CRUISE REPORT

HUDSON 2007011

LABRADOR SEA

WOCE LINE AR7W

May 10 – May 27, 2007

A. CRUISE NARRATIVE

1. Highlights

a. WOCE Designation: WOCE Line AR7W

b. Expedition Designation: HUD2007011 or 18HU07011 (MEDS format)

c. Chief Scientist:
Ross Hendry
Ocean Sciences Division
Department of Fisheries and Oceans
Bedford Institute of Oceanography
PO Box 1006
Dartmouth, NS, Canada B2Y 2A4
Internet hendryr@mar.dfo-mpo.gc.ca

d. Ship: CCGS Hudson

e. Ports of Call: May 10, 2007 St. John's, NL, Canada
May 27, 2007 BIO, Dartmouth, NS, Canada

f. Cruise Dates: May 10 to May 27, 2007

2. Cruise Summary Information

Note that mission HUD2007011 included a short second leg with a new science staff led by Mr. James Hamilton (OSD/BIO HamiltonJ@mar.dfo-mpo.gc.ca) that departed from BIO on the afternoon of 27 May 2007 and returned to BIO on the morning of 29 May 2007. This was included as part of an overall mission HUD2007011 for administrative convenience only and no details will be reported here.

a. Cruise Track

A cruise track is shown in Figure A.2.1. The ship's position at 0000 UTC on each day of the cruise is indicated with a date label.

The World Ocean Circulation Experiment (WOCE) -format cruise station summary file (SUM) outlines the science operations conducted during the cruise.

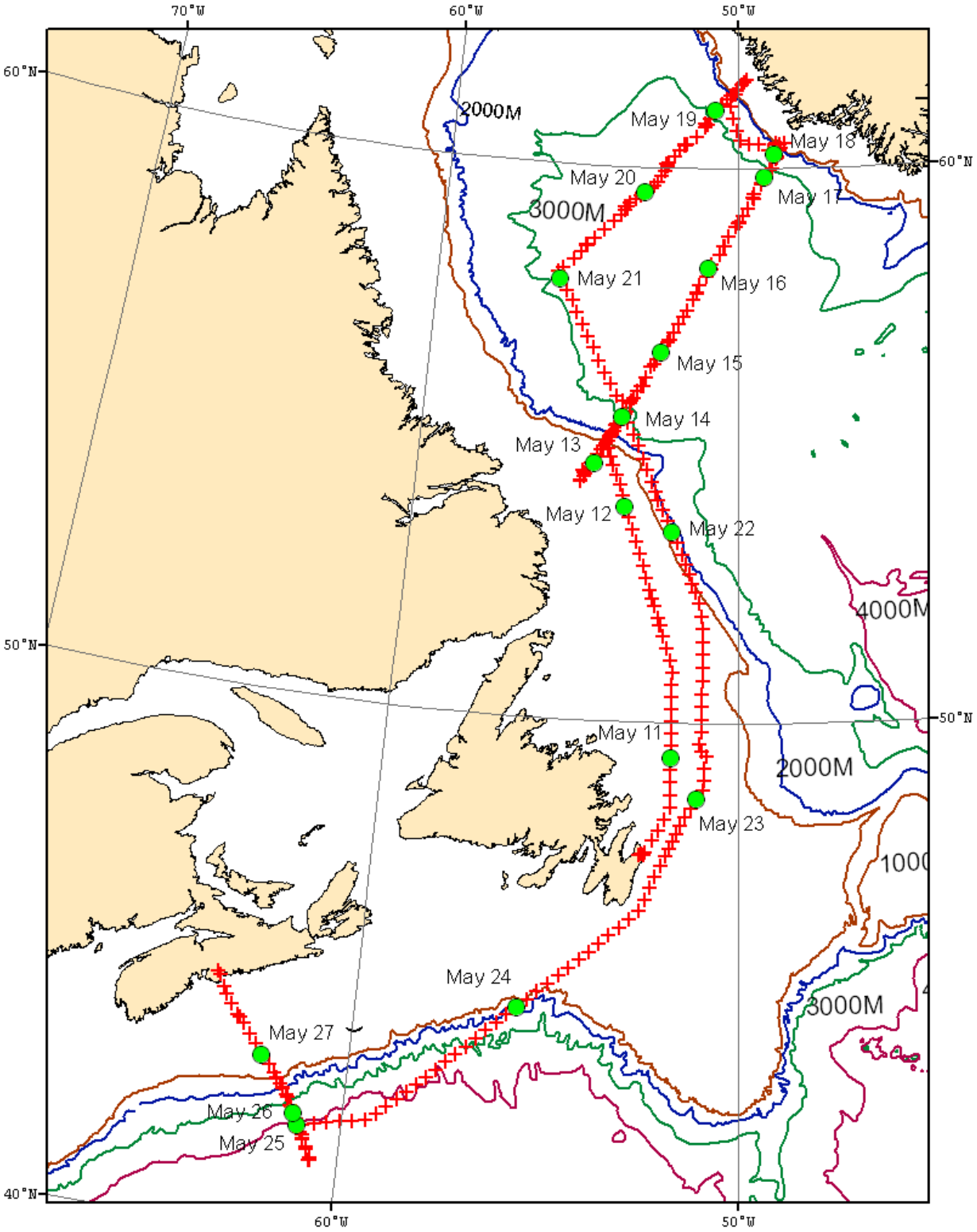


Figure A.2.1 Cruise track for HUD2007011. The date labels indicate the ship's position at 0000 UTC.

b. Total Number of Stations Occupied

The CTD / ROS station positions are shown in Figure A.2.2. Table A.2.1 lists the science operations for HUD2007011.

Along AR7W, the stations were full-depth WHP small volume rosette casts with up to 24 rosette bottles. Water samples were analyzed for CFCs, total inorganic carbon (TIC), total alkalinity, oxygen, salinity, nutrients (nitrate, phosphate, and silicate), total organic carbon (TOC), and bacterial abundance. Chlorophyll was analyzed at depths less than 200 m at most stations. Samples were collected for ^{129}I (iodine-129) on selected casts.

Cast Type	Number of Operations	Detailed Division	Operation Numbers
Rosette & CTD	27	23 of the 27 regular AR7W Sites (L3 line) plus sites 4.5, 8.5, 25.3 and 25.7	see Table A.2.2
	11	Halifax Line	227, 228, 233, 238, 241, 245, 248, 250, 251, 254, 257, 261
	7	Biology Casts not included in other tables	35, 63, 96, 145, 210, 218, 225
	1	Station 27	3
	3	Misc. Transit_01 and Transit_02	8, 9
	12	L2 Line (20, 19a, 19, 18, 17, 15.5, 14, 13, 12, 10, 8 and 6.5)	186, 189, 192, 196, 197, 201, 204, 207, 211, 214, 219, 222
Moorings	2 1	1 recovery, 1 deployment Release test	28, 29 7
Floats	5	APEX floats deployed	68, 114, 192, 213, 226
Biology	92	40 (200 micron net tows)	2, 5, 11, 15, 19, 22, 26, 33, 41, 46, 53, 61, 73, 81, 95, 110, 122, 131, 144, 152, 159, 166, 170, 174, 177, 181, 185, 188, 191, 194, 199, 203, 206, 209, 213, 216, 221, 224, 256, 260
		52 (76 micron net tows)	1, 4, 6, 10, 12, 14, 18, 21, 25, 32, 34, 40, 45, 47, 52, 60, 62, 72, 80, 82, 94, 109, 111, 121, 130, 132, 143, 151, 153, 158, 169, 171, 173, 176, 178, 180, 184, 187, 190, 193, 195, 198, 200, 202, 205, 208, 212, 215, 217, 220, 223, 259
	7	Multi-net tows	226, 232, 236, 242, 246, 249, 252
Chemistry		^{129}I surface	48, 83, 112, 146, 172, 175
		^{129}I profile	42, 64, 97, 133, 160, 222, 228, 233, 241, 245
Other		396 Hrs Ship Board ADCP	No number assigned
	93	XBT Deployments	30, 31, 37 - 39, 43, 44, 50, 51, 55 - 59, 66 - 71, 75 - 79, 84 - 93, 98 – 108, 114 – 120, 124 – 129, 134 – 142, 147 – 150, 155 – 157, 161 – 165, 229 – 231, 237, 239, 243, 244, 247, 253, 255, 258, 262

Table A.2.1 Science operations conducted on HUD2007011.

