26-BC5	10, 30, 50, 75, 100, 125, 300, 600	53	50, 100; 100, 53, and 20 µm
28-BC4	10, 30, 50, 75, 100, 125, 200, 400	53	50, 100; 100, 53, and 20 µm
31-BC3	10, 30, 50, 60, 80, 100, 125	53	50, 100; 100, 53, and 20 µm
34-BC2	10, 30, 40, 50, 60	53	50; 100, 53, and 20 µm

Small Volume ^{234}Th

Station	Depths
7-HV2	Surf, 5,10,15,25,40
9-EHS0	5,10,15,20,30,BOT
10-EHS0.5	Surf, 10,15,20,30,BOT
12-EHS1	5,10,15,20,30,BOT
13-EHS2	5,10,15,20,40,50
14-EHS3	5,10,15,20,40,BOT
15-EHS3.1	5,15,30,50,60,BOT
16-EHS4	10,30,50,75,100,125
17-EHS5	25,50,75,100,150,200
18-EHS5.1	20,40,75,150,200,250
19-EHS6	15,20,40,100,150,200,300,400,500
20-EHS6	10,20,40,100,150,200,300,400,500,1500
23-SB4	5, 15, 25, 30, 40, BOT
26-BC5	20, 40, 150, 200, 250, 500
27-BC6	10, 30, 40, 80, 100, 150, 250, 320, 375, 500, 1100, 1700
28-BC4	20, 40, 80, 150, 200, 250, 400, 565
30–BC3.2	10, 20, 50, 125

Data Summary

Pumping Results:

Some ^{234}Th samples from EHSS have been found to be near equilibrium with ^{238}U(activity ratio ~0.85), though most are not (activity ratio ~0.5). Not all samples have been analyzed. Sufficient sample volumes have been filtered to ensure that measurable quantities of ^{234}Th have been collected for all size fractions.

Trap Comparison:

Measurable quantities of ^{234}Th have been collected in the sediment traps, though further comment is unwarranted due to incomplete analysis.

Sediment Comparison:

Sediments from the benthic component (HAPS core, Multi-Core), have been collected from HV2, EHS0, EHS4, EHS5, EHS6, SB5, BC5, BC4, BC3, BC2. No analysis will be conducted until they are returned to URI.

Other Particle Types

Several samples from the Zooplankton component of SBI have been obtained for ^{234}Th analysis. These include two different species of copepod, cheatognaths, and samples of 300 and 1350 copepod fecal pellets. Thus far it is apparent hat at least 75 copepods are required to obtain a measurable quantity of ^{234}Th, and that no measurable Th resides on fresh fecal pellets.

Small Volume Results:

Measurable quantities of ^{234}Th have been collected, though further comment is unwarranted due to incomplete analysis.

14. Water/sediment tracers, sediment metabolism and benthic community structure

PIs: Jackie Grebmeier and Lee Cooper;
on-board team members: Arianne Balsom, Rebecca Pirtle-Levy and Catherine Lalande

The purpose of the benthic component is to investigate pelagic-benthic coupling and carbon cycling in the SBI study area. Methods used include population studies, carbon tracer collections, sediment studies, and water mass tracers. Forty-five stations were occupied during HLY-04-02 for various data collections within our component, both water and sediment samples (Table 1a-c). A sub-sample of water from the surface and chlorophyll max was collected by Dean Stockwell (service cast) and Victoria Hill (productivity cast) and preserved in Lugol's solution for phytoplankton identification by Dr. Mickle Flint of the Shirshov Institute of Oceanology in Russia as part of our core project. Bottom water was collected from the service CTD for sediment respiration experiments.

Sediments were collected at each station using both a 0.1 m^2 van Veen grab and a 0.0133 m^2 HAPS benthic corer. Four van Veen grabs were used up to a 500 m depth interval to collect replicate quantitative samples for benthic population studies. Sediment was sieved through 1 mm screens and retained animals preserved in 10% buffered formalin for analysis on land. Sediment collections from both the van Veen and multiple-

HAPS corer will be analyzed for chlorophyll pigment content (both fluorometric shipboard and HPLC), total organic carbon and nitrogen content, grain size, and various radioisotopes. Surface sediment were collected in whirl pack bags and frozen. Downcore samples for radioisotope tracers were cut in 1 cm sections to 4 cm depth, 2 cm sections to 20 cm depth, then 4 cm sections to the bottom of the core, sealed in cans, and frozen for laboratory analyses on shore. Measurements of Be-7 and Cs-137 will be made on a high-resolution gamma detector in Tennessee. Large volume surface sediments were also collected in Marinelli beakers for gamma counting. Two additional HAPS cores were collected at each station for sediment metabolism experiments. Overlying water was replaced with bottom water and flux rates determined for oxygen, carbon dioxide and nutrients. Once the experiment was completed, cores were sieved to retain the benthic organisms, which were preserved as outlined above. In addition to sediments collected for our component, we provided sediment to Brad Moran for Th-232 and Pb-210 measurements.

Table 1a. *Water column and other sample collections during HLY0402.*

		CTD sampling		Other sampling			
Stn #	**Stn Name**	**O-18**	**Bottom Water**	**Devol core for Be-7 & Cs-137**	**Gravity core**	**Be-7 snow sampling**	**Sediment trap**
1	BRS-1	+					
2	BRS-2	+					
3	BRS-3	+					
4	BRS-4	+					
5	BRS-5	+	+				
6	HV-1	+	+				
7	HV-2	+	+			+	
9	EHS-0	+	+			+	
10	EHS-0.5	+	+				
12	EHS-1	+					
13	EHS-2	+	+				
14	EHS-3	+					
15	EHS-3.1	+					
16	EHS-4	+	+			+	+
17	EHS-5	+	+			+	+
18	EHS-5.1	+					
19	EHS-6	+	+	+		+	+
20	EHS-7	+	+			+	
21	EHS-X	+	+	+			
22	SB-1	+					
23	SB-4	+	+			+	
24	SB-5	+	+			+	+
25	Prod. Cast & XCTD	+					
26	BC-5	+	+	+		+	+
27	BC-6	+		+			
28	BC-4	+	+		+		+
29	BC-3.1	+					
30	BC-3.2	+					
31	BC-3	+					
32	BC-3.4	+		+			
33	BC-3.5	+					
34	BC-2			+			

Table 1b: *Sediment sample collections from the van Veen grab during HLY0402.*

Sediment Van Veen Sampling

Stn #	Stn Name	Surface sed chl	Marinelli for Be-7 & Cs-137	TOC	HPLC	Dunton sample	1mm infauna sieved
1	BRS-1						
2	BRS-2						
3	BRS-3						
4	BRS-4						
5	BRS-5						
6	HV-1	+	+	+	+	+	+
7	HV-2	+	+	+	+	+	+
9	EHS-0	+	+	+	+	+	+
10	EHS-0.5	+	+	+	+	+	+
12	EHS-1						
13	EHS-2	+	+	+	+	+	+
14	EHS-3						
15	EHS-3.1						
16	EHS-4	+	+	+	+	+	+
17	EHS-5	+	+	+	+	+	+
18	EHS-5.1						
19	EHS-6						
20	EHS-7						
21	EHS-X	+	+	+	+	+	+
22	SB-1	+	+	+	+	+	+
23	SB-4	+	+	+	+	+	+
24	SB-5	+	+	+	+	+	+
25	Prod. Cast & XCTD						
26	BC-5						
27	BC-6						
28	BC-4	+	+	+	+	+	+
29	BC-3.1						
30	BC-3.2						
31	BC-3	+	+	+	+	+	+
32	BC-3.4					+	
33	BC-3.5						
34	BC-2	+		+	+	+	+

Table 1c: *Sediment sample collections from the HAPS corer during HLY0402.*

Sediment HAPS core sampling

Stn #	Stn Name	Oxygen uptake cores	1mm infauna sieved	0.5mm infauna sieved	Moran Samples	TOC	HPLC	Dunton sample	Be-7 & Cs-137 down-core	Stock-well sample	Sed chl down-core
1	BRS-1										
2	BRS-2										
3	BRS-3										
4	BRS-4										
5	BRS-5										
6	HV-1	+	+	+		+	+		+		+
7	HV-2	+	+	+	+	+	+		+	+	+
9	EHS-0				+	+	+		+	+	+
10	EHS-0.5					+	+		+	+	+
12	EHS-1										
13	EHS-2	+	+	+		+	+		+	+	+
14	EHS-3										
15	EHS-3.1										
16	EHS-4	+	+	+	+	+	+		+	+	+
17	EHS-5	+	+	+	+	+	+		+	+	+
18	EHS-5.1										
19	EHS-6	+	+	+	+	+	+	+		+	+
20	EHS-7										
21	EHS-X	+	+	+						+	+
22	SB-1										
23	SB-4	+	+	+		+	+		+	+	+
24	SB-5	+	+	+	+	+	+		+	+	+
25	Prod. Cast & XCTD										
26	BC-5				+	+	+		+	+	+
27	BC-6					+	+		+	+	+
28	BC-4	+	+	+	+	+	+		+	+	+
29	BC-3.1										
30	BC-3.2										
31	BC-3										
32	BC-3.4				+	+	+		+	+	+
33	BC-3.5										
34	BC-2					+	+		+	+	+

NOTE: TOC/HPLC sample to be taken from 0-1cm section of radioisotope core.

Preliminary results of sediment oxygen uptake (an indicator of carbon supply to the benthos) show a gradient from high to low values moving from the outer shelf to the basin on all transects. The mean highest sediment oxygen uptake rates (30.1 mM O_2 m^{-2} d^{-1}) occurred at the upper end of Barrow Canyon at the 128 m depth, declining to 9 mM O_2 m^{-2} d^{-1} values at the 500 m depth and subsequently declining to low values at the 1000 m depth (mean=2.2 mM O_2 m^{-2} d^{-1}). The highest sediment uptake rates In Barrow Canyon exceeded the Pacific-influenced Chukchi shelf site north of Bering Strait (HV1)which had a mean value of of 13.2 mM O_2 m^{-2} d^{-1}. It should be noted that past summer values at the HV1 site reach as high as 40 mM O_2 m^{-2} d^{-1} annually, suggesting that the deposition of phytodetritus to this productive site had not yet occurred in mid-May. The East Hanna Shoal transect in the Chukchi Sea had shelf (40-100 m) mean values

ranging from 4.2-7.5 mM O_2 m^{-2} d^{-1} to 5.6 mM O_2 m^{-2} d^{-1} at the 500 m slope site, with the lowest mean sediment respiration values at the 1000 m site (1.2 mM O_2 m^{-2} d^{-1}).

It is notable that higher sediment uptake rates occurred at deeper depths in Barrow Canyon, which are likely due to a focusing of organic carbon down the axis of the canyon. Of particular interest is the 500 m site on the Barrow Canyon line, which had 2x the sediment respiration rate as the site at EHS to the east at the same depth. Note that we also had rocks surrounded by concretions that appeared to be influenced by biologically mediated, chemical reactions at the 500 m Barrow Canyon site, similar to what was found in 2002. Finally, due to heavy ice conditions, we were unable to occupy the East Barrow line. However, we did reoccupy a similar line from the shelf to slope in the Beaufort Sea (Smith Bay (SB) line), that had a mean sediment respiration rate of 12.8 mM O_2 m^{-2} d^{-1} at 60m, which dropped to mean rate of 7.4 mM O_2 m^{-2} d^{-1} at 264 m, which is relatively high and suggests an inflow of organic matter from the rich Pacific-water being advected into the region and heading eastward into the Beaufort Sea.

14a. Sediment trap deployments

Graduate student: Catherine Lalande

The objective of the deployment of sediment traps is to estimate the vertical flux of biogenic matter through the measurements of POC and PON, chlorophyll *a*, phytoplankton, fecal pellets, ^{234}Th, ^{7}Be and $\delta^{13}C$. The traps were deployed at the depths of 30, 40, 50, 60 and 100m at stations EHS5, EHS6, BC5 and BC4 and at the depths of 30, 40, 50 and 60m at EHS4. ^{234}Th activities are counted in collaboration with Pat Kelly and Kate Hagstrom.

Measurements	Water from the traps
POC-PON	200ml
Chlorophyll *a*	2x100ml
Phytoplankton	100ml
Faecal pellets	100ml
Thorium-234	~3L
^{7}Be and $\delta^{13}C$	~3L

Fecal pellet production experiments are done in collaboration with Bob Campbell and Stephane Plourde at stations where sediment traps are deployed. One copepod is kept in 50ml of water (15 replicates) and the faecal pellets are counted over a period of 8 hours to obtain a fecal pellets production rate. The fecal pellets production rate and the amount of fecal pellets caught in the sediment traps will allow the estimation of the percentage of fecal pellets sinking in the water column.

Summary table of the measurements from the sediment traps 5 stations sampled: EHS4, EHS5, EHS6, BC4 and BC5

Sediment traps chlorophyll *a* (μg/L) measurements for HLY0204.

Depth	EHS4	EHS5	EHS6	BC5	BC4
30	25.5	13.3	31.8	12.1	16.0
40	13.8	10.6	48.4	12.5	22.6
50	19.6	10.7	28.2	18.1	34.3
60	12.6	6.6	9.3	21.8	36.7
100		8.2	7.2	26.9	26.9

14b. Sediment chlorophyll and macrofauna project

Graduate student: Rebecca Pirtle-Levy

Sediment chlorophyll has been measured downcore on one core from each multi-HAPS core deployment. Preliminary results indicate an increase in chlorophyll levels at the 3-6 cm interval of the cores. Further analysis will have to be performed to determine what is happening at this interval. Cores used for Jackie's sediment respiration experiments were sieved through a 1mm mesh with a 0.5mm mesh screen inserted to catch the smaller size fraction of animals. These samples will be analyzed at the University of Tennessee.

15. Carbon and Nitrogen Isotope Dynamics:

Susan Schonberg and Craig Aumack
on-board team members; PI: Ken Dunton

Carbon and nitrogen isotope signatures can provide information about the trophic links between pelagic and benthic components of the shelf and slope.

Our objective is to collect biological material from four trophic levels on the Arctic shelf and ocean basin to determine the natural abundance of $\delta^{13}C$ and $\delta^{15}N$.

1. POM was sampled by filtering water collected from two depths (10m and the chlorophyll maximum) onto glass fiber filters.
2. Pelagic animals were caught using a plankton nets, sorted by species and dried.
3. Benthic invertebrates were collected using sediment cores, sieved, sorted by species and dried.
4. Epibenthic invertebrates were collected using a rock dredge at Station 35 in the Barrow Canyon.

The dried samples will be taken back and analyzed using a mass spectrometer at The University of Texas Marine Science Institute upon return from the expedition.