AR7W Site Number	2007011 Deep Cast Operation Number
1	-
2	-
3	-
4	-
4.5	16
5	17
6	20
7	23
8	13
8.5	24
9	27
10	35
11	42
12	48
13	54
14	64
15	74
16	83
17	97
18	112
19	123
20	133
21	146
22	154
23	160
24	172
25	182
25.3	168
25.7	167
26	179
27	175
28	-

Table A.2.2. AR7W (L3) sites and rosette and CTD operation numbers for HUD2007011.

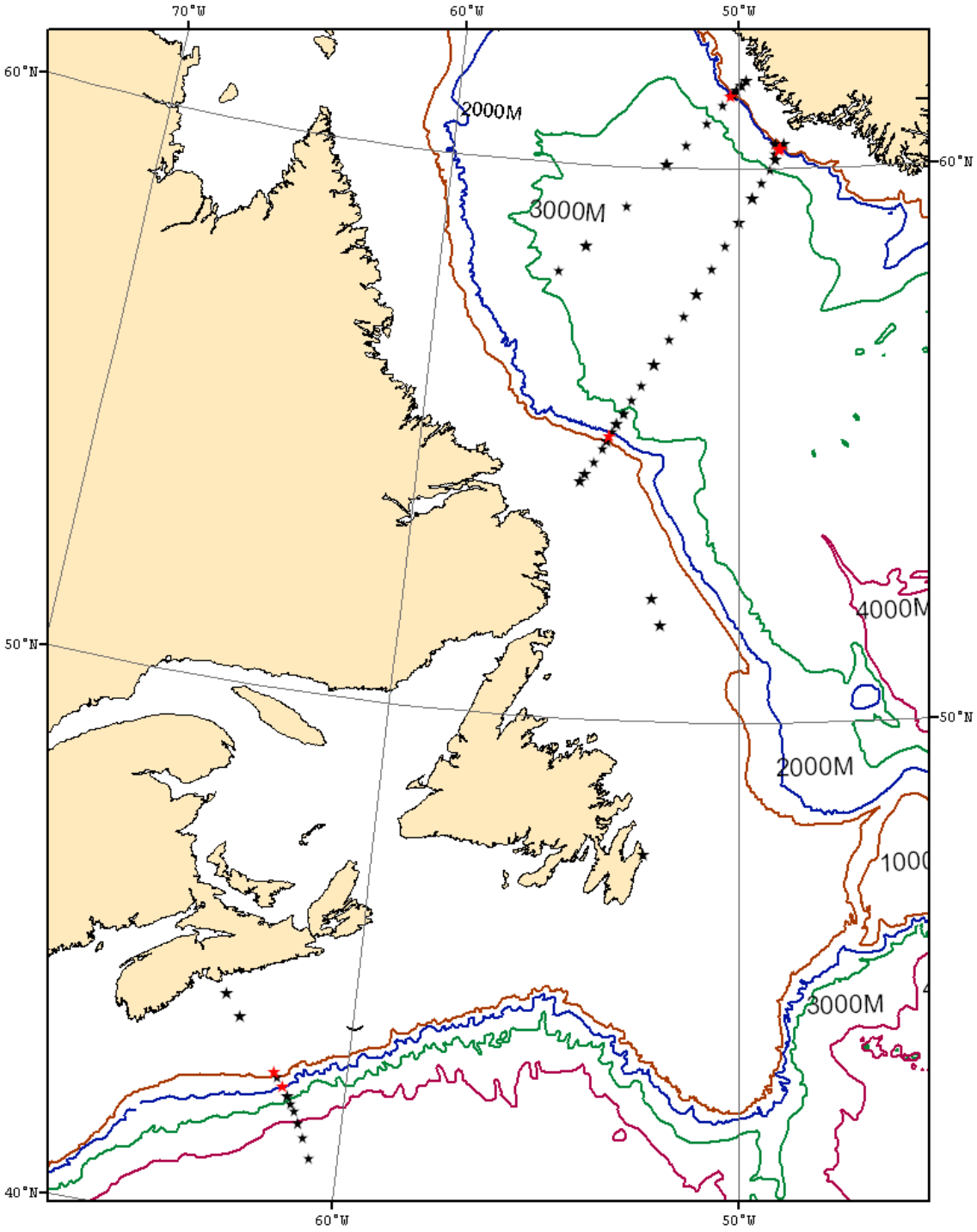


Figure A.2.2 This map shows the station positions for CTD only operations (red-filled stars) and rosette/CTD operations (black-filled stars) for Hudson HUD2007011.

Two full depth Labrador Sea hydrographic sections and the Halifax Section were occupied during the HUD2007011 mission. These survey lines combined with Orphan Basin and Laurentian Fan lines occupied within the same four week period on Hudson 2007007 provide a comprehensive assessment of the oceanographic conditions in the Canadian sector of the Atlantic Ocean.

c. Floats and Drifters deployed

As a Canadian Argo contribution to the international Argo project, five Webb Research Corporation Apex profiling floats equipped with Sea-Bird Electronics, Inc. model 41 CTD sensors were deployed, three on the AR7W line and two on the Halifax line. Two of the floats deployed on the AR7W line were equipped with Aanderaa Instruments Corporation Oxygen Optode 3830 dissolved oxygen sensors. One of the newer non-Optode floats was configured to do a deep profile immediately after deployment (deep profile first feature). A sixth float that was scheduled for deployment failed a pre-deployment test and was not available for use. Our float inventory is fully committed so no backup was available. Table A.2.3 gives details of the float deployments. Copies of the deployment log sheets are found in Appendix 4.

Apex Float		WMO #	Operation Number	Launch Position		Start Time	Launch Time
Type	SN			Latitude (N)	Longitude (W)		
APEX-SBE	3269	4901075	65	56.52	-52.69	14/05/2007 20:37:00	14/05/2007 22:02:00
APEX-SBE	3270	4901076	113	58.25	-50.96	15/05/2007 23:09:00	16/05/2007 00:40:00
APEX-SBE	3271	4901077	183	60.26	-48.70	17/05/2007 22:54:00	18/05/2007 00:15:00
APEX-SBE-Aanderaa	3273	4901079	234	41.80	-60.91	25/05/2007 09:59:00	25/05/2007 11:54:00
APEX-SBE-Aanderaa	3274	4901080	240	42.24	-61.20	25/05/2007 23:05:00	25/05/2007 23:54:00

Table A.2.3 APEX float deployments on HUD2007011.

d. Moorings deployed or recovered

The Aanderaa current meter mooring near station L3-8 on the AR7W line was once again serviced on May 13, 2007. Mooring #1601 was recovered successfully under moderate sea conditions. The RCM8 appeared to have worked properly and all mooring tackle was in good condition. The replacement mooring #1640 was deployed successfully.

Recovery:

M 1601	55º 07.20' N 54º 05.31' W	Standard mooring consisting of one current meter positioned 20m above bottom along AR7W on the Labrador Slope (12-month deployment) at the 1030 metres.

Deployment:

M 1640	55º 07.1' N 54º 05.3' W	Standard mooring consisting of one current meter positioned 20m above bottom along AR7W on the Labrador Slope (12-month deployment) at the 1019 metres.

A new software package called M-Cal (Mooring Calibrator) V 1.04 was used for the first time. M-Cal is a subset of a program called WorkBoat by James Illman of Software Engineering Associates. This enables the user to position the mooring once on the bottom. A computer is linked to the ship's navigation as well as, in this case, to the Benthos DS7000 deck unit. As the ship travels near the mooring, M-Cal transmits via transponder to the acoustic release and measures the time interval between the sent and reply pulses. This information combined with the navigation data enables the program to calculate the position of the release. As more and more data is gathered, the position continually updates. M-Cal also calculates a depth for the release.

This software is of great use if a mooring is off location for some reason. As M-Cal gives a position and not just a slant range, locating the mooring is much quicker. Communicating to a release via transponder only gives a slant range and not a direction. A ship has to randomly travel to minimize this slant range which could be time consuming. We did not have the opportunity on this mission to fine tune the program with inputs as "the speed of sound in water" for this location and the "turn around time of the acoustic release". However, as M-Cal saves the calibration, these inputs can be changed later to create a more accurate position.

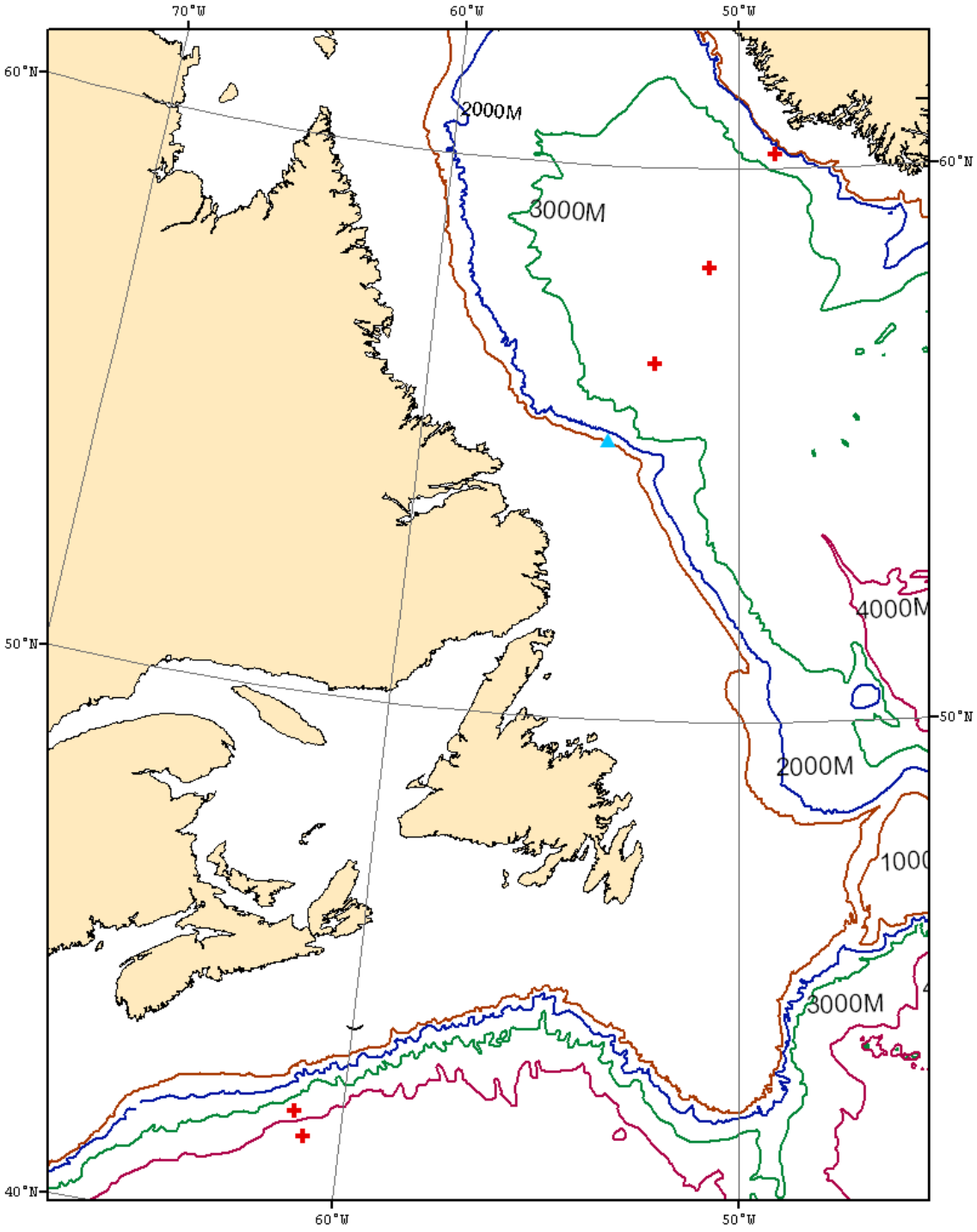


Figure A.2.3 Mooring operation (blue-filled triangle - a mooring was recovered and a new one deployed in the same location) and float deployment locations (red-filled crosses) for HUD2007011.

3. List of Principal Investigators

Name	Affiliation	Responsibility
Kumiko Azetsu-Scott	BIO Azetsu-ScottK@mar.dfo-mpo.gc.ca	Chemistry program coordination, Alkalinity, CO2, CFCs
Carina Gjerdrum	CWS Carina.Gjerdrum@ec.gc.ca	Sea bird program
Glen Harrison	BIO HarrisonG@mar.dfo-mpo.gc.ca	Associate Senior Scientist, Biological program coordination
Roberta Hamme	UVIC ??????	Inert Gas Sampling program
Erica Head	BIO HeadE@mar.dfo-mpo.gc.ca	Macrozooplankton distribution, abundance and metabolism
Ross Hendry	BIO HendryR@mar.dfo-mpo.gc.ca	Senior scientist Overall co-ordination
Paul Kepkay	BIO KepkayP@mar.dfo-mpo.gc.ca	Dissolved organic carbon, colloid chemistry and plankton respiration
Bill Li	BIO LiB@mar.dfo-mpo.gc.ca	Pico-plankton distribution and abundance, bacterial abundance and productivity
Robert Pickart	WHOI Pickart@rsp.whoi.edu	Lowered ADCP
John Smith	BIO SmithJN@mar.dfo-mpo.gc.ca	Radioisotope sampling program
Igor Yashayaev	BIO YashayaevI@mar.dfo-mpo.gc.ca	CTD program coordination, XBTs

Table A.3.1. List of Principal Investigators (see Section 7 for addresses).

4.1 Physical - Chemical Program

a. Narrative

This expedition was conducting operations in support of four ongoing scientific initiatives.

Since 1990, Maritimes Science Branch at the Bedford Institute of Oceanography has carried out annual occupations of a hydrographic section across the Labrador Sea. The section was designated AR7W (Atlantic Repeat Hydrography Line 7) in the World Ocean Circulation Experiment (WOCE). This effort continues as a regional monitoring and research program that contributes to the Climate Variability (CLIVAR) component of the World Climate Research Programme (WCRP) and the international Global Climate

Observing System (GCOS). The work also contributes to the international Arctic and Subarctic Ocean Fluxes (ASOF) programme. The occupation of the Labrador Sea section and the recovery of the one Labrador Sea mooring provide a measure of the winter cooling and water mass transformations over the 2005/2007 winter. The resetting of the mooring on the 1000m isobath on the Labrador slope continues a 20+ year observation program of the Labrador Current.