Some General observations:

POM

1. Water column particulate organic matter (POM) was greatest over the shelf (50m, 100m stations), became reduced at 500m and was negligible at stations with greater water depths (1000m and deeper).
2. POM in Barrow Canyon was extremely high at all stations and was very thick and gel-like.
3. POM collected at 10m depth varied between being zooplankton dominated and phytoplankton dominated.

ZOOPLANKTON

1. Arctic shelf copepod species are smaller in size than those found at stations nearer the basin.
2. Shelf samples contained large amounts of phytoplankton and a great number of nauplii and other larval stages of invertebrates (polychaete, decapod, tunicate, etc.) The large quantities of phytoplankton had a gel consistency which effectively clogged the zooplankton collection nets in Barrow Canyon and few copepods were collected.
3. Shelf organisms were collected at our deepest station (1800m) located north of Barrow Canyon (BC27) indicating water currents were distributing shelf organisms that far north towards the Basin.
4. Representatives of the copepod genus *Calanus* and the chaetognath, *Sagitta elegans,* were present in all zooplankton casts at all depths.

BENTHOS

1. Benthic biomass and diversity were greatest at the 50-500m stations and negligible at water depths of 1000m and greater.
2. Polychaete worm and bivalve species dominated the benthic biomass collected in the van Veen grabs.
3. Only a few species of benthic animals were collected from depths greater than 500m and they were small in size.
4. **The Barrow Canyon stations had well sorted cobbles and gravel and a greater number of filter feeding animals than other stations.**
5. The rock dredge was pulled at the southern end of Barrow Canyon (BC35). Numerous large invertebrates were collected from the seafloor surface including soft corals, many types of ascidians, sea anemones, sea urchins, and bryozoans. These animals are all filter or suspension feeders that require rock substrate for attachment.

After completion of Station 035 the following samples have been collected, sorted, identified and dried.

Sample Type	# Samples	Organisms Sampled
Particulate Organic Matter (POM)	182	
Zooplankton	165	*Copepods
		Amphipods
		Chaetognaths
		Pteropods
		Ctenophores
Benthic Invertebrates	441	*Bivalves
		*Polychaetes
		Sipunculids
		Cnidarians
		Ophiuroids
		Asteroids
		Amphipods
		Gastropods
		Priapulids
		Ascidians

*dominant groups

16. Benthic Carbon Oxidation and Dentirification Group

PI: Allan Devol;
onboard team support: Bonnie Chang

The benthic denitrification group has make sediment flux and pore water measurement. In total, we have sampled at 12 of the stations (all stations where benthic work was done). Core incubation experiments have been done for N2, O2 and nutrient fluxes as well as N:Ar ratio fluxes. N2 and O2 fluxes have been done by quadrapole mass spectrometery as has the N:Ar determination. Flux measurements were made at all 12 of the stations. Samples for nutrient flux (NO_3, NH_4, PO_3 and SiO_2) have been frozen for later analysis. Pore water profiles of O_2, alkalinity and nutrients have also been done, at all but one of the stations. Along with the flux measurements samples were taken from the overlying water at the initiation and termination of the incubation for analysis of dissolved oxygen and nitrogen gas isotopes $^{18/16}O_2$ and $^{15/14}N_2$, along with a water sample for the analysis of $^{15/14}NO_3$. Oxygen profiles have been determined by micro-electrode profiling and by whole core squeezing, both at millimeter resolution. Samples were also taken from the squeezed core for NO3 determination and frozen for later analysis.

An additional core was sampled by sectioning at all stations and pore waters were extracted for nutrient profiles (cm resolution). The solid phase of the sectioned cores were saved for later analysis. Additionally, at all stations downcore samples were also taken for the determination of sulfate reduction rate by 35-SO4 tracer techniques. Incubations were preformed in the radio-isotope van and samples were preserved for further processing at a shore based laboratory. Overall we are satisfied with our sampling program during the spring '04 SBI cruise (Although more stations would have been preferred, ice coverage precluded them).

Although many of the chemical analyses remain to be completed back at shore-based laboratories at the University of Washington and Bigelow Laboratory, several tings are clear at present. The measurement of N_2 fluxed due to denitrification was measurable by the quadrapole mass spectrometric method. Right now all we have is N2:Ar ratio changes relative to a reference water, but we will relate these to absolute standards once we return to shore. It is clear however that the shallow cores (`<500 m) have a definite N2 flux into the overlying water. We also expect that the pore water profiles of NO3 will show decreasing NO3 concentrations with depth indicative of denitrification deep in the core. Although these profiles indicate denitrification, the rates are two small to detect with short term incubations. These profiles will be modeled back on shore to obtain denitrification rates for these stations. A second thing that is quite clear is that the trend in oxygen penetration into the sediments is quite different at the various cross shelf sections as well as being distinct from those observed during the Summer '02 SBI cruises. Oxygen penetration depths at the Barrow Canyon section remained shallow but were still significantly deeper than prior summer data. At the East Hanna Shoal section oxygen penetration depths were quite a bit deeper (on order centimeters deeper) than the prior summer penetration depths. A simple diffusion calculation suggests that change in diffusion time is on the order of 100 days, that is it would take about 100 days for the oxygen to penetrate from the summer depths observed in '03 to those observed on this cruise. The oxygen penetration depth at the two non transect stations SBI 4B and SBI5 were both extremely shallow about 4 to 5 mm. This indicates a significant C-loading to these sediments even at this early date. Whether this is due to recent sedimentation of fresh planktonic debris or advective transport and deposition of somewhat older sediment to this site is unknown.

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STATION	DEPTH	N2 & O2 flux N:Ar ratio	O2 PW profile (electrode)	NO3 & O2 PW profile (squeeze)	Nutrient PW profile	SO4 R	solid phases	isotopes
HV1	50 m	x	x	x	x	x	x	x
EHS	50 m	x	x		x	x	x	x
EHS	160 m	x	x		x	x	x	x
EHS	200 m	x	x		x	x	x	x
EHS	1450 m	x	x		x	x	x	
EHS-X	400 m	x	x		x	x	x	x
SBI 4B	50 m	x	x		x	x	x	x
SBI-5	100 m	x	x	x	x	x	x	x
BC-5	1080 m	x	x		x	x	x	x
BC-6	2000 m	x	x		x	x	x	
BC-4	500 m	x	x		x	x	x	x
BC-3	129 m	x	x		x	x	x	x

17. Patty Cie, Yelm Middle School teacher from Washington State, NSF Research Experience for Teachers (RET) program

PI: Ken Dunton

Patty wrote 43 journal entries and have answered over 80 "Ask the Teacher" questions for the TREC (Teachers and Researchers Experiencing the Arctic) website. In addition, she corresponded with students from my classroom and responding privately to questions they requested not be asked and answered in a public format. Furthermore, she photo-documented sampling methods, ice floes, ship life and wildlife to use in future classroom lessons and public talks. She took 1600 digital pictures and filmed four hours of digital video.

On June 4th, a thirty-minute teleconference was held between the Healy and Yelm Middle School. In attendance on the Healy were: Captain Oliver, LCDR Peloquin, Jackie Grebmeier, Lee Cooper, Susan Schonberg, Craig Aumack and Patty Cie. Approximately 45 students were present in Yelm Middle School library. Power point slides were presented during the conference as visual aides; however, the majority of the time was devoted to answering questions the students had previously prepared.

18. Data Distribution/Field Catalog

PIs: Richard Dirks and Jim Moore; Steve Roberts;
on-Board Team Member

A new JOSS field catalog for the Spring cruise was installed on the USCGC Healy during transit from Seattle to Nome. A major new feature of this catalog is the use of OpenSource GIS (Geographic Information System) tools to allow the user to interactively generate maps via a browser interface. This new interface allows the user to plot the current ship position and track (updated every 10minutes) over various types of data layers. The user can zoom in/out pan, measure distances, pick latitude, longitude and depth via an easy to use interface. The data layers include all the past SBI cruise tracks/stations, planned futures stations, SBI moorings, IBCAO bathymetry, land topography, multibeam bathymetry from all the past SBI cruises plus current Seabeam data (updated every ½ hour), current visible satellites imagery (clear weather permitting), radarsat (when provided) and various miscellaneous layers such as towns and rivers.

The catalog is also acting as the repository of project related reports (chief scientist daily operational summaries, Patty Cie's Journals (TREC), daily photos) and the generation and archiving of underway data plots. These include:

- Satellite visible and infrared jpg images for each overpass of NOAA and DMSP that range in resolution from 1/2km to 4km.
- 24 hours time series plots of weather and Other Data (updated 4x hourly).

The catalog provides a web form allowing the ice team (Gradinger, Merkel, Story, Tateyama) to interactively enter their ice observation reports along with photos of ice conditions and upload into the catalog.

The catalog is acting as the host of the Hydrographic Team's CTD/bottle data plus various data plots for dissemination to the rest of the project scientist. The data being provided is:

CTD Data:

- WHP Exchange Format zip file
- Comments on each Cast
- CSV Format ASCII Data
- Standard Plots in jpg format

Bottle Data:

- WHP Exchange Format file
- Bottle Hydrographic Reports

After the end of each station an event log with start and end times, location, depths, and instruments is generated. A station table with maps for the entire cruise is kept up-to-date and is made available in the catalog. This acts as a continuously updating document of our progress.

Once a day during our two 1 hour internet sessions a subset of the catalog content is mirrored back to the JOSS server in Boulder, Colorado to allow people not on the ship to follow our progress. Except for the satellite images I have been able to transfer most of the catalog content to Boulder within about 2 days of their generation.

Satellite raw data pass files are also being archived on 4mm tape for each overpass of the ship by NOAA-12, 14, 15, 16, 17 and DMSP f-12, 13, 14. 15. These data will be added to the SBI Data Archive at JOSS when the cruise is over.

There was a problem found with the Seaspace Teascan system on the USCG Healy. The system was "upgraded" back in February 2004 by Seaspace Corp. This upgrade involved the installation of a new computer plus software but it seems the antenna is still the original equipment. Upon arriving on the Ship back in May the JOSS representative (Steve Roberts) noticed that the quality of the DMSP satellite images being received by the system were significantly degraded as compared to his experience with the system back in 2002. This problem was mentioned to MSTCS Glen Hendrickson and he told him that he was aware of this problem but did not know enough about the system to fix it. He was working with Seaspace on this issue but since this system is not his priority there has been little progress in getting the system fixed. The scientific concern was the need for high temporal coverage of the surface currents in the SBI region in order to use floating ice as a tracer. During the summer this region is mostly covered in clouds with only a few clear day. During these short clear periods it is possible to infer the ice movement from the 30+ DMSP overpasses per day that occur at this high latitude. However, with the Terascan's current state on average only 1 or 2 "good" DMSP passes are received per day. One or two images a day is not sufficient to infer surface current during these brief clear periods.

Important websites and e-mail addresses:
http://www.joss.ucar.edu/sbi - SBI Data Archive Web Page at JOSS
http://www.joss.ucar.edu/sbi/catalog_hly-04-02- JOSS SBI Field Catalog
sroberts@ucar.edu – Spring 2004 Cruise catalog questions, comments
gstoss@ucar.edu - SBI Data Archive questions
jmoore@ucar.edu – Comments, questions re: JOSS participation in SBI

APPENDICES

APPENDIX A: Science System Report: Dale Chase, LDEO.

Instrument Lab
Lamont-Doherty Earth Observatory of Columbia University
61 Route 9W
Palisades, NY 10964

Subject: SeaBeam 2112 performance during HLY-04-02
Project: Healy Multibeam Support
Created: June 20, 2004
Updated:
Engineer: Dale Chayes
Doc No.:
Revision:
Ref. 1
Ref. 2
Ref. 3
Ref. 4

The following observations characterize the performance of the SeaBeam 2112 multiple formed beam swath mapping sonar on the Healy during cruise HLY-04-02 (SBI Process I).

Cruise Info

Healy cruise HLY-04-02 departed from Nome, Alaska on Saturday, May 15, 2004, transited through Bering Strait into the Chukchi Sea and occupied a large number of stations in the southern Chukchi. The cruise ended at Nome, Alaska on Wednesday, June 23, 2004.

This cruise was the first of two "process" cruises for the Shelf Basin Interaction project in 2004 on the Healy. The science focus of this cruise was primarily on station data but all underway systems were routinely operated including the SeaBeam SB2112 multibeam sonar.

Watch standing

There was no routine watch for the multibeam during this cruise. The Healy's Marine Science Technicians (MSTs) were doing hourly rounds and checked on the status of the multibeam during their rounds.

System Overview

The multibeam installed on the Healy for this cruise is a SeaBeam model 2112 operating at 12 kiloHertz. It has sixty (60) hydrophones in the receive array and 12 projectors in the transmit array. The arrays are arranged in a Mills Cross at approximately frame 54. SeaBeam Real-Time Sonar System Software version 1.2.1A was used for the entire cruise.

Multibeam inputs

Sound speed at the keel

During the majoring of the cruise ice cover was too thick to allow proper operation of the recently updated science seawater system. Because of the ice cover, the sound speed at the keel (calculated from TSG and CTD data during stations) was surprisingly stable at 1437 m/s so the manual input mode was used. Late in

the cruise, when the vessel was in less dense ice, external sound speed at the keel was calculated from the forward SeaBird Thermosalinograph data in real-time, reformatted and provided to the SeaBeam. Sound speed was calculated using the Chen Millero 1977 equation and inputs of conductivity (converted to salinity) and temperature from the active TSG.

Sound speed profiles

A single sound speed profile was used during this cruise. No obvious artifacts due to improper sound speed profile were observed in real-time.

Navigation and heading

The real-time navigation input for the entire cruise was provided by the ship's integrated bridge system. There is no other reliable source capable of providing the right data in the correct formats available on the ship.

Heading derived from the ship's MK-37 gyrocompasses was provided through the IBS. There was no other continuously available source on board during this leg.

There were no substantial interruptions in the inputs from the IBS during this cruise.

Time synchronization

Time of day synchronization was provided from the IBS for the entire cruise. There was no other source available during this cruise.

Attitude

A Kongsberg Simrad Seatex MRU6 serial number 225 vertical reference was used for the entire cruise. There is no other vertical reference for the SB2112.

Performance Issues:

Multibeam (and other sonars) performance in ice

The science driving this cruise results in revisiting the same sites over multiple years and in different seasons. This provided a great opportunity to compare the relative performance operating in ice and in open water (at different times of the year.)

Hydrophones and projectors

A substantial fraction of the hydrophones and one projector array were replaced during the shipyard period prior to this season. The necessity of the repair effort was identified through electrical checks of the arrays during preparations for the 2003 field season. Electrical checks during the drydock and after the vessel was in the water indicated that the arrays were in good shape. After the substantial icebreaking during this leg, the electrical checks were made again on June 20, 2004 by ships force ETs.