Maritimes Region of DFO has designated the AR7W surveys as a core element of our regional ocean monitoring program. As such, they will continue to contribute both to a better scientific understanding of this region and its links to processes in eastern Canadian waters, and to the monitoring mandate of the international Global Climate Observing System.

The second initiative is the continuation of the Labrador Sea project concerned with the natural and anthropogenic carbon cycles. The biological program is designed to characterize the late spring biological processes in the Labrador Sea and its shelf regions and is discussed in a later section of this document. The physical/chemical oceanographic program observes nutrients, total carbonate, alkalinity, and chlorofluorocarbons (CFCs) over the entire water column in order to document the vertical transport of carbon via winter convection in the Labrador Sea and changes in carbon storage in the deep waters of the North Atlantic.

DFO chemical and biological research programs associated with the AR7W surveys have contributed to a better understanding of the carbon cycle within the international Joint Global Ocean Flux (JGOFS) research program and the Canadian program on Enhancement of Greenhouse Gas Sinks (EGGS).

The third initiative is to observe the physical and chemical parameters at the Halifax Section fixed-station monitoring site in support of DFO's Atlantic Zonal Monitoring Program (AZMP). Additional stations in the offshore zone to depths of 4000 m were made as a pilot version of a possible enhancement of this monitoring effort.

The fourth initiative was to deploy profiling floats as part of Canadian Argo, a contributor to the international Argo Project. Five Apex profiling floats were deployed in the Labrador Sea.

b. Radioisotope Sampling Program **John Smith**

Water samples were collected for ^{129}I from a near surface rosette bottle at 11 stations on the L3 (AR7W) line. Full depth sampling for ^{129}I was carried out at five stations on the same section and two on the Halifax line. See table A.2.1 for the list of operations during which ^{129}I was sampled.

c. Inert Gas Sampling Program **Roberta Hamme**

Water samples were collected for dissolved inert gases at five stations along the L3 (AR7W) line with the aim of sampling the core of the different water masses in the area (LSW_{new}, LSW_{2000}, LSW_{1994}, surface, DSOW, NEADW, and ISW). See table A.4.2.1 for cast and sample numbers. The usual sampling order was for these bottles was CFCs, DOC, oxygen, inert gases, DIC etc... The Niskins were sampled out of the usual order of deepest first, so that the deepest Niskin that inert gases would be collected from was sampled first, then other non inert gas Niskins were sampled until the next inert gas Niskin was ready to be sampled. In this way, the time the water in the Niskin was exposed to a headspace before the inert gas samples were drawn was reduced as much as possible. These samples will be analyzed for dissolved Ar, Kr, Xe and N_2 using an isotope dilution IRMS method (Hamme and Severinghaus 2007, Deep-Sea Res. I). The goal of this work is to quantify the physically-driven disequilibrium of gases during water mass formation. Theoretical work and samples from the deep Pacific suggest that these gases (as well as CO_2, O_2, CFCs etc…) cannot maintain equilibrium with the atmosphere during the rapid cooling and high wind speeds driving bubble-mediated gas exchange that occur during convective episodes. It is our intention to sample for these gases in multiple years to study inter-annual variability in this disequilibrium.

Station #	**L3-14**	**L3-15**	**L3-16**	**L3-22**	**L3-24**
Event #	**64**	**74**	**83**	**154**	**172**
BIO sample #	309682	309712	309741	309891	309955
	309683	309714	309743	309892	309956
	309684	309715	309744	309896	309957
	309686	309716		309897	
	309687			309898	

Table A.4.1.1 Inert gas sampling on HUD2007011.

4.2 Biological Program

a. Narrative

The biological program conducted as part of cruise 2007011, with some modifications, was a continuation of studies began in 1994 to describe the large-scale (spatial and temporal) variability in plankton biomass, productivity and biogenic carbon inventories in the Labrador Sea.

The program has consisted of essentially four elements:
1) a phytoplankton biomass/primary productivity program conducted by Jeff Anning (for Glen Harrison),
2) a microbial program conducted by Tim Perry (for Bill Li),
3) a mesozooplankton program conducted by Les Harris (for Erica Head), and
4) a dissolved organic carbon program conducted by Jay Bugden (for Paul Kepkay)

An additional program, investigating the relationship between (prokaryotic) microbial community structure and its ecological and biogeochemical function in the Labrador Sea, was conducted by Ryan Murphy, a graduate student at Memorial University of Newfoundland working under the supervision of Professor Richard Rivkin.

The ultimate aim of these studies is twofold:

1) to provide a description of the inventories in and export of biogenic carbon from the Labrador Sea, their turnover rates and variability in space and time as part of Ecosystem Research Division's (ERD) continuing climate studies and
2) to provide a description of plankton life-cycles and productivity in the Labrador Sea and its influence or contribution to ecosystems downstream in support of ERD's ecosystem-related research.

In addition to the Labrador Sea study, phytoplankton, mesozooplankton and nutrient samples were collected along the Halifax Section in support of ERD/OSD's obligations to the Atlantic Zone Monitoring Program (AZMP).

A pelagic bird survey was carried out by Carina Gjerdrum, a wildlife biologist with Environment Canada's Canadian Wildlife Service (Dartmouth, NS) working on seabird issues. The goal of this survey was to gather data on the offshore distribution and abundance of marine birds in order to identify and minimize the impacts of human activities at sea on birds. These data will provide critical, and currently unavailable, information for environmental assessments for offshore developments, and will help identify areas where birds are at high risk from oil pollution, and other human activities.

b. Zooplankton Sampling **L. Harris / E. Head**

The zooplankton sampling is part of an ongoing program, the aim of which is to investigate the distribution, abundance and life history of the major zooplankton groups found in the Labrador Sea and its associated shelf systems. Particular emphasis is placed on the copepod species of the Calanus genus, which dominate the zooplankton in this region.

Vertical net tows were taken at 41 stations (Station 27, Transit_01, 25 on the L3 line, 11 on the L2 line, and 3 on the Halifax Line). At all stations, tows were made from 100 meters to the surface using a ¾ m 200 micron mesh̩ring net, except at Station 27 and those on the Halifax Line where tows were from the bottom. An additional tow was made using a using a 30 cm 76 micron mesh ring net at all stations except HL5 and HL3. See Figure A.4.2.1 below for station locations where nets were used.

c. Measurements Of Copepod Reproduction Rates — L. Harris / E. Head

Egg production rates of *Calanus finmarchicus*, the dominant copepod species, were measured at 12 stations on the L3 Line, 4 stations on the L2 Line and Transit_01.