Thermosalinograph (TSG)

The SB2112 installation on the Healy (in addition to other science systems) depends up real-time measurements of water temperature and conductivity to estimate the speed of sound used in the beam former. Errors in estimating this parameter are very hard if not impossible to accurately remove after the

fact. Therefore, problem with water flow that result in poor performance of the TSG and hence inaccurate sound speed are critical.

Forward Thermosalinograph
The newly installed science seawater system was out of service for several extended periods during this cruise. The initial problems were due to very heavy, tight sea ice cover that forced ice to be ingested into the system. It is also likely that the super cooled sea-water was freezing in the system. During the cruise one of the pump couplings failed, most likely due to ice or debris ingested into the pump. No spare coupling was on board but the system was run in an alternate configuration. During much of the cruise, the ship's engineers found it possible to keep the system running but due to tight bends and small piping in the lab areas, it was not possible to keep them from freezing up. Further effort should be made toward improving the ability to get seawater from the intake into the flow through science systems.

Aft Thermosalinograph
Portions of the science program for this cruise used the aft TSG. It was on sporadically, mostly during stations.

Navigation resolution
The format for navigation input to the SB2112 on the Healy only allows for two places for decimal minutes of latitude and longitude. The resulting truncation in precision results in some jitter in the real-time display. The navigation accuracy in the multibeam data can be improved in post processing by merging data from either of the existing P-Code receivers.

Shallow water performance

The SB2112 on the Healy is not capable of shortening it's transmit array when operating in shallow water. As a result, the data in less than about 250m of water is taken with the sonar operating in the near field. The resulting data quality is substantially worse than data collected in deeper water. Much of the data collected during this cruise was in water depths less than 250m.

VRU error messages

As in previous cruises, there were intermittent bursts of "FATAL" error messages reported in the Status window by the SB2112. Unfortunately, these errors are not recorded which makes documenting correlation with external events difficult.
There is no direct evidence that the bathymetry data is significantly degraded in association with these errors but it is possible. Perhaps more importantly, these errors are very alarming.
The long cable run between the SB2112 (in the Computer Lab) and the VRU (in the IC/Gyro Space) provides power down to the VRU and data communications between the VRU and the SB2112 receiver processor. It is possible that EMI is causing interference with the communications between the two devices. Options for addressing this issue include moving the VRU to the Computer Lab, adding EMI filters, installing filtered line drivers and re-routing the cable. Careful thought should be given prior to future effort.

VRU alignment

A roll and pitch bias calibration was done during the shakedown prior to this field season.
No roll or pitch bias data was collected during this cruise.

Ping rate

This SB2112 has a minimum ping interval of about 1.5 seconds. As a result, along track sampling in less than about 500m of water is significantly less that desirable.

APPENDIX B: UPDATED FOC'SLE INCUBATOR PLAN: 31 MAY 2004

The following plan was finalized during HLY0403 for providing ambient seawater to the 3-E-O-W ballast tank and out to the incubators on the foc'sle deck. The responsibilities of the science user component, the Chief Scientists, USCG Marine Science Technicians (MSTs), and engineering department are outlined in this plan below:

Responsibilities of Scientists running incubator experiments

1. When the scientist needs seawater on the foc'sle deck they contact the lead scientist on duty (Grebmeier or Cooper).
2. The scientists using the incubators on the foc'sle need to coordinate hose hook up and drainage depending on whether setting up or terminating all experiments. Both manifolds must be in use or the one not being used will freeze. The manifold not in use needs to have a minimal flow rate to prevent freezing.
3. During the experiments the scientists will monitor the flow and temperature and pass requests for seawater needs through Grebmeier/Cooper who will pass requests to lead MST.
4. If the incubators are in use at the end of a process station, the scientist will regulate flow to maintain temperature range desired to the incubators. Coordination between starboard and port hose usesrs is necessary for efficient use of the remaining seawater in the ballast tank through the end of the experiments.
5. At the end of all experiments the scientist will contact the lead chiefs scientist who then contacts the lead MST to turn off the pump. Once the pump is off (turn switch on starboard side of foc'sle), the scientists will drain the hoses.
6. The scientists will then open up the spigots on the ballast manifold so it drains and does not freeze.

Responsibilities of Chief Scientists

1. Grebmeier/Cooper will contact lead MST to request turning on the ballast tank pump when requested by user scientists.
2. The chief scientist will periodically verify the current ballast tank volume with ECC and write it on the white board in the main science lab.
3. Once all the incubator experiments are complete, the final user scientist will tell the lead chief scientist to tell the lead MST to turn the pump system off completely. MST will contact engineering.

Responsibilities of MST

1. When requested, the lead MST will turn on the pump to the ballast tank, or turn it off if all incubator experiments are terminated and there will be a time lapse between stations.
2. If the lead scientist requests full ballast refill, he/she will request the MST to turn off the ballast tank pump and that the MSTs verify that the nozzles on the manifold are in the open position to drain the manifold.
3. Once the above is confirmed, the lead MST will contact engineering to initiate the dumping of seawater and subsequent refill of the ballast tank via the SSW input manifold to the ballast tank.

Responsibilities of Engineering Dept.

1. If the station is "short" (<1.5hr), the ballast tank will not be dumped, but only topped off while on station with cold water from the SSW system.
2. If there are no incubation experiments on the bow, as confirmed by the MSTs, then one hour before reaching a process (long) station engineering will start emptying the ballast tank to its 6000gallon

("empty") volume. Once the ballast tank is "empty" and the Healy stops on station, engineering will open the installed SSW valve, located in the forward starboard side 01 deck vestibule, and begin pumping in seawater into the 3-E-O-W ballast tank.

At the end of the station engineering will secure the installed SSW system (with the exception of #4 SSW pump). MSTs will then energize the ballast tank pump as needed to supply the incubators.

HLY-04-02 Service Group Bottle Data Documentation

15 May to 23 June 2004
Nome, Alaska to Nome, Alaska

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Data Set Overview

98 CTD casts on 35 stations were attempted. One of these was aborted, with no CTD data and no water samples, six additional casts were aborted, the CTD data from these casts were reported, but there were no water samples. These casts were:

Station	Cast	
003	01	CTD data reported, 12 bottles tripped.
006	02	CTD data reported, 12 bottles tripped.
016	01	CTD data reported, 4 bottles tripped.
016	03	CTD data not reported, no bottles
027	01	CTD data reported, no bottles.
031	03	CTD data reported, aborted mid down-cast

Instrumentation

CTD casts were performed with a rosette system consisting of a 12-place rosette frame with 30 liter bottles and a 12-place SBE-32 Carousel pylon. Underwater electronic components consisted of: Sea-Bird Electronics, Inc. (SBE) 911plus CTD, WETLabs C-Star transmissometer with a 25cm path length and 660nm wavelength, Biospherical Instruments, Inc. Photosynthetically Active Radiation (PAR) sensor, Chelsea MkIII Aquatracka fluorometer, and Simrad, 5 volt - 500 meters altimeter.

Additionally, a Dr. Haardt fluorometer designed to detect colored organic matter (CDOM) and a Secchi disk were mounted on the CTD package. The CTD, transmissometer, and the two fluorometers were mounted horizontally along the bottom of the rosette frame. The PAR sensor was located at the top of the rosette. The surface PAR sensor was located on the aft, starboard railing of the helicopter shack. All sensors except the Secchi disk were interfaced with the CTD system. This instrument package provided pressure, dual temperature and dual conductivity channels as well as light transmissivity and fluorometric signals at a sample rate of 24 scans per second.

The bottles on the rosette were General Oceanic 30 liter bottles. The bottles were equipped with internal nylon coated springs and silicone o-rings which are used to minimize toxicity to the sample. Bottle numbering is 1 to 12 with 1 tripped first usually at the deepest sampling level and 12 tripped last at the shallowest sampling level. The rosette system was suspended from a standard UNOLS 3 conductor 0.322" electromechanical cable.

The CTD used was serial number 09P24152-0638 and the sensor's model and serial numbers are listed in Table 1.

TABLE 1. *Instrument/Sensor Serial Numbers*

Primary Temperature	Primary Conductivity	Secondary Temperature	Secondary Conductivity	Pressure	Transmissometer
SBE 3plus	SBE 4C	SBE 3plus	SBE 4C	401K-105	C-Star
03-2796	04-2545	03-2824	04-2568	83009	CST-390DR

Oxygen	Fluorometer	PAR	Surface PAR	Altimeter
SBE 43	Aqua 3	QSP-2300	QSR-240	807
0459	088233	4643	6367	9711090

Equipment Positions

TABLE 2. *Instrument mounting heights in reference to the bottom of the rosette frame.*

Sensor	Height above base of rosette		Sensor	Height above base of rosette
Altimeter	2 cm		Pressure	19 cm
Transmissometer	8 cm		T (pri)	10 cm
Fluorometer (Chelsea)	10 cm			
Fluorometer (Haardt)	8 cm		Par	215 cm Sta. < 2000 m

The distance of the mid-points of the 30 L Niskin bottles from the bottom-mounted sensors was ~1.19m. The 30 Liter Niskin bottles are ~1.0 m long. The secchi disk was mounted 2.2m above the bottom of the rosette frame.

Problems and/or Procedural Changes

Bottle 7 was replaced after station 010. At times the nylon coating on the springs broke down and some rust was apparent. To minimize the occurrence of rust, the springs were inspected before the cruise and, as feasible during the cruise. During the mid-cruise servicing of the CTD/rosette system that occurred following station 021, all springs were inspected and 6 were replaced. HLY0402 rosette operations were continually beset by problems with bottle leaks caused by Niskin bottle end o-rings falling out of position. Typically, each cast had one such occurrence. Although some Niskin bottles were more prone than others to have an o-ring problem, in general the problem shifted from bottle to bottle between casts. Some of the problems were gross, i.e. the o-ring would be visible out the side of the end cap, but others were more subtle. Every time an o-ring problem was suspected, the o-ring was carefully inspected, and replaced if necessary. Also, at several points during the cruise all o-rings were inspected. The contents of various packages of spare o-rings were measured to locate 'large' or 'small' o-rings (within the manufacturer's tolerance), and a remedial 'large' set was installed. Another time Coast Guard personnel replaced all the o-rings from their own supply. Yet all these remedial attempts were to no particular avail. The problem bears further thought toward a satisfactory solution.

CTD Data

CTD Laboratory Calibration Procedures

Pre-cruise laboratory calibrations of CTD pressure, temperature and conductivity sensors were used to generate coefficients for the calculation of these parameters from their respective sensor frequencies. The temperature and conductivity calibrations were performed at Sea-Bird Electronics, Inc. in Bellevue, Washington. Calibration of the pressure sensor was performed by Scripps Institution of Oceanography, Shipboard Technical Support/Oceanographic Data Facility (SIO/STS/ODF) personnel. The Sea-Bird laboratory temperature calibrations were referenced to the International Temperature Scale of 1990 (ITS-90).

CTD Data Acquisition

The CTD 911plus was operated generally as suggested in the Sea-Bird CTD Operating and Repair Manual, which contains a description of the system, its operation and functions (Sea-Bird Electronics, Inc., 2002). One difference from Sea-Bird's operation is that data acquisition was started on deck. This procedure allows a check of the pressure offset and an unblocked reading of the transmissometer. The Seasoft acquisition program as described in the CTD Data Acquisition Software Manual (Sea-Bird Electronics, Inc., 2001) provided a real-time graphical display of selected parameters adequate to monitor CTD performance and information for the selection of bottle-tripping depths. Raw data from the CTD were archived on the PC's hard disk at the full 24 Hz sampling rate.

A CTD Station Sheet form was filled in for each deployment, providing a record of times, positions, bottom depth, bottle sampling depths, and every attempt to trip a bottle, as well as any pertinent comments. When the equipment and personnel were ready, data acquisition was started. The CTD operator pressed a control key (flag), which appends a summary line into the files created for "inventory" files. This file contains a summary of the time, ship's position, and current scan number each time the control key is pressed. They are used as a reference to mark important events during the cast, such as on deck pressure, when the lowering was initiated, when the package was at the bottom, when bottles were tripped and the on-deck pressure with ending position. After the initial flag, the rosette/CTD system was lowered into the water and held at 5 meters wire out for 3-5 minutes to permit activation of the CTD pumps and equilibration of the sensors. Then, the operator had the CTD raised to the surface, again created a flag, and simultaneously directed the winch operator to begin lowering. The operator created a flag at the deepest point of the cast. Bottom depths were calculated by combining the distance above bottom, reported by the altimeter, and the maximum depth of the CTD package when bottom altimeter readings were available. If there was no

altimeter reading, then the bottom depth is reported from the ship's Bathy 2000 or Knudsen model 320B/R depth recorder. These data, corrected for the draft of the transducer, were logged in uncorrected meters (assuming a sound velocity of 1500 m/sec). If the altimeter and depth recorder data were unavailable, the final resort was to use depth data from the SeaBeam system (corrected sound velocities).

The wire out corresponding to each bottle trip was written on the station log and the trips were electronically flagged in the data file. The performance of all sensors was monitored during the cast. After the rosette recovery, the operator created a final flag denoting the end of the cast. Any faulty equipment or exceptionally noisy data were noted on the log sheet.

Problems and Procedural changes

Prior to station 007, position information was not being appended to every scan. The wrong configuration file was later inadvertently chosen and the absolute positions were not appended to the data for Stations 020 casts 3-7, 021 cast 01, 023 casts 1-1, 024 casts 2-3 and 025 cast 1.

CTD Data Processing

Pressure

CTD values determined on deck before and after each cast were compared to determine a pressure offset correction. The comparison suggested that no pressure offset was necessary.

Temperature

The temperature sensors were calibrated in November of 2003. The dual temperature sensors were monitored during the expedition and exhibited good agreement. It appears that no additional corrections need to be applied. A post-cruise calibration will be performed.

Conductivity

Corrected CTD pressure and temperature values were used with bottle salinities to back-calculate bottle conductivities. Comparison of these bottle values with the CTD primary conductivity values indicated no additional offset needed to be applied to the data.

Transmissometer

A WETLabs calibrated transmissometer was utilized throughout the cruise. An on deck calibration check was performed and even though there was little degradation from the last calibration, the new coefficients were applied to the data set.

Oxygen, Fluorometer, and PAR

The CTD oxygen data are only intended for qualitative use. Similarly, the fluorometric and PAR data are not calibrated.

Data Processing

Sea-Bird Seasoft CTD processing software was employed. The processing programs are outlined below. A more complete description may be found in the Sea-Bird Software Manual which is available from the Sea-Bird website (www.seabird.com).