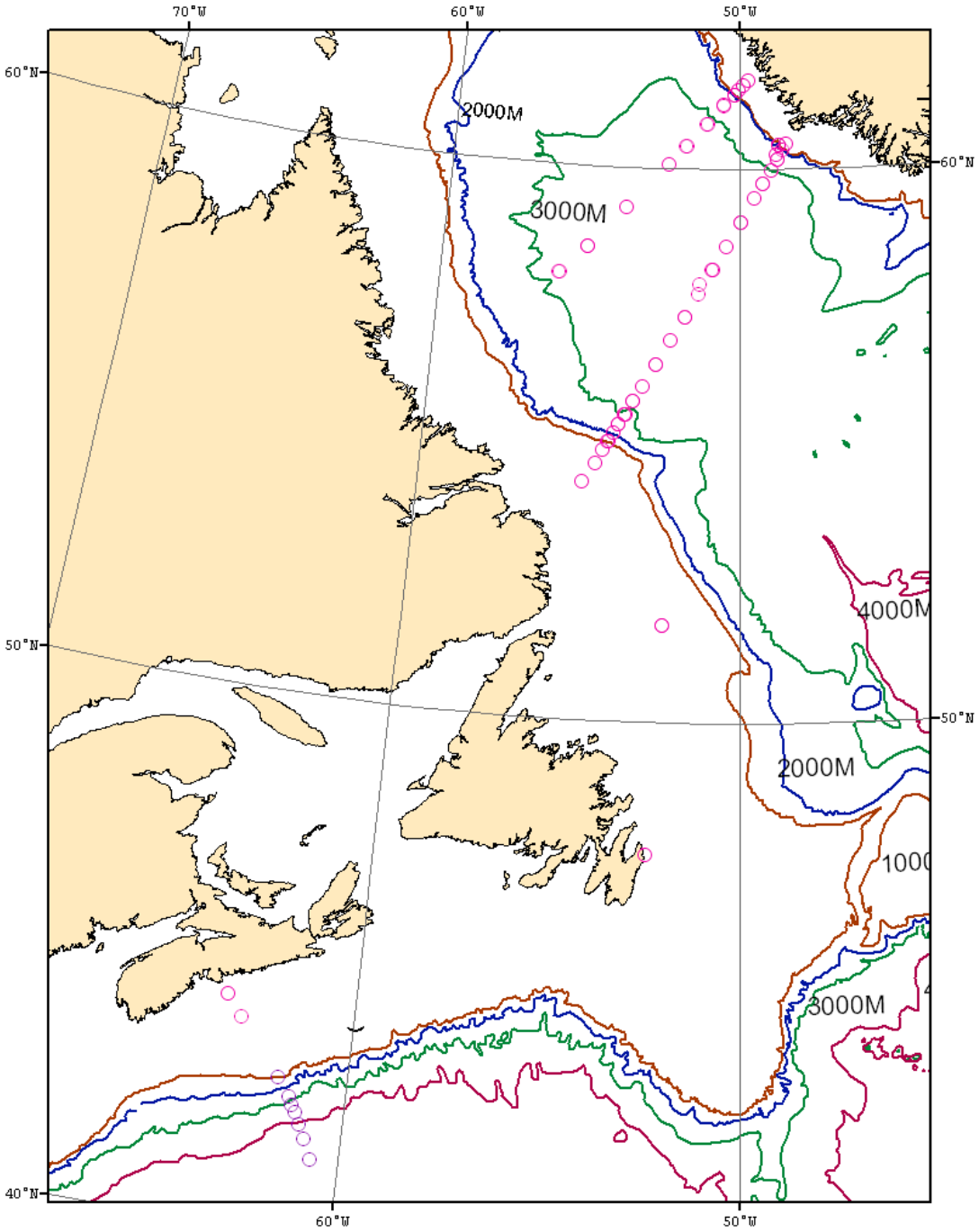


Figure A.4.2.1 Ring net tows (pink open circles) and multi-net tows (purple open circles) locations for HUD2007011.

d. Depth Distribution of *Calanus finmarchicus* in the Slope Water off the Scotian Shelf **L. Harris / E. Head**

The vertical depth distribution of *Calanus finmarchicus* in the Slope Water off the Scotian Shelf was investigated. At 7 stations, HL 6-12, five depth strata (1000-800, 800-600, 600-400, 400-200, 200-0 meters) were sampled using a ¼ meter multi-net fitted with five 200 micron mesh nets.

e. Total Organic Carbon (TOC) **Jay Bugden / Paul Kepkay**

In order to better understand the cycling of carbon in the Labrador Sea, it is necessary to examine the pool of total organic carbon (TOC). Obtaining a profile of TOC concentration in the water column can help determine the fate of organic carbon. Elevated concentrations of TOC at depth are indicative of transport of carbon to the deep ocean, which basically removes it from the effects of biological re-mineralization. This can result in the long term storage of organic carbon in the deep ocean. Such information can be applied to models that track the fate of carbon in the environment and its potential effects on climate change.

During CCGS Hudson cruise HUD2007011, TOC depth profiles were collected from the following stations on the AR7W line as indicated in the table below.

Station	TOC Profile
AR7W site 1	Not sampled due to ice
AR7W site 2	Not sampled due to ice
AR7W site 3	Not sampled due to ice
AR7W site 4	Not sampled due to ice
AR7W site 4.5	X
AR7W site 5	X
AR7W site 6	X
AR7W site 7	X
AR7W site 8	X
AR7W site 9	X
AR7W site 10	X
AR7W site 11	X
AR7W site 12	X
AR7W site 13	X
AR7W site 14	X
AR7W site 15	X
AR7W site 16	X
AR7W site 17	X
AR7W site 18	X
AR7W site 19	X
AR7W site 20	X
AR7W site 21	X
AR7W site 22	X
AR7W site 23	X

AR7W site 24	X
AR7W site 25	X
AR7W site 26	X
AR7W site 27	X
AR7W site 28	Not sampled due to ice

Table A.4.2.1 TOC sampling on HUD2007011.

f. Primary Production Measurements — Jeff Anning / Glen Harrison

Water samples for photosynthesis-irradiance (P-I) experiments were collected from the rosette at 12 stations. For each incubation experiment, 33 aliquots were inoculated with ^{14}C labelled sodium bicarbonate and then incubated at in situ temperatures at 30 light levels (+ 3 dark bottles) for approximately 3 hours. At the end of the incubation period the cells were harvested onto GF/F glass fibre filters for later counting in a scintillation counter. On one occasions (L2-12), a parallel P-I incubation from a single depth was done using the stable isotopes $^{13}C/^{15}N$ instead of the radioisotope, for comparison. Duplicate chlorophyll, duplicate particulate organic carbon, one HPLC, and one Absorption Spectra sample were collected for each incubation experiment.

Station	Event	Lat.	Long.	Date	Time	Depth	ID
Transit 02	9	52.282	-52.557	"May 11 2007"	"16:12:31"	1	309450
Transit 02	9	52.282	-52.557	"May 11 2007"	"16:12:31"	30	309446
L3-4.5	16	54.350	-54.867	"May 12 2007"	"15:11:25"	1	309490
L3-10 BIO	35	55.417	-53.817	"May 13 2007"	"19:16:06"	1	309564
L3-10 BIO	35	55.417	-53.817	"May 13 2007"	"19:16:06"	30	309560
L3-14 BIO	63	56.500	-52.700	"May 14 2007"	"18:57:54"	1	309671
L3-14 BIO	63	56.500	-52.700	"May 14 2007"	"18:57:54"	30	309667
L3-17 BIO	96	57.800	-51.334	"May 15 2007"	"14:36:34"	1	309756
L3-17 BIO	96	57.800	-51.334	"May 15 2007"	"14:36:34"	30	309752
L3-21 BIO	145	59.467	-49.467	"May 16 2007"	"15:57:50"	1	309862
L3-21 BIO	145	59.467	-49.467	"May 16 2007"	"15:57:50"	30	309866
L3-24	172	60.167	-48.667	"May 17 2007"	"13:43:02"	1	309961
L3-27	175	60.433	-48.350	"May 17 2007"	"16:49:58"	1	309974
L3-27	175	60.433	-48.350	"May 17 2007"	"16:49:58"	30	309978
L2-19	192	61.367	-50.000	"May 18 2007"	"13:37:07"	1	310051
L2-19	192	61.367	-50.000	"May 18 2007"	"13:37:07"	30	310055
L2-12 BIO	210	60.050	-52.450	"May 19 2007"	"14:16:05"	1	310153
L2-12 BIO	210	60.050	-52.450	"May 19 2007"	"14:16:05"	30	310157
L2-08 BIO	218	58.583	-55.117	"May 20 2007"	"14:05:27"	1	310219
L3-11	225	55.600	-53.617	"May 21 2007"	"13:06:38"	1	310276
L3-11	225	55.600	-53.617	"May 21 2007"	"13:06:38"	30	310280

Table A.4.2.2 Photosynthesis/Irradiance incubations were conducted at the above stations.

g. Bacterial Abundance and Production of Microbial Plankton — Tim Perry

At every depth at every station on the L3 line and stations sampled on the HL line a sample was collected for bacterial counting by flow cytometry. On the L2 line a surface sample was collected for the stations sampled.

Water samples were collected from all depths at 7 stations on the L3 line and incubated for between 3-24 hours after inoculation with 3H labelled leucine. The cells were collected by centrifugation and prepared for scintillation counting back on shore.

Station	Event	Lat.	Long.	Date	Time
L3-08	13	55 06.236	-54 07.495	"May 12 2007"	"08:06:24"
L3-4.5	16	54 21.711	-54 52.292	"May 12 2007"	"14:59:51"
L3-11	42	55 36.618	-53 36.886	""May 14 2007""	"01:12:40"
L3-14	64	56 30.550	-52 42.207	""May 14 2007""	"19:32:00"
L3-18	112	58 13.066	-50 53.088	""May 15 2007""	"21:58:37"
L3-24	172	60 10.599	-48 40.752	""May 17 2007""	"11:51:12"
L3-27	175	60 26.928	-48 21.476	""May 17 2007""	"16:33:56"

Table A.4.2.3. Microbial production incubations were conducted at the above stations.

h. Stable Isotope Studies of Carbon and Nitrogen (nitrate and ammonium) Utilization by Phytoplankton — Glen Harrison

This work represents a continuation of research begun in 1994 to determine the primary productivity (in terms of carbon and nitrogen) of phytoplankton in the Labrador Sea. On this particular mission, stations were selected along the L3 and L2 lines to determine productivity inside and out of the high phytoplankton biomass zone (determined from satellite ocean colour) off the coast of Greenland (Fig A.4.2.2). Carbon dioxide (CO_2), nitrate (NO_3) and ammonium (NH_4) utilization rates from eight depths in the photic zone (i.e. the 1% light level ranged from 25-60 m) were determined using stable isotope tracer (^{13}C and ^{15}N) methods. Incubations experiments were carried out in on-deck 'simulated in-situ' incubators. A total of 8 experiments were conducted (see Table A.4.2.1). In addition to isotope tracer experiments, particulate organic matter (nitrogen and carbon) were determined at the productivity depths, samples were collected in surface waters for determination of natural C and N isotope abundance and ammonium concentrations were measured at 11 depth in the upper 200m.

Date	Site	Event #	Photic Depth (m)	$^{15}N/^{13}C$	POC/ PON
14-May-07	L3_14	63	50	x	x
15-May-07	L3_17	93	30	x	x
16-May-07	L3_21	145	40	x	x
17-May-07	L3_27	175	40	x	x
18-May-07	L2_19	192	25	X	x
19-May-07	L2_12	210	30	X	x
20-May-07	L2_08	218	50	X	x
21-May-07	L3_11	225	60	X	x

Table A.4.2.4 Stable isotope productivity stations.

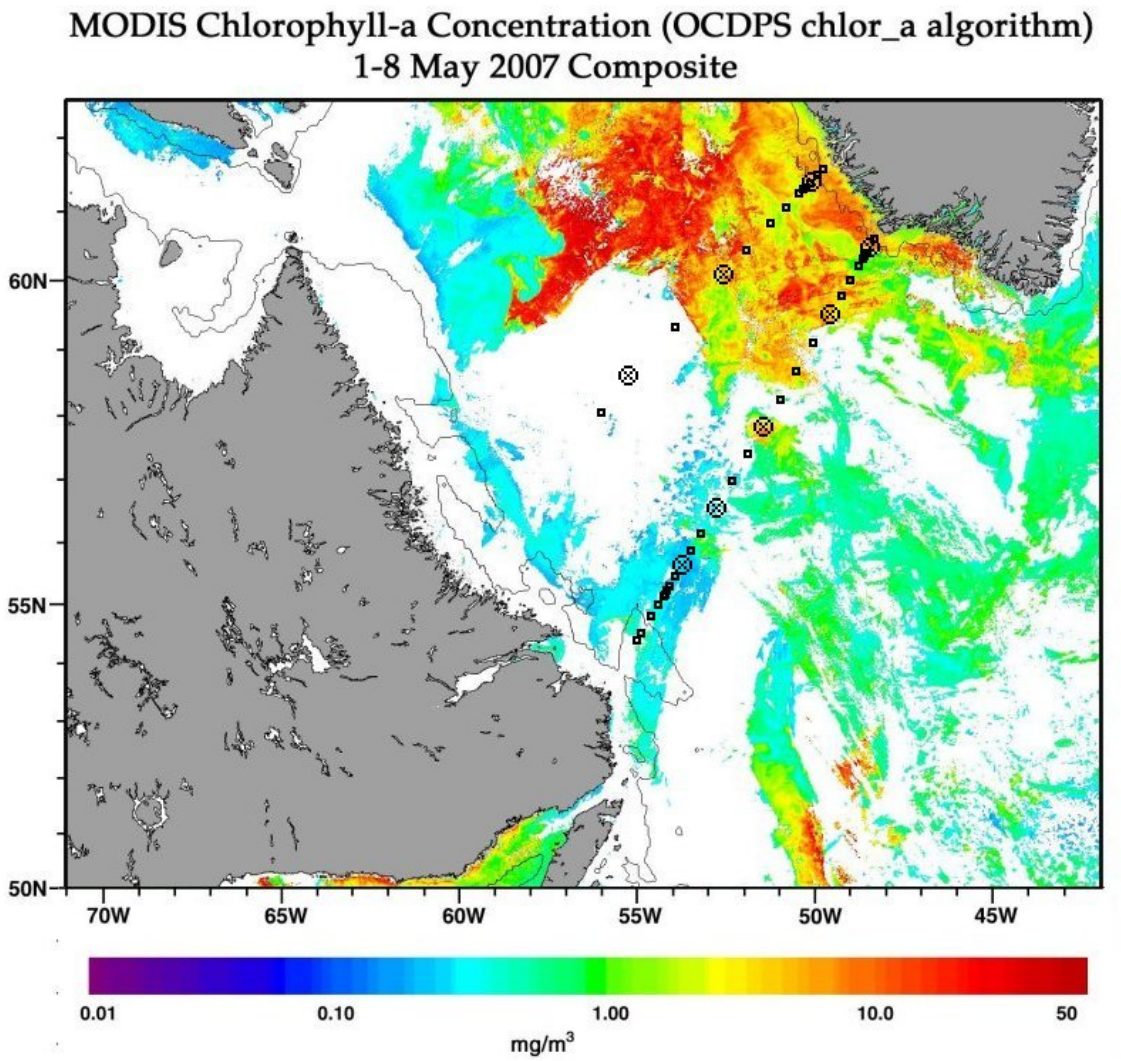


Figure A.4.2.2 Stable isotope productivity stations (circles) in relation to surface chlorophyll concentrations from satellite ocean colour composite image.