The sequence of programs that were run in processing CTD data from this cruise are as follows:

- ***DATCNV*** - Converts data from raw frequencies and voltages to corrected engineering units
- ***WILDEDIT*** - Eliminates large spikes
- ***CELLTM*** - Applies conductivity cell thermal mass correction

- ***FILTER*** – A low pass filter to smooth pressure for LOOPEDIT
- ***LOOPEDIT*** - Marks scans where velocity is less than selected value to avoid pressure reversals from ship roll, or during bottle flushing.
- ***DERIVE*** - Computes calculated parameters
- ***BINAVG*** - Average data into desired pressure bins

The quality control steps included:

- ***Sensor verification*** After the CTD was set up and sensor serial numbers and sensor location was entered into the computer, another check was made to verify that there were no tabulation errors.
- ***Seasoft Configuration File*** was reviewed to verify that individual sensors were represented correctly, with the correct coefficients.
- ***Temperature*** was verified by comparing primary and secondary sensor data.
- ***Conductivity*** was checked by comparison of the two sensors with each other and with bottle salinity samples.
- ***Position Check*** A chart of the ship's track was produced and reviewed for any serious problems. The positions were acquired from the ship's Trimble P-code navigation system.
- ***Visual Check*** Plots of each usable cast were produced and reviewed for any noise and spikes that may have been missed by the processing programs.
- The density profile was checked for inversions that might have been produced by sensor noise or response mismatches.

CTD Data Footnoting

WHP water bottle quality flags were assigned as defined in the WOCE Operations Manual (Joyce and Corry, 1994). These flags and interpretation are tabulated in the CTD and Bottle Data Distribution, Quality Flags section of this document.

Data Comments

Fine structure including minor density inversions that may appear in the upper ~ 10 m of the profiles is most likely caused by ship discharges/turbulence. To minimize the ship effect, engine cooling water discharges were restricted to the port side of the Healy. A "yo yo" procedure was adopted to induce bottle flushing whenever waves and ship motion were weak. This procedure was employed for all bottle trips under quiescent conditions except for productivity casts. Regardless of the procedure employed, the CTD operators were instructed to wait for at least 1 minute (typically > 1.5 minutes) before tripping the bottle.

All salinity, nutrient and dissolved oxygen data collected by the "service" team have gone through several stages of editing and are not likely to change significantly. This included a post-cruise examination of the nutrient data by L.A. Codispoti who pointed out suspect values that were then double checked and flagged as appropriate by SIO/ODF personnel.

Bottle Data

There were five generic types of casts performed with differing sampling protocols. Generally speaking, the samplings during these casts were as follows, but there is some cast-to-cast variation.

- **Hydrographic**
  - ***Oxygen,***
  - ***Total CO2,***
  - ***Total Alkalinity,***
  - ***Nutrients***
  - ***Chlorophyll/Phaeophytin***
  - ***Phytoplankton***
  - ***Salinity***
  - ***O18/O16***
  - ***Benthic***
  - ***Dissolved Organic Matter/Particulate Organic Matter***
  - ***Thorium-234***
- **Productivity/Zooplankton**
  - ***Oxygen***
  - ***Oxygen Respiration***
  - ***Productivity***
  - ***Nutrients***
  - ***Chlorophyll***
  - ***HPLC***
  - ***Bacteria***
  - ***Micro Zooplankton***
  - ***Particulate Organic Matter***
  - ***Dissolved Organic Matter/Lignin***
  - ***Bio-Optics***
  - ***Taxonomy***
  - ***C13/N15***
- **Bio-Markers**
  - ***Nutrients***
  - ***Particulate Organic Matter***
  - ***Dissolved Organic Matter/Lignin***
- **Radium**
  - ***Nutrients***
  - ***Radium***
- **Zooplankton**
  - ***Nutrients***
  - ***Micro Zooplankton***
  - ***C13/N15***

The correspondence between individual sample containers and the rosette bottle from which the sample was drawn was recorded on the sample log for the cast. This log also included any comments or anomalous conditions noted about the rosette and bottles.

Normal sampling practice included opening the drain valve before the air vent on the bottle, to check for air leaks. This observation together with other diagnostic comments (e.g., "lanyard caught in lid", "valve left open") that might later prove useful in determining sample integrity was routinely noted on the sample log.

Bottle Data Processing

After the samples were drawn and analyzed, the next stage of processing involved merging the different data streams into a common file. The rosette cast and bottle numbers were the primary identification for all ODF-analyzed samples taken from the bottle, and were used to merge the analytical results with the CTD data associated with that bottle.

Diagnostic comments from the sample log, and notes from analysts and/or bottle data processors were entered into a computer file associated with each station (the "quality" file) as part of the quality control procedure. Sample data from bottles suspected of leaking were checked to see if the properties were consistent with the profile for the cast, with adjacent stations, and, where applicable, with the CTD data. Direct inspection of the tabular data, property-property plots and vertical sections were all employed to check the data. Revisions were made whenever there was an objective reason to delete, annotate or re-calculate a datum. WHP water sample codes were selected to indicate the reliability of the individual parameters affected by the comments. WHP bottle codes were assigned where evidence showed the entire bottle was affected, as in the case of a leak, or a bottle trip at other than the intended depth.

Specific data processing and techniques and additional quality control are included with the parameter write-up.

Pressure and Temperatures

All pressures and temperatures for the bottle data tabulation were obtained by averaging CTD data for a brief interval at the time the bottle was closed and then applying the appropriate calibration data.

The temperatures are reported using the International Temperature Scale of 1990.

Salinity

384 salinity samples were analyzed in 14 analyses runs.

Sampling and Data Processing

Salinity samples were drawn into 200 ml high alumina borosilicate bottles, which were rinsed three times with sample prior to filling. The bottles were sealed with custom-made plastic insert thimbles and Nalgene screw caps. This container provides very low container dissolution and sample evaporation.

Equipment and Techniques

A Guildline Autosal 8400B #65-715, standardized with IAPSO Standard Seawater (SSW) batch P-144, was used to measure the salinities. Prior to the analyses, the samples were stored to permit equilibration to laboratory temperature, usually 8-20 hours. The salinometer was outfitted with an Ocean Scientific International interface for computer-aided measurement. The salinometer was standardized with a fresh vial of standard seawater (SSW) at the beginning of each analysis run. Instrument drift was determined by running a SSW vial after the last sample was run through the autosal. The salinometer cell was flushed until two successive readings met software criteria for consistency; these were then averaged for a final result. The estimated accuracy of bottle salinities run at sea is usually better than 0.002 PSU relative to the particular standard seawater batch used.

Laboratory Temperature

The temperature stability in the salinometer laboratory was good; variation was no more than 1ºC during a run of samples. The laboratory temperature was generally 2-3ºC lower than the Autosal bath temperature.

Oxygen

463 samples were analyzed for oxygen.

Sampling and Data Processing

Samples were collected for dissolved oxygen analyses as the first sample after the rosette was brought on board. Using a Tygon drawing tube, nominal 125ml volume-calibrated iodine flasks were rinsed three times, then filled and allowed to overflow for approximately 3 flask volumes. The sample draw temperature was measured with a small platinum resistance thermometer embedded in the drawing tube. Reagents were added to fix the oxygen before stoppering. The flasks were shaken twice to assure thorough dispersion of the precipitate, once immediately after drawing, and then again after about 20 minutes. The samples were usually analyzed within a few hours of collection. Thiosulfate normalities were calculated from each standardization and corrected to 20ºC. Periodically, the 20ºC normalities and the blanks were plotted versus time and were reviewed for possible problems. New thiosulfate normalities were recalculated as a linear function of time, if warranted. The oxygen data were recalculated using the smoothed normality and an averaged reagent blank. Oxygens were converted from milliliters per liter to micromoles per kilogram using the sampling temperature. **Equipment and Techniques**

Dissolved oxygen analyses were performed with an ODF-designed automated oxygen titrator using photometric end-point detection based on the absorption of 365nm wavelength ultra-violet light. The titration of the samples and the data logging were controlled by PC software. Thiosulfate was dispensed by a Dosimat 665 buret driver fitted with a 1.0 ml buret. The ODF method used a whole-bottle modified-Winkler titration following the technique of Carpenter (1965) with modifications by Culberson (1991), but with higher concentrations of potassium iodate standard (approximately 0.012N) and thiosulfate solution (55 g/l). Standard KIO3 solutions prepared ashore were run at the beginning of each run. Reagent and distilled water blanks were determined, to account for presence of oxidizing or reducing materials.

Volumetric Calibration

Oxygen flask volumes were determined gravimetrically with degassed deionized water to determine flask volumes at ODF's chemistry laboratory. This was done once before using flasks for the first time and periodically thereafter when a suspect bottle volume was detected. The volumetric flasks used in preparing standards were volume-calibrated by the same method, as was the 10 ml Dosimat buret used to dispense standard iodate solution.

Standards

Potassium iodate was obtained from Johnson Matthey Chemical Co. and was reported by the supplier to be >99.4% pure.

Nutrients

1229 samples were analyzed for nutrients in 63 analyses runs.

Sampling and Data Processing

Nutrient samples were drawn into 45 ml polypropylene, screw-capped "oak-ridge type" centrifuge tubes. The tubes were rinsed with 10% HCl and then with sample three times before filling. Standardizations were performed at the beginning and end of each group of analyses (typically 6-24 samples) with an intermediate concentration mixed nutrient standard, which was prepared prior to each run from a secondary standard in a low-nutrient seawater matrix. The secondary standards were prepared aboard ship by dilution from primary standard solutions. Dry standards were pre-weighed at the laboratory at ODF, and transported to the vessel for dilution to the primary standard. Sets of 6-7 different standard concentrations covering the range of sample concentrations were analyzed periodically to determine the deviation from linearity, if any, as a function of concentration for each nutrient analysis. A correction for non-linearity was applied to the final nutrient concentrations when necessary. After each group of samples was analyzed, the raw data file was processed to produce another file of response factors, baseline values, and absorbances. These values were then checked for accuracy against values taken from strip chart recordings. A stable deep seawater check sample was run occasionally as a substandard check.

Nutrients, when reported in micromoles per kilogram, were converted from micromoles per liter by dividing by sample density calculated at 1 atm pressure (0 db), *in situ* salinity, and the sample temperature measured at the time of analysis.

Equipment and Techniques

Nutrient analyses (nitrate+nitrite, nitrite, phosphate, silicate, ammonium, and urea) were performed on an ODF-modified 6-channel Technicon AutoAnalyzer II, generally within a few hours after sample collection. The samples were kept in the dark by covering with tin foil or refrigerated at 4°C, if necessary, but brought to within 5°C of lab temperature before analysis. The analog outputs from each of the six channels were digitized and logged automatically by computer (PC) at 2-second intervals.

A modification of the Armstrong *et al*. (Armstrong 1967) procedure was used for the analysis of nitrate and nitrite. For the nitrate plus nitrite analysis, the seawater sample was passed through a cadmium reduction column where nitrate was quantitatively reduced to nitrite. The stream was then passed through a 15mm flowcell and the absorbance measured at 540nm. The same technique was employed for nitrite analysis, except the cadmium column was bypassed, and a 50mm flowcell was used for measurement. Periodic checks of the column efficiency were made by running alternate equal concentrations of NO2 and NO3 through the NO3 channel to ensure that column efficiencies were high (> 95%). Nitrite concentrations were subtracted from the nitrate+nitrite values to obtain nitrate concentrations.

Phosphate was analyzed using a modification of the Bernhardt and Wilhelms [Bernhardt 1967.] technique. The reaction product was heated to ~55ºC to enhance color development, then passed through a 50mm flowcell and the absorbance measured at 820m.

Silicate was analyzed using the technique of Armstrong *et al*., (Armstrong, 1967). The sample was passed through a 15mm flowcell and the absorbance measured at 660nm.

Ammonium was determined by the Berthelot reaction (Patton and Crouch 1977) in which sodium hypochlorite and phenol react with ammonium ion to produce indophenol blue, a blue compound. The solution was heated to 55°C and passed through a 50mm flowcell at 640nm.

Urea was analyzed via a modification of the method of Rahmatullah and Boyde (1980), which is based on the classic diacetyl monoxime method. A solution of diacetyl monoxime, thiosemicarbizide and acetone is followed by the addition of ferric chloride, which acts as a catalyst. The resultant solution was heated to 90°C and passed through a 50mm flowcell. The absorbance was measured at 520nm.

Also reported is N**, a parameter calculated from nitrate, nitrite, ammonium and phosphate concentrations. This parameter is defined as N** = ((N-16P + 2.98)µM) 0.87, where P = the phosphate concentration in µM, and N = (nitrate+nitrite+ammonium in µM). This parameter is quite similar to the original N* parameter defined by Gruber and Sarmiento (1997) except that we include ammonium concentrations because of the high ammonium concentrations that can occur in the SBI region. The underlying premise of both N* and N** is that the N/P atomic regeneration ratio in seawater is normally close to the 16/1 N/P Redfield ratio. The assumption is that deviations from this ratio in N/P ratios in a water mass arise primarily from nitrogen fixation which produces organic matter with N/P ratios in excess of 16/1, or denitrification which consumes nitrate and other forms of fixed nitrogen and converts these forms into elemental dinitrogen gas. Values less than 2.98 suggest that a water mass has experienced net denitrification and higher values suggest net nitrogen fixation. The factors 2.98 and 0.87 are explained by Gruber and Sarmiento (1997), and there is some debate about whether they should be included, but we do so in order to facilitate comparison with the distributions presented by Gruber and Sarmiento (1997).

Nutrient Standards

Na_2SiF_6, the silicate primary standard, was obtained from Johnson Matthey Company and Fisher Scientific and was reported by the suppliers to be >98% pure. Primary standards for nitrate (KNO3), nitrite ($NaNO_2$), and phosphate (KH_2PO_4) were obtained from Johnson Matthey Chemical Company, and the supplier reported purities of 99.999%, 97%, and 99.999%, respectively. Ammonia, (NH4(SO4)2), and Urea primary standards were obtained from Fisher Scientific and reported to be >99% pure.

Bottle Data Footnoting

WHP water bottle quality flags were assigned as defined in the WOCE Operations Manual [Joyce]. These flags and interpretation are tabulated in the Data Distribution, Bottle Data, Quality Flags section of this document.

Data Distribution

The CTD and bottle data can be obtained through NCAR's Earth Observing Laboratory web site, www.eol.ucar.edu/projects/sbi. These data were formerly mounted on a JOSS web site. The data are reported using the WHP-Exchange (WOCE Hydrographic Program) format and the quality coding follows those outlined by the WOCE program (Joyce, 1994). In addition, the format can be obtained through the WOCE Hydrographic Program website, WHPO.ucsd.edu. The descriptions in this document have been edited from the reference to annotate the format specific to this data distribution. ASCII files for each station were created with comments recorded on the CTD Station Logs during data acquisition. These ASCII files include data processing comments noting any problems, the resolution, and footnoting that may have occurred. A separate ASCII file was also created with the comments from the Sample Log Sheets that include problems with the Niskin bottles that could compromise the samples. Comments arising from inspection and checking of the data are also included in the ASCII file. These comment files are also in the EOL/JOSS database. Raw (unprocessed) CTD data are located in the EOL/JOSS database as well. The file hly0402_ctd_raw.zip contains ssscc.cfg, ssscc.con, ssscc.dat and ssscc.hdr (where sss = station number and cc = cast number) files as acquired by the SeaBird SeaSave acquisition program, sbscan.sum file and calibration information for all sensors. The *.cfg file is datcnv.cfg with the beginning scan number and *.con files may include a correction based on the bottle salinity samples. The sbscan.sum file is a list of stations and beginning scan number. Configuration files for the various SeaBird CTD processing programs are also included where applicable.