5. Major Problems and Goals Not Achieved

6. Other Incidents of Note

7. List of Cruise Participants

Name	Responsibility	Affiliation
Jeffrey Anning	Biological	ERD, BIO
Carol Anstey	Nutrients, Oxygens	ERD, BIO
Kumiko Azetsu-Scott	Scientist, Carbonate, Alkalinity	OSD, BIO
Jorge Urrego Blanco	Computer Room	KNMI
Richard Boyce	Salts, Mooring	OSD, BIO
John (Jay) Bugden	TOC Levels	ERD, BIO
Michael Dunphy	Winch Room	DAL
Eva Falck	Oxygens	UiB
Carina Gjerdrum	Sea bird observer	EC, CWS
Roberta Hamme	Inert Gas Sampling	UVIC
Leslie Harris	Biological, Net Tows	ERD, BIO
William Glen Harrison	Associate Chief Scientist, Biological	ERD, BIO
Adam Hartling	Winch Room	OSD, BIO
Ross Hendry	Chief Scientist	OSD, BIO
Jeffrey Jackson	Data management, Computer Room	OSD, BIO
Richard Nelson	CFCs	ERD, BIO
Timothy Perry	Biological	ERD, BIO
Clark Richards	Winch Room, XBT	DAL
Brian Robinson	CFCs	BDR
Robert Ryan	CTD Tech., Winch Room	OSD, BIO
David Slauenwhite	Carbonate, Alkalinity	BDR
Igor Yashayaev	Scientist, Computer Room	OSD, BIO

BIO Bedford Institute of Oceanography
PO Box 1006, Dartmouth, NS, Canada, B2Y 2A4

BDR BDR Research Ltd.
Box 652, Station 'M', Halifax, NS, Canada, B3J 2T3

EC, CWS Environment Canada, Canadian Wildlife Service
45 Alderney Drive, Dartmouth, Nova Scotia, Canada, B2Y 2N6

ERD Ecosystem Research Division

DAL Dalhousie University
Halifax, NS, Canada, B3H 4R2

KNMI Royal Netherlands Meteorological Institute
PO Box 201, NL-3730 AE De Bilt, Netherlands

OSD Ocean Sciences Division

UiB University of Bergen
P.O. Box 7800, 5020 Bergen

UVIC University of Victoria
PO Box 1700 STN CSC, Victoria BC, Canada, V8W 2Y2

B. UNDERWAY MEASUREMENTS

1. Navigation and Bathymetry — Jeff Jackson

The navigation system onboard CCGS Hudson consists of a differential GPS receiver and navigation software. The receiver is one of many NMEA feeds into a multiplexer that provides all the NMEA strings to a PC on the bridge. The PC running the navigation software, then rebroadcasts the NMEA strings to distribution units in the computer room, which provide many output lines for the working labs. The resulting broadcast navigation strings are ~ 1 Hz. The navigation data are then logged at specified intervals on a PC. For this cruise the navigation was logged approximately every second.

AGCNAV is a PC-based display and waypoint setting software package, developed at the Atlantic Geoscience Centre at BIO. This software graphically displays ship position, waypoints, course, speed, etc. to the various science working areas. This has been the standard software package for years now and we used it again on this mission.

New to the navigation acquisition arena is the Geological Survey of Canada's (GSC) Survey Suite navigational software. This is a windows package which grabs every NMEA string broadcast over the network. It adds a date/time stamp to every data record acquired. It was tested on this cruise and it seemed to work very well without any problems. It is easier to configure and operate than AGCNAV. The only negative observation that can be made is that it does not have a waypoint viewer.

The echo sounder system used for collecting bathymetric data at station locations consisted of a 12 KHz Raytheon PTR echo sounder that created an analog trace on a Raytheon Line Scan Recorder located in the forward laboratory. The transducer beam width is 15 degrees. The sweep rate of the recorder was adjusted throughout the course of data collection to aid in identifying the bottom signal. One transducer is positioned on a Ram that can be lowered or raised depending on conditions. When the ram is up, the waterline to transducer offset is 6 m. When the ram is down, the offset is 8 m.

2. Vessel Mounted Acoustic Doppler Current Profiler — Adam Hartling

The Ocean Surveyor II vessel mounted acoustic Doppler current profiler system consists of a 75 kHz phased array transducer assembly mounted in a well in the ship's hull. The deck unit and computer are located in the forward lab.

The transducer assembly is mounted on a ram penetrating the ships hull that can be lowered if necessary. Transducer remained in the retracted position for the duration of the cruise. It was determined during sea acceptance testing that lowering the transducer did not effect the operation of the system.

The system is capable of collecting bottom track data to 1000m and profile data to 650m. Setup includes 100-8m bins. Position, heading, pitch and roll data is provided by the ADU5 attitude determination unit at a 5Hz rate. Ships gyro heading data is connected directly to the OSII deck unit.

WinADCP software package used monitor profile data in real time. WinADCP is set to display times series of short-term averaged profile and attitude data. VmDas Software package used to deploy OSII and log raw data, VmDas option files, intermediate and processed files. Data back-up on external hard-drive. Data back-up includes only raw data and VmDas option files.

All NMEA strings are logged during data collection. The gyro heading is included in the raw data. Raw data is processed in real time for a short term average of 30sec and a long term average of 600sec.

A power surge caused by a UPS failure resulted computer failure. Logging resumed ~2hrs later with backup computer. No loss of recorded data. Electronic chassis exhibits irregular communication timeouts after power failure resulting in occasional ensemble I/O errors that do not seriously affect profile data.

Data will have to be reprocessed using gyro heading during periods with low quality or no attitude solution. Raw data can be reprocessed using VmDas.

There is a significant increase in noise floor caused by the bow thrusters while on station, during high sea states, or during travel at speeds in excess of 12 knots in rough conditions. Increase in noise floor results in a significant decrease in data quality and reduction in profile range.

3. Continuous Flow Multisensor Package (CFMP) — Jeff Anning

Water from approximately 4m was continuously pumped to the forward lab. The temperature, conductivity and fluorescence were measured and logged every 30 sec. The temperature and conductivity were measured with Sea-Bird sensors and the fluorescence by a Wetlabs flow through fluorometer. Incident Photosynthetically Active Radiation was measured with a Li-Cor Spherical Quantum Sensor and this data was merged with the sea water parameters. Exact time and positions were provided by the ships GPS and logged with the other data.

4. XBT measurements and high-resolution mapping of the thermal structure of the upper layer — Igor Yashayaev

Expendable Bathythermographs were routinely deployed during the HUD2007011 mission. See Fig. B.4.1 for a map with the XBT drops indicated. We used three different models of XBTs: Sparton T5, Sippican T7 and Sippican T10. T5s are capable of

measuring to maximum depths of 1900m at the cruising speed of 6 knots, T7s record temperature to 800m at the cruising speed 15 knots and T10s to 200m. The vertical resolution of the measurements was about 0.6-0.8m. There were 24 T5, 45 T7 and 27 T10 XBTs launched during the cruise (Table A.2.1 lists the operation numbers when these were deployed).