General rules for WHP-exchange:

1. Each line must end with a carriage return or end-of-line.
2. With the exception of the file type line, lines starting with a "#" character, or including and following a line which reads "END_DATA", each line in the file must have exactly the same number of commas as do all other lines in that file.

3. The name of a quality flag always begins with the name of the parameter with which it is associated, followed by an underscore character, followed by "FLAG", followed by an underscore, and then followed by an alphanumeric character, W.
4. The "missing value" for a data value is always defined as -999, but written in the decimal place format of the parameter in question. For example, a missing salinity would be written -999.0000 or a missing phosphate -999.00.
5. The first four characters of the EXPOCODE are the U.S. National Oceanographic Data Center (NODC) country-ship code, then followed by up to an 8 characters expedition name of cruise number, i.e. 32H1HLY0402.

CTD Data

CTD data is located in file 32H1hly0402_ct1.zip. This file contains ssscc_ct1.csv files for each station and cast where sss=3 digit station identifier and cc=2 digit cast identifier.

Description of ssscc_ct1.csv file layout.

1st line	File type, here CTD, followed by a comma and a DATE_TIME stamp YYYYMMDDdivINSwho YYYY 4 digit year MM 2 digit month DD 2 digit day div division of Institution INS Institution name who initials of responsible person
# lines	A file may include 0-N optional lines at the start of a data file, each beginning with a "#" character and each ending with carriage return or end-of-line. Information relevant to file change/update history may be included here, for example.
2nd line	NUMBER_HEADERS = n (n = 10 in this table and the example_ct1.csv file.)
3rd line	EXPOCODE = [expocode] The expedition code, assigned by the user.
4th line	SECT_ID = [section] The SBI station specification. *Optional*.
5th line	STNNBR = [station] The originator's station number
6th line	CASTNO = [cast] The originator's cast number
7th line	DATE = [date] Cast date in YYYYMMDD integer format.
8th line	TIME = [time] Cast time that CTD was at the deepest sampling point.
9th line	LATITUDE = [latitude] Latitude as SDD.dddd where "S" is sign (blank or missing is positive), DD are degrees, and dddd are decimal degrees. Sign is positive in northern hemisphere, negative in southern hemisphere
10th line	LONGITUDE = [longitude] Longitude as SDDD.dddd where "S" is sign (blank or missing is positive), DDD are degrees, and dddd are decimal degrees. Sign is positive for "east" longitude, negative for "west" longitude
11th line	DEPTH = [bottom] Reported depth to bottom. Preferred units are "meters" and should be specified in Line 2. In general, corrected depths are preferred to uncorrected depths. Documentation accompanying data includes notes on methodology of correction. *Optional.*
next line	Parameter headings.

next line	Units.
data lines	A single _ct1.csv CTD data file will normally contain data lines for one CTD cast.
END_DATA	The line after the last data line must read END_DATA, and be followed by a carriage return or end of line.
other lines	Users may include any information they wish in 0-N optional lines at the end of a data file, after the END_DATA line.

Parameter names, units, format, and comments

Parameter	Units	Format	Comments
CTDPRS	DB	F7.1	CTD pressure, decibars
CTDPRS_FLAG_W		I1	CTDPRS quality flag
CTDTMP	ITS-90	F8.3	CTD temperature, degrees C (ITS-90)
CTDTMP_FLAG_W		I1	CTDTMP quality flag
CTDSAL		F8.3	CTD salinity
CTDSAL_FLAG_W		I1	CTDSAL quality flag
CTDOXY	UMOL/KG	F7.1	CTD oxygen, micromoles/kilogram
CTDOXY_FLAG_W		I1	CTDOXY quality flag
STHETA		F8.3	Sigma Theta
STHETA_FLAG_W		I1	Sigma Theta quality flag
XMISS	%TRANS	F7.1	Transmissivity, percent transmittance
XMISS_FLAG_W		I1	XMISS quality flag
FLUOR	VOLTS	F8.3	Fluorometer, voltage
FLUOR_FLAG_W		I1	Fluorometer quality flag
PAR	VOLTS	F8.3	PAR, voltage
PAR_FLAG_W		I1	PAR quality flag
SPAR	VOLTS	F8.3	Surface PAR, voltage
SPAR_FLAG_W		I1	Surface PAR quality flag
FLCDOM	VOLTS	F8.3	CDOM Fluorometer, voltage
FLCDOM_FLAG_W		I1	CDOM Fluorometer quality flag
DEPTH	METERS	F8.0	Depth

Quality Flags

CTD data quality flags were assigned to the CTDTMP (CTD temperature), CTDSAL (CTD salinity) and XMISS (Transmissivity) parameters as follows:

2 Acceptable measurement.

3 Questionable measurement. *The data did not fit the station profile or adjacent station comparisons (or possibly bottle data comparisons). The data could be acceptable, but are open to interpretation.*

4 Bad measurement. *The CTD data were determined to be unusable.*

5 Not reported. *The CTD data could not be reported, typically when CTD salinity is flagged 3 or 4*.

9 Not sampled. *No operational sensor was present on this cast*

WHP CTD data quality flags were assigned to the CTDOXY (CTD O_2), FLUORO (Fluorometer), PAR (PAR), SPAR (Surface PAR), and HAARDT (Haardt Fluorometer CDOM) parameter as follows:

1 Not calibrated. *Data are uncalibrated*.

9 Not sampled. *No operational sensor was present on this cast. Either the sensor cover was left on or the depth rating necessitated removal.*

10

Bottle Data

Description of 32H1HLY0402_hy1.csv file layout.

1st line	File type, here BOTTLE, followed by a comma and a DATE_TIME stamp YYYYMMDDdivINSwho YYYY 4 digit year MM 2 digit month DD 2 digit day div division of Institution INS Institution name who initials of responsible person
#lines	A file may include 0-N optional lines, typically at the start of a data file, but after the file type line, each beginning with a "#" character and each ending with carriage return or end-of-line. Information relevant to file change/update history of the file itself may be included here, for example.
2nd line	Column headings.
3rd line	Units.
data lines	As many data lines may be included in a single file as is convenient for the user, with the proviso that the number and order of parameters, parameter order, headings, units, and commas remain absolutely consistent throughout a single file.
END_DATA	The line after the last data line must read END_DATA.
other lines	Users may include any information they wish in 0-N optional lines at the end of a data file, after the END_DATA line.

Header columns

Parameter	Format	Description notes
EXPOCODE	A12	The expedition code, assigned by the user.
SECT_ID	A7	The SBI station specification. *Optional*.
STNNBR	A6	The originator's station number.
CASTNO	I3	The originator's cast number.
BTLNBR	A7	The bottle identification number.
BTLNBR_FLAG_W	I1	BTLNBR quality flag.
DATE	I8	Cast date in YYYYMMDD integer format.
TIME	I4	Cast time (UT) as HHMM
LATITUDE	F8.4	Latitude as SDD.dddd where "S" is sign (blank or missing is positive), DD are degrees, and dddd are decimal degrees. Sign is positive in northern hemisphere, negative in southern hemisphere
LONGITUDE	F9.4	Longitude as SDDD.dddd where "S" is sign (blank or missing is positive), DDD are degrees, and dddd are decimal degrees. Sign is positive for "east" longitude, negative for "west" longitude

DEPTH	I5	Reported depth to bottom. Preferred units are "meters" and should be specified in Line 2. In general, corrected depths are preferred to uncorrected depths. Documentation accompanying data includes notes on methodology of correction. *Optional.*

Parameter names, units, and comments:

Parameter	Units	Format	Comments
CTDPRS	DB	F9.1	CTD pressure, decibars
CTDPRS_FLAG_W		I1	CTDPRS quality flag
SAMPNO		A7	Cast number *100+BTLNBR. *Optional*
CTDTMP	ITS-90	F9.4	CTD temperature, degrees C, (ITS-90)
CTDTMP_FLAG_W		I1	CTDTMP quality flag
CTDCOND	MS/CM	F9.4	CTD Conductivity, milliSiemens/centimeter
CTDCOND_FLAG_W		I1	CTDCOND quality flag
CTDSAL		F9.4	CTD salinity
CTDSAL_FLAG_W		I1	CTDSAL quality flag
SALNTY		F9.4	bottle salinity
SALNTY_FLAG_W		I1	SALNTY quality flag
SIGMA	THETA	F9.4	Sigma Theta
SIGMA_FLAG_W		I1	Sigma Theta quality flag
CTDOXY	UMOL/KG	F9.1	CTD oxygen, micromoles/kilogram
CTDOXY_FLAG_W		I1	CTDOXY quality flag
CTDOXY	ML/L	F9.3	CTD oxygen, milliliters/liter
CTDOXY_FLAG_W		I1	CTDOXY quality flag
OXYGEN	UMOL/KG	F9.1	bottle oxygen
OXYGEN_FLAG_W		I1	OXYGEN quality flag
OXYGEN	ML/L	F9.3	bottle oxygen, milliliters/liter
OXYGEN_FLAG_W		I1	OXYGEN quality flag
O2TEMP	DEGC	F6.1	Temperature of water from spigot during oxygen draw, degrees C
O2TEMP_FLAG_W		I1	O2TEMP quality flag
SILCAT	UMOL/KG	F9.2	SILICATE, micromoles/kilogram
SILCAT_FLAG_W		I1	SILCAT quality flag
SILCAT	UMOL/L	F9.2	SILCATE, micromoles/liter
SILCAT_FLAG_W		I1	SILCAT quality flag
NITRAT	UMOL/KG	F9.2	NITRATE, micromoles/kilogram
NITRAT_FLAG_W		I1	NITRAT quality flag
NITRAT	UMOL/L	F9.2	NITRATE, micromoles/liter
NITRAT_FLAG_W		I1	NITRAT quality flag
NITRIT	UMOL/KG	F9.2	NITRITE, micromoles/kilogram
NITRIT_FLAG_W		I1	NITRIT quality flag
NITRIT	UMOL/L	F9.2	NITRITE, micromoles/liter

NITRIT_FLAG_W		I1	NITRIT quality flag
PHSPHT	UMOL/KG	F9.2	PHOSPHATE, micromoles/kilogram
PHSPHT_FLAG_W		I1	PHSPHT quality flag
PHSPHT	UMOL/L	F9.2	PHOSPHATE, micromoles/liter
PHSPHT_FLAG_W		I1	PHSPHT quality flag
NH4	UMOL/KG	F9.2	AMMONIUM, micromoles/kilogram
NH4_FLAG_W		I1	NH4 quality flag
NH4	UMOL/L	F9.2	AMMONIUM, micromoles/liter
NH4_FLAG_W		I1	NH4 quality flag
UREA	UMOL/KG	F9.2	UREA, micromoles/kilogram
UREA_FLAG_W		I1	UREA quality flag
UREA	UMOL/L	F9.2	UREA, micromoles/liter
UREA_FLAG_W		I1	UREA quality flag
FLUORO	VOLTS	F8.3	Fluorometer, voltage
FLUORO_FLAG_W		I1	Fluorometer quality flag
PAR	VOLTS	F8.3	PAR, voltage
PAR_FLAG_W		I1	PAR quality flag
SPAR	VOLTS	F8.3	Surface PAR, voltage
SPAR_FLAG_W		I1	Surface PAR quality flag
HAARDT	VOLTS	F8.3	CDOM Fluorometer, voltage
HAARDT_FLAG_W		I1	CDOM Fluorometer quality flag
N**	UMOL/L	F9.2	N**, micromoles/liter
N**_FLAG_W		I1	N** quality flag
CHLORO	UG/L	F8.2	Chlorophyll, micrograms/liter
CHLORO_FLAG_W		I1	Chlorophyll quality flag
PHAEO	UG/L	F8.2	Phaeophytin, micrograms/liter
PHAEO_FLAG_W		I1	Phaeophytin quality flag
BTL_DEP	METERS	F5.0	bottle depth, meters
BTL_LAT		F8.4	Latitude at time of bottle trip, decimal degrees
BTL_LONG		F9.4	Longitude at time of bottle trip, decimal degrees
JULIAN		F8.4	Julian day and time as fraction of day of the bottle trip.

Quality Flags

CTD data quality flags were assigned to CTDPRS (CTD pressure), CTDTMP (CTD temperature), CTDCOND (CTD Conductivity), and CTDSAL (CTD salinity) as defined in Data Distribution, CTD Data, Quality Flags section of this document. CTDOXY (CTD O_2), FLUORO (Fluorometer), PAR (PAR), and SPAR (Surface PAR) parameters are flagged with either a 2, acceptable or 9, not drawn.

Bottle quality flags were assigned to the BTLNBR (bottle number) as defined in the WOCE Operations Manual [Joyce] with the following additional interpretations:

2 No problems noted.

3 Leaking. *An air leak large enough to produce an observable effect on a sample is identified by a flag of 3 on the bottle and a flag of 4 on the oxygen. (Small air leaks may have no observable effect, or may only affect gas samples.)*

4 Did not trip correctly. *Bottles tripped at other than the intended depth were assigned a flag of 4. There may be no problems with the associated water sample data.*

9 The samples were not drawn from this bottle.

WHP water sample quality flags were assigned to the water samples using the following criteria:

1 The sample for this measurement was drawn from the water bottle, but the results of the analysis were not (*yet*) received.

2 Acceptable measurement.

3 Questionable measurement. *The data did not fit the station profile or adjacent station comparisons (or possibly CTD data comparisons). No notes from the analyst indicated a problem. The data could be acceptable, but are open to interpretation.*

4 Bad measurement. *The data did not fit the station profile, adjacent stations or CTD data. There were analytical notes indicating a problem, but data values were reported. Sampling and analytical errors were also flagged as 4.*

5 Not reported. *The sample was lost, contaminated or rendered unusable.*

9 The sample for this measurement was not drawn.

Not all of the quality flags are necessarily used on this data set.

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APPENDIX A: Bottle Quality Comments

Remarks for deleted samples, missing samples, PI data comments, and WOCE codes other than 2 from USCGC Healy, HLY-04-02. Comments from the Sample Logs and the results of ODF's investigations are included in this report. Investigation of data may include comparison of bottle salinity and oxygen data with CTD data, review of data plots of the station profile and adjoining stations, and rereading of charts (i.e. nutrients). Units stated in these comments are degrees Celsius for temperature, Practical Salinity Units for salinity, and unless otherwise noted, milliliters per liter for oxygen and micromoles per liter for Silicate, Nitrate, Nitrite, Phosphate and Urea and Ammounium, if appropriate. The first number before the comment is the cast number (CASTNO) times 100 plus the bottle number (BTLNBR).

Station 001.001

101-104 Nutrients: "Autoanalyzer error, clorox line popped off, NH4 samples lost."
103 Urea appears 0.2 high compared with station profile. No analytical problems noted, higher on chart, could be bad. Footnote urea questionable.
103-104 Oxygen and salinity not drawn per sampling schedule.
104 Sampled for POM.
105 Sample Log: "Leak in bottle from top vent." Oxygen as well as other samples are acceptable. Salinity: "Loose thimble." Bottle salinity agrees with CTD and appears okay on profile.
109-111 Oxygen and salinity not drawn per sampling schedule.
110 Sampled for DOM.
111 Sampled for DOM and Lignin.
112 Sample Log: "Leak in small spigot." Oxygen and salinity as well as nutrients are acceptable.

Station 002.001

105 Salinity, oxygen and nutrients were not drawn per sampling strategy.
107 Sample Log: "Leak in bottle from top cap." Oxygen as well as other samples are acceptable.
109 Sampled for POM.
110 Sampled for DOM and Lignin.

Station 003.001

Cast 1 CTD: "No samples were drawn because the top vents had been left open. Cast was redone as cast 02."

Station 003.002

203-204 No samples taken per sampling strategy.
207 Sample Log: "Top cap leak on bottle." Salinity appears a little low. O2 is high. Bottle leak appears to have effected the samples, nutrients appear okay. Footnote bottle leaking, salinity and oxygen bad.
210 Nosamples taken.
211 Sampled for POM, DOM-2 and Lignin.
212 Sample Log: "Major leak on bottle from small bottom spigot." Oxygen as well as other samples are acceptable. Salinity: "Thimble popped off." Bottle salinity agrees with CTD and appears okay on profile.

Station 004.001

103 Oxygen, salinity and nutrients not drawn per sampling schedule, samples taken for POM.
105 Oxygen: "Computer crashed lost sample."
106 Salinity: "Bung broke off before salinity analyzed, delay. Loose thimble." Bottle salinity agrees with CTD and appears okay on profile. PI: "NH4 may be high." Nutrient analyst: "Bubble in line, corrected value, data okay."
107 Sample Log: "Small air vent or cap leak on bottle." Oxygen as well as other samples are acceptable.

109 Oxygen, salinity and nutrients not drawn per sampling schedule, samples taken for POM, DOM and Lignin.
110 Oxygen, salinity and nutrients not drawn per sampling schedule, samples taken for POM and DOM.
111 Salinity: "Loose thimble." Bottle salinity agrees with CTD and appears okay on profile. Oxygen: "Computer crashed lost sample."
112 SampleLog: "Major leak in bottle and will not be sampled out of until repaired."

Station 005.001
102 Samples taken for Benthic.
106 Salinity: "Loose thimble." Bottle salinity agrees with CTD and appears okay on profile. Oxygen: "Computer crashed lost sample."
107 Sample Log: "Small vent leak on bottle." Oxygen as well as other samples are acceptable. Salinity: "Three readings before two good readings were made. Second reading was low and would make the salinity even less saline. No obvious reason why salinity low by about about 0.005. Footnote salinity bad.
109 Samples taken for POM only.
110 Samples taken for DOM and Lignin only.
112 SampleLog: "No sample taken out of bottle due to major leak."

Station 006.001
101 Samples taken for Bact, C13/N15 only.
103 Samples taken for Bact, C13/N15 only.
106 Samples taken for POM only.
107 Samples taken for POM and Lignin only.
109 Sample Log: "Small bubbles found in Oxy flask upon second shake." Oxygen appears slightly high compared with CTD and station profile. Footnote oxygen bad.
111 Nosamples drawn per sampling strategy.
112 Nosamples drawn per sampling strategy.
Cast 1 Salinity not drawn, Productivity cast.

Station 006.002
Cast 2 CTD: "A-Frame h.p.u was dead. Rosette hung out under A-Frame (-0.36) until whole A-frame power was being restored. No water samples taken."

Station 006.003
304 Nosamples drawn per sampling strategy.
306 Salinity 0.01 high vs. the CTD, could be interpreted as high on the station profile. Both conductivity sensors agree fairly well. No analytical or sample drawing notes to indicate a problem. Footnote salinity uncertain.
308 Samples taken for POM only.
310 Nosamples drawn per sampling strategy.

Station 006.004
401 Salinity and oxygen not drawn, nutrients drawn per sampling strategy, Radium cast.
402-412 Salinity, oxygen and nutrients not drawn unless noted otherwise, Radium cast.

Station 007.001
101-110 Salinity, oxygen and nutrients not drawn, Radium cast and Thorium.
111 Salinity and oxygen not drawn, nutrients drawn per sampling strategy, Radium cast.
112 Salinity, oxygen and nutrients not drawn, Radium cast and Thorium.

Station 007.002
207 Samples taken for POM.
208 Nosamples drawn per sampling strategy.
211 Nosamples drawn per sampling strategy.

Station 007.003
301 Samples taken for Bacteria only.
303 PI: "Urea and NH4 high." Nutrient analyst: "No analytical problems noted; possible contamination, NH4 could be related to higher Urea." Footnote Urea and NH4 questionable.
304 Sample Log: "Bubble noticed in oxygen on second shake." Oxygen agrees with CTD and station profile.
306 Samples taken for POM only.
307 Samples taken for DOM/Lignin only.
308 SampleLog: "Oxygen redrawn." Oxygen agrees with CTD and station profile.
310-311 No samples taken per sampling strategy.
312 Samples taken for O2 incubation only.
Cast 3 Salinity not drawn, Productivity cast.

Station 008.001
101 Samples taken for Bact, C13/N15 only.
102 Samples taken for POM only.
103 Samples taken for DOM/Lignin only.
105 Sample Log: "Bottom cap leak, not stopped by jiggling cap. Serious leak when air vent open." Samples not drawn.
106 SampleLog: "Used for the samples originally intended for 5."
108 Samples taken for POM only.
112 Samples taken for O2 respiration only.
Cast 1 Salinity not drawn, Productivity cast. Taxonomy samples were not written down, not sampled in order. Received sample numbers after the cast. Sample Log: "Sampled from deep to shallow."

Station 009.001
101 Samples taken for Bact, C13/N15 and O18 only.
102 SampleLog: "Redraw on oxygen."
104 Samples taken for HPLC, Taxonomy, and C13/N15 only.
106 Samples taken for POM only.
107 Samples taken for DOM/Lignin and O18 only.
108 Samples taken for O2 incubation only.
110 SampleLog: "Redraw on oxygen."
112 Nosamples drawn per sampling strategy.
Cast 1 Salinity not drawn, Productivity cast.

Station 009.002
201 Onlynutrients drawn, Zooplankton cast also N15/C13.
202 Nosamples drawn per sampling strategy.
203 Onlynutrients drawn, no other samples drawn.
204 Nosamples drawn per sampling strategy.
205-209 Samples taken for Zooplankton.
210 Nosamples drawn per sampling strategy.
211-212 Samples taken for Zooplankton.

Station 009.003
301 Salinity and oxygen not drawn, nutrients drawn per sampling strategy, Radium cast.
302-312 Salinity, oxygen and nutrients not drawn per sampling strategy, Radium cast.

Station 009.004
401 Salinity: "Loose thimble." Levels at the bottom (3 bottles) and at 30 meters, bottle 4, CTD salinity 0.277 higher, bottles on 0.070 higher. CTD Oxygen 0.440 lower, bottle Oxygen only 0.034 lower. Water changed salinity in 2-3 meters about the same as what the difference is between the bottle and CTD. The salinity problem on bottle 4 accounts for only a small part of the 4 vs. 1 bottle differences.
401-403 CTD Log: "Small near-bottom layer, too close to yo-yo."
402 SampleLog: "Suspect only about 18l in bottle." Samples taken for C13/N15 only.
403 Samples taken for POM only.
404 Salinity: "Suspect salt crystal entered from chipped neck seal." The salt crystal would make the salinity a little higher which it is, ˜0.006. Footnote salinity questionable.
407 Sample Log: "Vent is open." Oxygen and salinity are acceptable, therefore, other samples okay too.
409 Nosamples drawn per sampling strategy.
412 Nosamples drawn per sampling strategy.

Station 010.001
101 O2 high, salinity low, nutrients also indicate bottle may not have been flushed adequately. Footnote samples questionable.
106 Nosamples drawn per sampling strategy.
107 SampleLog: "Top cap leak."
108 Nosamples drawn per sampling strategy.
110 Nosamples drawn per sampling strategy.
111 Sample Log: "Bottom cap leak, o-ring is out of position." Samples taken for POM only.

Station 010.002
201 Onlynutrients drawn per sampling schedule, samples for POM, Zooplankton cast.
202-205 POM only samples drawn.
206 DOMonly samples drawn.
207 Only nutrients drawn per sampling schedule, Zooplankton cast. Bottle was changed out at the end of the last cast.
208 Nosamples drawn per sampling strategy.
209 Onlynutrients drawn per sampling schedule, Zooplankton cast.
210-212 Samples for Zooplankton only.

Station 011.001
101 Sample Log: "Water froze in spigot." Only nutrients drawn per sampling schedule,
Bacteria.
102 Samples taken for C13/N15 only.
103 SampleLog: "Water froze in spigot."
104 Oxygen appears to be ˜0.5 low, no analytical problems noted. Footnote oxygen questionable.
105 Samples taken for C13/N15 only.
107-108 No samples drawn per sampling strategy.
110 Samples taken for O2 incubation only.
Cast 1 Salinity not drawn, Productivity cast.

Station 012.001
101 Sample Log: "Slight leak from spigot when vented, suspect ice stuck in cap." Samples taken for O2 and POM only. Switch sampling to bottle 2.
104 Sample Log: "Slight leak from spigot when vented." Bottle salinity ˜0.5 high, O2 ˜0.04 low relative to CTD; suggest non-ideal flushing. Leave as is.
105 SampleLog: "Bottom cap leak when vented."
109 Samples taken for C13/N15, DOM and POM only.
111 Nosamples drawn per sampling strategy.
112 Sample Log: "Bottom cap leak when vented. O2 redrawn." Oxygen high by about 0.07 ml/l. Footnote oxygen questionable.
Cast 1 Biological slime on rosette.

Station 013.001
103 Bottle salinity appears to be low by about 0.1, oxygen appears high by 0.1-0.2 compared to CTD. Acceptable for gradients.
105 Samples taken for TH-234, C13/N15 only.
107 Samples taken for TH-234.
108 Bottle O2 high by about 0.02-0.03. No analytical notes. Could be a drawing problem. Within the accuracy of the measurement, leave as is.
109 Samples taken for TH-234, C13/N15 only.
111 Samples taken for TH-234.

Station 014.001
101-102 Bottle salinity low compared to CTD, but appears to be close to correct for gradient.
103 Samples taken for TH-234, C13/N15 only.
104 Sample Log: "Small spigot leak when vented." Oxygen high by ˜0.3 and salinity low by 0.04-0.05. Salinity appears to be close to correct for gradient, (bottles are 1.5m shallower than CTD). Okay as is. Footnote bottle leaking, oxygen questionable.
105 Salinity: "Thimble blew out when cap removed." Salinity may by low by 0.02, footnote salinity questionable. Bottle salinity low compared to CTD, but appears to be close to correct for gradient.
109 Samples taken for TH-234, C13/N15 only.
111 Samples taken for TH-234 only.

Station 015.001
102 Samples taken for DOM/Lignin only.
103 CTDO2 agrees with bottle O2 that 103 has lower O2, higher nutrient water than does 101. Data is acceptable.
103-105 Bottle salinity lower than CTD, but appears to be correct for vertical gradient (bottle is 1.5m above CTD).
109-111 Bottle salinity higher than CTD. No apparent issues. Data is acceptable.
Cast 1 CTD: "Waited five minutes for bridge to give permission, secondary temperature sensor -1.8 degrees at deployment, may have frozen a bit, was okay in water."

Station 016.001
101-104 Bottles were tripped, no samples taken.
Cast 1 CTD: "Cast was aborted due to data communication problems. Cast was redone as cast 02."

Station 016.002
201 SampleLog: "Leak in small spigot." O2 could be a little low, leave as is.
205 NO2high by by ˜0.04. Higher on chart, no problems. Footnote NO2 questionable.
212 CTD: "Pulled rosette out of the water before the last bottle tripped reinserted rosette wait for pumps to come back on before tripping last bottle."
Cast 2 Cast 1, Productivity, aborted, problem with CTD.

Station 016.003
Cast 1 CTD: "Cast was aborted when pumps did not turn on. Cast was redone as cast 04. The sample depth for 3-13 are to be mid-point of bottle, or CTD 1.5m deeper than desired depths.

Station 016.004
401 Sample Log reports samples were not drawn, but nutrients are reported. Sample Log: "Major bottom cap leak when air vent was opened." MSTs reported bottle leaking on deck. Urea high compared to this level at other casts. Urea higher than adjacent samples, but so is NH4. No analytical problem or contaminated? Footnote Urea questionable.
402 Samples taken for DOM/Lignin.
403 Onlynutrients drawn, Zooplankton cast.
404 Samples taken for Zooplankton.
405 SeeUrea comments on 401. Footnote urea questionable.
405-407 Only nutrients drawn, Zooplankton cast.
406 SeeUrea comments on 401. Footnote urea questionable.
408-410 Samples taken for Zooplankton.
411 Onlynutrients drawn per sampling schedule, Zooplankton cast.
412 Nosamples drawn per sampling strategy.
Cast 4 Cast 3 aborted. CTD: "The sample depth for bottles 3-13 are to be mid-point of bottle, or CTD 1.5m deeper than desired depths.

Station 016.005
501 Salinity and oxygen not drawn, nutrients drawn per sampling strategy, Radium cast.
502 Salinity, oxygen and nutrients not drawn, DOM/Lignin only.
503-512 Salinity, oxygen and nutrients not drawn, Radium cast.

Station 016.006
601 Salinity and oxygen not drawn, nutrients drawn per sampling strategy, Radium cast.
602-606 Salinity, oxygen and nutrients not drawn, Radium cast.
607 Salinity and oxygen not drawn, nutrients drawn per sampling strategy, Radium cast.
608-612 Salinity, oxygen and nutrients not drawn, Radium cast.

Station 017.001
102 Samples taken for DOM/Lignin only.
103 Samples taken for POM only.
104 Samples taken for POM only.
105 Oxygen: "Lost sample, possibly pickling error, no end point reached."
110 Samples taken for DOM/Lignin only.
111 Samples taken for POM only.
112 Samples taken for POM only.

Station 017.002
203 NH4˜0.04 high. Leave as is. NO2 0.04-0.05 high. No analytical problems, definitely higher. Leave as is.
205 Samples taken for Bact, C13/N15, and POM only.
206 Samples taken for O2 incubation only.
207 Samples taken for DOM/Lignin only.
210 Samples taken for Bact, C13/N15 only.
211 Nosamples drawn per sampling strategy.

Station 017.003
301 Salinity and oxygen not drawn, nutrients drawn per sampling strategy, Radium cast.
302-306 Salinity, oxygen and nutrients not drawn, Radium cast.
307 Salinity and oxygen not drawn, nutrients drawn per sampling strategy, Radium cast.
Urea high by ˜0.3, NH4 by ˜0.05, compared with cast 1 and 2. Odd looking peaks
Urea-could easily be lower. Footnote Urea questionable. NH4 within analytical precision, but could be high-noisy peak. Leave NH4 as is.
308-312 Salinity, oxygen and nutrients not drawn, Radium cast.

Station 017.004
401 Nutrients drawn per sampling schedule, Bacteria sampled.
402 Nutrients drawn per sampling schedule, Bacteria sampled.
403 Oxygen: "Sample lost, overtitrated then back-titrated but sample never went to clear."
405 SampleLog: "O2 redrawn."
406 Samples taken for O2 incubation only.
410-412 No samples drawn per sampling strategy.
Cast 4 Salinity not drawn, Productivity cast.

Station 018.001
101 Sample Log: "leak in bottle 1, cap not sealed." No samples drawn per sampling strategy.
102 NO2seems high, but there is a near-bottom increase though not to such a high level, at Station 17 (but not at Station 19). Still may be questionable. No analytical problems, data are acceptable.

Station 019.001
103 Ureaappears to be ˜0.04 high. Urea high on chart. Footnote Urea questionable.
104 Salinity: "Bottle loose thimble, no fit with others-retired bottle." Salinity agrees with CTD. Data are acceptable.
107 Sample Log: "Has a small leak." Salinity and O2 agrees with CTD. Data are acceptable.
112 Bottle O2 ˜0.12 high compared to CTDO, but it is possible this is correct for gradient.

Station 019.002
206 Salinity: "Bottle thimble popped out, salt drop ran into bottle use first reading." Salinity is 0.05 higher than CTD. Gradient, leave as is.
207 Sample Log: "Still has a small leak." Salinity 0.04 higher than CTD, O2 agrees fairly well.
210 SampleLog: "Top o-ring is out of place." No samples drawn except O-18.

Station 019.003
301 Nutrients drawn per sampling schedule, Zooplankton cast.
302-309 Samples taken for Zooplankton only.
310 Nutrients drawn per sampling schedule, Zooplankton cast.
311-312 Samples taken for Zooplankton only.

Station 019.004
401-405 Salinity, oxygen and nutrients not drawn, Radium cast.
406 Salinity and oxygen not drawn, nutrients drawn per sampling strategy, Radium cast.
Autoanalyzer error nh4 channel only
407-411 Salinity, oxygen and nutrients not drawn, Radium cast.
412 Salinity and oxygen not drawn, nutrients drawn per sampling strategy, Radium cast.
Autoanalyzer error nh4 channel only

Station 019.005
501-508 Salinity, oxygen and nutrients not drawn, Radium cast.
509 Salinity and oxygen not drawn, nutrients drawn per sampling strategy, Radium cast.
Autoanalyzer error nh4 channel only
510-512 Salinity, oxygen and nutrients not drawn, Radium cast.

Station 019.006
601-602 Salinity, oxygen and nutrients not drawn, Bio-Marker cast.
603-604 Salinity and oxygen not drawn, nutrients drawn per sampling strategy, Bio-Marker cast.
605-607 Salinity, oxygen and nutrients not drawn, Bio-Marker cast.
608 Salinity and oxygen not drawn, nutrients drawn per sampling strategy, Bio-Marker cast.
609-610 Salinity, oxygen and nutrients not drawn, Bio-Marker cast.
611 Salinity and oxygen not drawn, nutrients drawn per sampling strategy, Bio-Marker cast. Autoanalyzer error nh4 channel only
612 Salinity, oxygen and nutrients not drawn, Bio-Marker cast.

Station 019.007
701-702 Nutrients drawn per sampling schedule, samples taken for Bacteria.
705 SampleLog: "Redraw oxygen."
707 Samples taken for O2 incubation only.
710-712 No samples drawn per sampling strategy, Productivity cast.
Cast 7 Salinity not drawn, Productivity cast.

Station 020.001
101 Samples taken for Bacteria.
105 Samples taken for O2 incubation only.
106-107 No samples drawn per sampling strategy.
110 SampleLog: "Oxygen redrawn." Oxygen is acceptable.
111-112 No samples drawn per sampling strategy.
Cast 1 Salinity not drawn, Productivity cast.

Station 020.002
201 Nutrients drawn per sampling schedule, Zooplankton cast.
202-209 Samples taken for Zooplankton only.
210 Sample Log: "Vent not shut tight." Nutrients drawn per sampling schedule, Zooplankton cast.
211-212 Samples taken for Zooplankton only.
Cast 2 Oxygen and Salinity not drawn, Zooplankton cast.

Station 020.003
302 Samples taken for DOM/Lignin only.
303-305 Samples taken for POM only.
312 Sample Log: "Small bottom cap leak-stopped when reset (pushed in)." Oxygen and salinity are acceptable.

Station 020.004
402-403 Autoanalyzer problem, PO4 lost.
407 Salinity: "Too full above shoulder." Salinity is 0.007 compared with CTD, gradient.
Okay as is.
410 Salinity: "Too full above shoulder." Salinity is 0.023 high compared with CTD, gradient. Okay as is.
412 Sample Log: "Leak when vent is open on bottom cap." Salinity: "Too full above shoulder." Oxygen and salinity are acceptable.

Station 020.005
501 Salinity and oxygen not drawn, nutrients drawn per sampling strategy, Bio-Marker
cast.
502-503 Salinity, oxygen and nutrients not drawn, Bio-Marker cast.
504 Salinity and oxygen not drawn, nutrients drawn per sampling strategy, Bio-Marker cast.
505-506 Salinity, oxygen and nutrients not drawn, Bio-Marker cast.
507-508 Salinity and oxygen not drawn, nutrients drawn per sampling strategy, Bio-Marker cast.
509 Salinity, oxygen and nutrients not drawn, Bio-Marker cast.
510 Sample Log: "Major bottom cap leak, o-ring out of groove, visibly." No samples drawn.
511 Salinity and oxygen not drawn, nutrients drawn per sampling strategy, Bio-Marker cast.
512 Salinity, oxygen and nutrients not drawn, Bio-Marker cast.

Station 020.006
601 Salinity and oxygen not drawn, nutrients drawn per sampling strategy, Radium cast.
Urea ˜0.08 high compared with other casts. No analytical problems, data are acceptable.
602-606 Salinity, oxygen and nutrients not drawn, Radium cast.
607 Salinity and oxygen not drawn, nutrients drawn per sampling strategy, Radium cast.
608-612 Salinity, oxygen and nutrients not drawn, Radium cast.

Station 020.007
701 Salinity and oxygen not drawn, nutrients drawn per sampling strategy, Radium cast.
702-706 Salinity, oxygen and nutrients not drawn, Radium cast.
707 Salinity and oxygen not drawn, nutrients drawn per sampling strategy, Radium cast.
Urea about 0.05-0.08 high compared with other bottles/casts near this level. No analytical problems, data is acceptable.
708-712 Salinity, oxygen and nutrients not drawn, Radium cast.

Station 021.001
106 Salinity ˜0.04 high, could be okay for gradient and incomplete flushing except that bottle O2 does not show same sense of error. May be questionable salinity. Footnote salinity questionable.
107-108 Appears that nutrient tubes were switched. No equivalent structure was seen in CTDO and O2. Switch nutrients.

Station 022.001
101 Samples taken for O2 incubation and POM.
106 Samples taken for Bact, C13/N15 only.
107 Samples taken for O2 incubation and Zoop.
110 Samples taken for O2 incubation.

111 Samples taken for DOM/Lignin.
112 Samples taken for POM only.
Cast 1 Salinity not drawn, Productivity cast.

Station 022.002
201 Nutrients drawn per sampling schedule, Zooplankton cast.
202-208 Samples taken for Zooplankton only.
209 Nosamples drawn per sampling strategy.
210 Samples taken for DOM/Lignin only.
211 Nosamples drawn per sampling strategy.
212 Samples taken for POM only.

Station 023.001
101 Urea approximately 0.05 higher than same depth other samples. No analytical problems found on recheck of data. NH4 higher as as well; probably okay. 0.05 is within analytical precision.
102 Samples taken for DOM/Lignin only.
107 SampleLog: "Small leak in niskin when vent was closed". Oxygen agrees with CTD.
111 Samples taken for DOM/Lignin only.
112 Salinity: "Salinity bottle mislabeled on Sample Log Sheet as 12."

Station 023.002
201 Salinity and oxygen not drawn, nutrients drawn per sampling strategy, Radium cast.
202-204 Salinity, oxygen and nutrients not drawn, Radium cast.
205 Sample Log: "May be leaking as came on deck, pushed up on bottom cap and then it stopped." No samples drawn.
206-208 Salinity, oxygen and nutrients not drawn, Radium cast.
209 Nosamples drawn per sampling strategy.
210 Salinity and oxygen not drawn, nutrients drawn per sampling strategy, C13/N15.
Urea is 0.29 higher than similar depths on other casts. Analytical recheck indicates peak in higher, but noisy, other nutrients are higher too than 212. Footnote urea questionable.
211 Salinity, oxygen and nutrients not drawn, O2 incubation.
212 Salinity and oxygen not drawn, nutrients drawn per sampling strategy, Zooplankton.
Urea is 0.13 higher than similar depths on other casts. No analytical problem found.
Footnote urea questionable.

Station 024.001
101 Bottle salinity low by approximately 0.15, but is in high gradient, high salinity bottom layer so it probably okay.
105 Sample Log: "Major leak from bottom end cap when vented." Did not sample for oxygen. Nutrients and salinity samples were taken and very little water was left. After cast repair found o-ring had come out of groove. Salinity: "Three readings to obtain two good readings." Salinity is acceptable.
107 This is an unusual water sample, but CTDS agrees with bottle salinity, CTDO agrees with bottle O2, and nutrients agree with O2, so appears to be genuine.
108 Bottle salinity low by approximately 0.2, but could be okay for high salinity gradient.
111 Sample Log: "Bottom cap leak when vented, water pouring out. After cast repair found o-ring had come out of groove.

Station 024.002
201 Salinity, oxygen and nutrients not drawn, DOM/Lignin.
202-203 Salinity and oxygen not drawn, nutrients drawn per sampling strategy, Bio-Marker cast.
204 Salinity, oxygen and nutrients not drawn, POM only.
205-207 No samples taken per sampling strategy.
Cast 2 Cast was changed to Bio-Mark cast, only 7 bottles tripped when the ice closed in on rosette, had to bring back on board.

Station 024.003
301-302 Nutrients drawn per sampling schedule, Bacteria.
303 Samples taken for O2 incubation only.
305-306 Samples taken for C13/N15 only.
306 SampleLog: "Bottom o-ring leak.
308 Samples taken for O2 incubation only.
Cast 3 Salinity not drawn, Productivity cast.

Station 024.004
401 Nutrients drawn per sampling schedule, Zooplankton cast. Urea high by about 0.2 compared to other samples near this level at this station. No analytical problems found. Footnote urea questionable.
402-404 Samples taken for Zooplankton only.
405 Nutrients drawn per sampling schedule, Zooplankton cast.
406-412 Samples taken for Zooplankton only.
Cast 4 Oxygen and Salinity not drawn, Zooplankton cast.

Station 024.005
501 Salinity and oxygen not drawn, nutrients drawn per sampling strategy, Radium cast.
Urea slightly high for this level. No analytical problems found.
502-506 Salinity, oxygen and nutrients not drawn, Radium cast.
505 SampleLog: "Also did not seat, but not as bad as 8."
507 Salinity and oxygen not drawn, nutrients drawn per sampling strategy, Radium cast.
508 SampleLog: "Did not seat properly (bad leak)."
508-512 Salinity, oxygen and nutrients not drawn, Radium cast.

Station 025.001
101 NH4appears high; may be okay for this layer at nearby casts. No analytical problems found.
101-104 Salinity and oxygen not drawn per sampling schedule, Bacteria.
105 Salinity, oxygen and nutrients not drawn per sampling schedule, samples for O2 incubation and DOM/lignin.
107 Ureais high for this level, approximately 0.08. No analytical problems found. Footnote urea questionable.
108 Salinity, oxygen and nutrients not drawn per sampling schedule, samples for O2 incubation.
Cast 1 Salinity not drawn, Productivity cast.

Station 026.001
107 SampleLog: "Leak from top cap."

Station 026.002
205 SampleLog: "Top cap out of line-leaking."
211 Sample Log: "No water left for nutrients." No salinity, oxygen or nutrients, samples for C13/N15.
212 Nutrients drawn per sampling schedule, no salinity or oxygen, samples for C13/N15.

Station 026.003
301 Salinity and oxygen not drawn, nutrients drawn per sampling strategy, Radium cast.
Urea unusually high for this station. No analytical problem found, the "peak' is higher than other samples, could be contamination. Footnote questionable.
302-306 Salinity, oxygen and nutrients not drawn, Radium cast.
307 Salinity and oxygen not drawn, nutrients drawn per sampling strategy, Radium cast.
308-312 Salinity, oxygen and nutrients not drawn, Radium cast.

Station 026.004
401 Salinity and oxygen not drawn, nutrients drawn per sampling strategy, Radium cast.
402-406 Salinity, oxygen and nutrients not drawn, Radium cast.
407 Salinity and oxygen not drawn, nutrients drawn per sampling strategy, Radium cast.
408-412 Salinity, oxygen and nutrients not drawn, Radium cast.

Station 026.005
501 Salinity and oxygen not drawn, nutrients drawn per sampling strategy, Bio-Marker cast.
502-503 Salinity, oxygen and nutrients not drawn, Bio-Marker cast.
504 Salinity and oxygen not drawn, nutrients drawn per sampling strategy, Bio-Marker cast.
505 Salinity, oxygen and nutrients not drawn, Bio-Marker cast.
506 Salinity and oxygen not drawn, nutrients drawn per sampling strategy, Bio-Marker cast.
507 Salinity, oxygen and nutrients not drawn, Bio-Marker cast.
508 Salinity and oxygen not drawn, nutrients drawn per sampling strategy, Bio-Marker cast.
509 Salinity, oxygen and nutrients not drawn, Bio-Marker cast.
510 Salinity and oxygen not drawn, nutrients drawn per sampling strategy, Bio-Marker cast.
511 Salinity, oxygen and nutrients not drawn, Bio-Marker cast.
512 Salinity and oxygen not drawn, nutrients drawn per sampling strategy, Bio-Marker cast.

Station 026.006
601-602 Nutrients drawn per sampling schedule, Bacteria.
603 Nutrients drawn, no other measurements.
604 Nutrients drawn per sampling schedule, Bacteria.
606 SampleLog: "O2 redrawn."
611 Samples taken for O2 incubation and Bacteria.
612 Samples taken for O2 incubation only.
Cast 6 Salinity not drawn, Productivity cast.

Station 027.001
Cast 1 Cast aborted, no water samples.

Station 027.002
201 Nutrients drawn per sampling schedule, Zooplankton cast.
202-203 Samples taken for Zooplankton only.
204-205 Samples taken for C13/N15 only.
206 Nutrients drawn per sampling schedule, Zooplankton cast. Sample Log: "Bottom cap leak when vented."
207-212 Samples taken for Zooplankton only.
Cast 2 Oxygen and Salinity not drawn, Zooplankton cast.

Station 027.003
302 Sample Log: "O2 redraw, twice." Similar agreement with CTD as other samples. Oxygen is acceptable.
310 Sample Log: "Bad leak bottom when vented." Oxygen is acceptable, gradient area, salinity is acceptable.
311 Sample Log: "Leaking bottom cap when spigot pushed in." Salinity does not agree with CTD, oxygen is a little low, gradient and data are acceptable.

Station 027.004
401-402 Nutrients drawn per sampling schedule, Bacteria sampled.
403 Samples taken for O2 incubation and Bacteria.
406 Samples taken for O2 incubation and Bacteria.
407 SampleLog: "Top cap leak." Oxygen as well as other samples are acceptable.
409 Sample Log: "Triplicate oxygen drawn for O2 incubation experiment." Salinity and nutrients not drawn per sampling schedule.
412 Samples taken for Bacteria only.
Cast 4 Salinity not drawn, Productivity cast.

Station 027.005
505 Sample Log: "Top cap leak." O2 high, but is in unusual layer, so may be okay; bottle salinity is okay as are nutrients.
506 Sample Log: "Bottom cap did not seal, leaking, o-ring, did not sample oxygen or salinity."
511 Sample Log: "Bottom cap small leak." Salinity and oxygen are acceptable, good agreement with CTD.

Station 027.006
601 Salinity and oxygen not drawn, nutrients drawn per sampling strategy, Radium cast.
602-606 Salinity, oxygen and nutrients not drawn, Radium cast.
607 Salinity and oxygen not drawn, nutrients drawn per sampling strategy, Radium cast.
608-612 Salinity, oxygen and nutrients not drawn, Radium cast.

Station 027.007
701 Salinity and oxygen not drawn, nutrients drawn per sampling strategy, Radium cast.
702-706 Salinity, oxygen and nutrients not drawn, Radium cast.
707 Salinity and oxygen not drawn, nutrients drawn per sampling strategy, Radium cast.
Urea is highest value, 0.05, at this level on Stations 024-027. But compares to Station 026, so may be okay. Rechecked data, no analytical problems.
708-712 Salinity, oxygen and nutrients not drawn, Radium cast.

Station 027.008
801 Salinity and oxygen not drawn, nutrients drawn per sampling strategy, Bio-Marker cast.
802-803 Salinity, oxygen and nutrients not drawn, Bio-Marker cast.
804 Salinity and oxygen not drawn, nutrients drawn per sampling strategy, Bio-Marker cast.
805 Salinity, oxygen and nutrients not drawn, Bio-Marker cast.
806-807 Salinity and oxygen not drawn, nutrients drawn per sampling strategy, Bio-Marker cast.
808 Salinity, oxygen and nutrients not drawn, Bio-Marker cast.
809 Salinity and oxygen not drawn, nutrients drawn per sampling strategy, Bio-Marker cast.
810 Salinity, oxygen and nutrients not drawn, Bio-Marker cast.
811 Salinity and oxygen not drawn, nutrients drawn per sampling strategy, Bio-Marker cast.
812 Salinity, oxygen and nutrients not drawn, Bio-Marker cast.

Station 028.001
101-104 Nutrients drawn per sampling schedule, Bacteria.
105 Samples taken for O2 incubation only.
112 Samples taken for O2 incubation, HPLC Bio-Optics and taxonomy.
Cast 1 Salinity not drawn, Productivity cast.

Station 028.002
201 Nutrients drawn, Zooplankton cast.
203 SampleLog: "Bottom o-ring replaced before cast, bottles look okay at end of cast."
204-205 Samples taken for C13/N15.
208 SampleLog: "Bottom o-ring replaced before cast, bottles look okay at end of cast."
209-211 Samples drawn for Zooplankton.
212 Nutrients drawn, Zooplankton cast.
Cast 2 Salinity, Oxygen and nutrients not drawn, except as noted, Zooplankton cast.

Station 028.003
304 Urea is slightly high for this level. No analytical problems found. Data are acceptable.
307 SampleLog: "Top cap leak." Oxygen and salinity are acceptable.
312 Large O2/CTDO difference seems to be okay for gradient.

Station 028.004
407 Sample Log: "Small leak with vent closed-suspect crack in handle mount." CTD vs. bottle oxygen difference is a little lower than other bottles, but is in a gradient that supports this difference. Nutrients are in general agreement. Bottle oxygen is okay.

Station 028.005
501 Salinity and oxygen not drawn, nutrients drawn per sampling strategy, Bio-Marker cast.
502-503 Salinity, oxygen and nutrients not drawn, Bio-Marker cast.
504 Salinity and oxygen not drawn, nutrients drawn per sampling strategy, Bio-Marker cast.
505-506 Salinity, oxygen and nutrients not drawn, Bio-Marker cast.
507 Salinity and oxygen not drawn, nutrients drawn per sampling strategy, Bio-Marker cast.
508-509 Salinity, oxygen and nutrients not drawn, Bio-Marker cast.
510 Salinity and oxygen not drawn, nutrients drawn per sampling strategy, Bio-Marker cast.
511-512 Salinity, oxygen and nutrients not drawn, Bio-Marker cast.

Station 028.006
601 Salinity and oxygen not drawn, nutrients drawn per sampling strategy, Radium cast.
602-606 Salinity, oxygen and nutrients not drawn, Radium cast.
606 SampleLog: "Bottom end cap leak."
607 Salinity and oxygen not drawn, nutrients drawn per sampling strategy, Radium cast.
608-612 Salinity, oxygen and nutrients not drawn, Radium cast.

Station 028.007
701 Salinity and oxygen not drawn, nutrients drawn per sampling strategy, Radium cast.
702-712 Salinity, oxygen and nutrients not drawn, Radium cast.
708 SampleLog: "Bottom end cap leak."

Station 029.001
101-102 Interesting nutrient relationship at bottom; SiO3 and PO4, Urea, NH4 increase while NO3 and NO2 decrease. Probably okay. NO2 looks looks, NO3 does decrease, no analytical problems found, oxygen lower.

103 SampleLog: "Top cap leak cannot get water out of spigot." No samples.
105 SampleLog: "Oxygen 1542 broken after draw, but before pickling had to redraw oxygen." Oxygen is acceptable.
108 Sample Log: "Leak when put pallet jack down, stopped leaking by reseating. At Oxygen draw, top cap leak when vented, bottom cap leak, flow." Bottle O2 is a little high, but not outrageously so. Oxygen is acceptable.

Station 029.002
201 Nutrients drawn per sampling schedule, samples taken for Bact.
202 Nutrients drawn per sampling schedule, samples taken for Bact, C13/N15 only.
203 Samples taken for O2 incubation only.
206 Samples taken for O2 incubation only.
207 Samples taken for C13/N15.
211 Sample Log: "Top cap leak, changed sampling to 12." Samples taken for Bact, zoop.
Cast 2 Salinity not drawn, Productivity cast.

Station 029.003
301 Nutrients drawn per sampling schedule, Zooplankton cast.
306-302 Samples taken for Radium only.
311-307 Samples taken for Zooplankton only.
312 Bottle appears to have mistripped (see below). Nutrients drawn per sampling schedule, Zooplankton cast. NO3 higher by 10-12 uM than other samples near this level at this and nearby stations. Other nutrients also high for this level, but not to the extent of NO3. NO3 is higher, no analytical problems, so are PO4 and SIL, could be contamination.
Footnote all nutrients questionable.
Cast 3 Oxygen and Salinity not drawn, Zooplankton cast.

Station 030.001
101 Salinity bottle-CTD difference is low, but low salinity is okay for gradient.
104 SampleLog: "Bottle loose on mount - needs to be replaced".
106 Sample Log: "Large leak from bottom cap, no O2's drawn". No samples drawn due to leak.
109 SampleLog: "Small bottom cap leak". Oxygen is acceptable.

Station 031.001
105 SampleLog: "Top cap leak; o-ring". Oxygen is acceptable.
106 SampleLog: "Bottom cap leak, no samples taken". No samples drawn due to leak.
108-110 CTD Log: "Bottles tripped on the fly." Salinity CTD-bottle very high, but bottles were tripped on the fly due to sea ice. Data are acceptable.

Station 031.002
201 Salinity and oxygen not drawn, nutrients drawn per sampling strategy, Radium cast. Urea is approximately 0.2 higher than any other near this level at this station. Footnote urea questionable. No analytical problem found, but it is higher.
202-206 Salinity, oxygen and nutrients not drawn, Radium cast.
207 Salinity and oxygen not drawn, nutrients drawn per sampling strategy, Radium cast.
208-212 Salinity, oxygen and nutrients not drawn, Radium cast.

Station 031.003
Cast 3 CTD: "Launch delayed for ice floes drifting past. CTD stopped at ~70meters, due to ice floe problem. Cast aborted."

Station 031.004

401 NH4is slightly high, but there are some similar values nearby. Leave as is. No analytical problems found, urea is higher too.

401-402 Nutrients drawn per sampling schedule, Bacteria.

Cast 4 Salinity not drawn, Productivity cast. Cast was aborted after bottle 2 was tripped, ice encrouchment.

Station 031.005

501 Salinity and oxygen not drawn, nutrients drawn per sampling strategy, Bio-Marker cast.

502-503 Salinity, oxygen and nutrients not drawn, Bio-Marker cast.

504 Salinity and oxygen not drawn, nutrients drawn per sampling strategy, Bio-Marker cast.

505-506 Salinity, oxygen and nutrients not drawn, Bio-Marker cast.

507 Salinity and oxygen not drawn, nutrients drawn per sampling strategy, Bio-Marker cast.

508-509 Salinity, oxygen and nutrients not drawn, Bio-Marker cast.

510 Salinity and oxygen not drawn, nutrients drawn per sampling strategy, Bio-Marker cast.

511 Salinity, oxygen and nutrients not drawn, Bio-Marker cast.

512 Salinity not drawn, oxygen and nutrients drawn per sampling schedule, Bio-Marker cast.

Station 032.001

104 Sample Log: "Small leak before vent open." Oxygen as well as other data are acceptable.

107 Sample Log: "Small leak before vent open." Oxygen as well as other data are acceptable.

111 Sample Log: "Big leaker out of bottom. No samples." Footnote bottle leaking and no samples drawn.

Cast 1 Appears to have been a bad SSW vial at the beginning of the run, corrected salinity files by approximately 0.002. Salinity is acceptable.

Station 033.001

108 Salinity difference, CTD-bottle, is moderately high, but is okay for gradient.

Station 034.001

101 Salinity and oxygen not drawn, nutrients drawn per sampling schedule, Bacteria and POM. Urea is very high. NH4 and NO2 are also high, but for them 102 and 101 are about the same, whereas 101 urea is much higher than 102. Rechecked data, no analytical problems found. Footnote urea questionable.

102 Nutrients drawn per sampling schedule, Bacteria and DOM/Lignin.

103 Nutrients drawn per sampling schedule, Bacteria and POM. Sample Log: "Leaking from bottom cap, reseated then okay until top vent opened then flowing."

104 Samples taken for O2 incubation only. Sample Log: "Leaking from bottom cap, flowing."

106 SampleLog: "Oxygen redrawn."

107 Samples taken for O2 incubation only.

111 Sample Log: "Oxygen redrawn." Oxygen is acceptable. Urea is high. No supporting data in other parameters, including Station 34 cast 2. Rechecked data, no analytical problems found. Footnote urea questionable.

112 Samples taken for O2 incubation only.

Cast 1 Salinity not drawn, Productivity cast.

Station 034.003

301 Salinity and oxygen not drawn, nutrients drawn per sampling strategy, Radium cast. Urea is somewhat high compared to other values near this depth. Rechecked data, no analytical problems found. Footnote urea questionable.

302-306 Salinity, oxygen and nutrients not drawn, Radium cast.

307 Salinity and oxygen not drawn, nutrients drawn per sampling strategy, Radium cast.

308-312 Salinity, oxygen and nutrients not drawn, Radium cast.

Station 035.001

101 Sample Log: "Oxygen redraw." Oxygen is acceptable. Oxygen is consistent with nutrients. CTDO at 103 is a bit low, but no problem exists.
102 Sample Log: "Bottom leak coming out of water. Major leak when vented." Samples taken for POM only.
105 SampleLog: "Oxygen redraw." Oxygen is acceptable.

Station 035.002

201 Salinity and oxygen not drawn, nutrients drawn per sampling strategy, Radium cast.
202-212 Salinity, oxygen and nutrients not drawn, Radium cast.

CCHDO Data Processing Notes

Date	Person	Data Type	Action	Summary
2014-01-09	Barna, Andrew	BTL	Website Updated	Bottle Data online
	The bottle data have been coppied over from the CARINA collection.			
2014-01-14	Staff, CCHDO	CrsRpt	Website Update	Available under 'Files as received'
	The following files are now available online under 'Files as received', unprocessed by the CCHDO. 32H1hly0402_final.doc			
2014-01-23	Lee, Rox	maps	Website Update	Maps created
	========== 32H120040515 processing - Maps ========== 2014-01-23 R Lee .. contents:: :depth: 2 Process ======= Changes ------- - Maps created from 32H120040515_hy1.csv Directories =========== :working directory: /data/co2clivar/arctic/HLY0402/original/2014.01.23_maps_RJL :cruise directory: Updated Files Manifest ========== ========== ===== file stamp ========== ===== 32H120040515_trk.jpg 32H120040515_trk.gif ========== =====			
2014-03-19	Kappa, Jerry	CrsRpt	Website Update	Fianl PDF version online
	I've placed a new PDF version of the cruise report: 32H120040515do.pdf into the directory: http://cchdo.ucsd.edu/data/co2clivar/arctic/HLY0402/ . It includes all the reports provided by the cruise PIs, summary pages and CCHDO data processing notes, as well as a linked Table of Contents and links to figures, tables and appendices.			