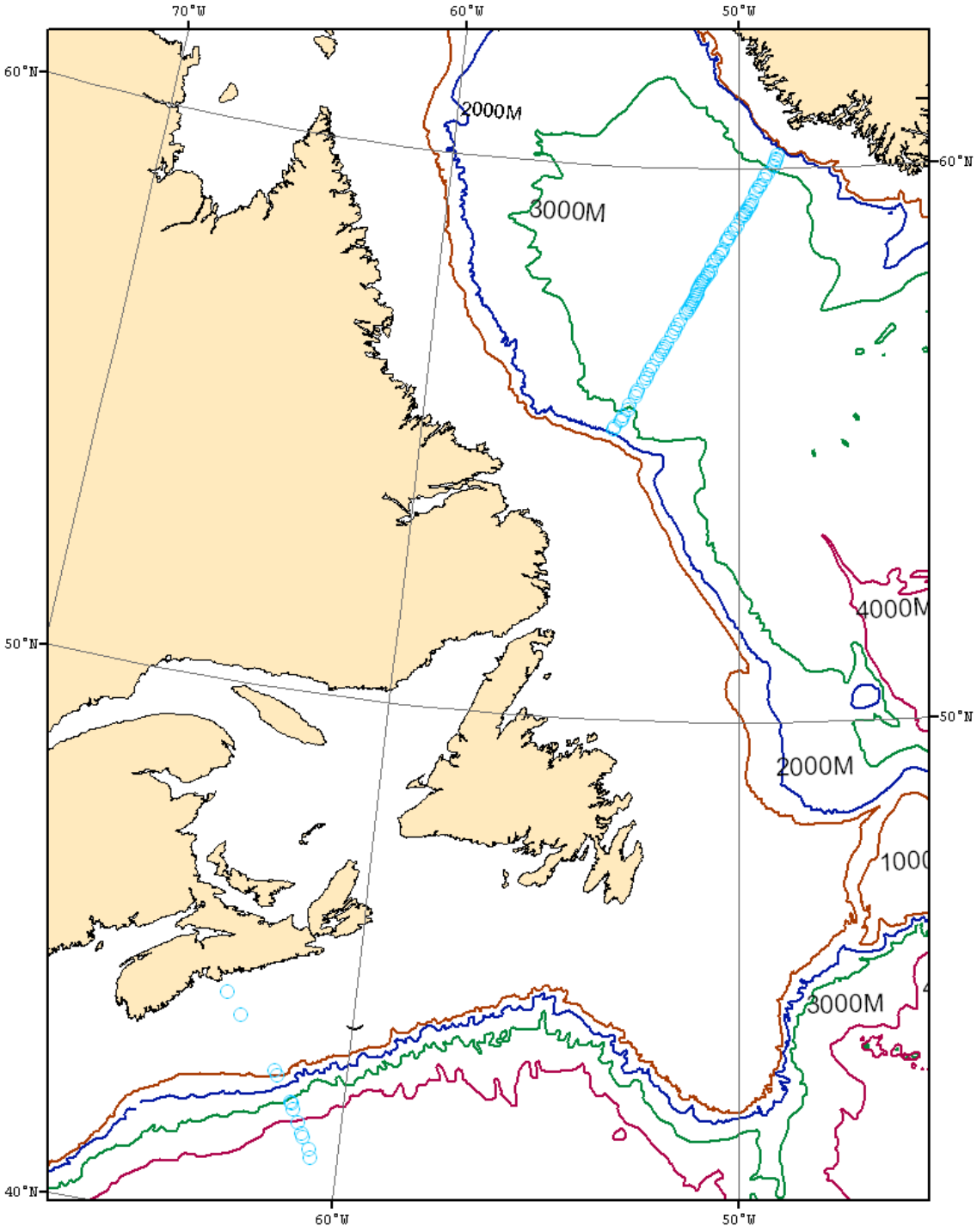


Figure B.4.1 XBT sites (indicated by blue open circles) during HUD2007011.

5. Thales Navigation ADU5 Attitude Determination Unit **Adam Hartling**

4-antenna receiver configuration uses differential carrier phase measurements to compute heading, roll, and pitch in real-time at a 5-Hz update rate.

Position and velocities are computed only for Antenna 1. The remaining antennas provide carrier phase data for attitude determination. Antenna 1 is a Beacon antenna providing differential position when in range of a base station. Beacon corrections were available for all but the most north – east portion of the cruise.

Antenna separations in a normal multipath environment determine the level of solution accuracy. Fore - aft antenna separation is 3m provides potential heading accuracy of 0.2 degrees. Port – starboard antenna separation of 1m provides potential pitch/roll accuracy of 0.6 degrees.

User configurable data is output on two serial ports. Output Port A provides position data for ship wide NMEA Mux including strings
GGA,GLL,VTG,ZDA

Output Port B, 115200, 5Hz update rate, provides position and attitude data for Ocean Surveyor II
GGA,VTG,ZDA,
PASHR,AT2 (heading, pitch, roll)

When the receiver is searching for the ambiguities, or when a valid solution has not been found code phase estimate of heading appears in the PASHR,AT2 string and pitch and roll are displayed as exactly 0.00. Heading may also be displayed as 0.00 if no estimate is available.

When either of these situations exist, the attitude reset flag is set to 1 in the attitude output message (a 0 for the attitude reset flag indicates a good attitude solution).

If noisy or bad satellite measurement data was received by the ADU5 the Kalman filters sometimes get lost. This results in no valid solution. This often is the result of high multipath interference. BRMS and MRMS fields in the PASHR,AT2 string will exceed maximum noise levels, and the PDOP will become large. For a good solution PDOP should be less than 6.

ADU5 was reset to reset attitude kalman filters approximately every 1-2 days. No loss of position resulted. If the interference is not prolonged the unit can recover on its own.

In the presence of multipath the attitude solution suffers degradation in accuracy and an increase in processing time is required to regain a lost solution. To reduce multipath errors choke rings have been installed on the fore and aft antennas. Choke rings may have to be added to the port and starboard antennas, or the location of the array may have

to be modified to reduce multipath effects. Errors seem to be both heading and sea state related.

Solution quality was monitored on a daily basis with the aid of the Teledyne RDI VMDAS and WinADCP software packages used to log and monitor the OSII ADCP current profile data.

6. Meteorological observations

The officer of the watch manually logged meteorological variables at regular intervals. Negotiations are ongoing with the Meteorological Service of Canada to install an automated weather reporting system on Hudson.

7. Atmospheric Chemistry

There was no atmospheric chemistry program.

C. HYDROGRAPHIC MEASUREMENTS - DESCRIPTIONS, TECHNIQUES AND CALIBRATIONS

1. CTD Measurement — Igor Yashayaev

a. Description of the Equipment and technique

The CTD measurements were made with a standard SEABIRD model 11 Plus deck unit and model 9 Plus CTD equipped with two temperature sensors, two conductivity sensors, a paroscientific digiquartz model 410K-105 pressure sensor, two dissolved oxygen sensors, an altimeter sensor, par/irradiance sensor and a fluorometer sensor. All but the pressure sensor are mounted in one of two ducts through which separate pumps pull seawater. Hence the water flow past the actual sensors is independent of the lowering rate. This simplifies the data processing considerably.

The sensors used for the various Systems and the sensor arrangement for each station is listed below.

BIO System Number	Sensor	Model	Serial Number
8	Temperature	3-02/F	03P2129
	Conductivity	4-02/0	041730
10	Temperature	3-02/F	03P2303
	Conductivity	4-02/0	041874

Table C.1.1. System numbers and sensor serial numbers.

Model	Serial Number
SBE43	430133, Cal. 21-Jan-2006
SBE43	430042, Cal. 29-Dec-2005

Table C.1.2. Oxygen sensors used during 2006019.

BIO Deck Unit Number	Model	Serial Number
3	11 plus	11P7032-0267
2 (spare, never used)	11 plus	11P5676-0243

Table C.1.3. Seabird deck units for 2006019.

BIO CTD Probe Number	Model	Serial Number	Pressure Sensor
6	9 plus	MOD12P-0362	69009

Table C.1.4. Seabird CTD units for 2006019.

Stations	Circuit	Probe	Pressure	Temp.	Cond.	Oxygen	Pump
All	Primary	6	6	8	8	430133	051775
	Secondary			10	10	430042	051776

Table C.1.5. CTD and sensor configurations used during 2006019.

Instrument	Serial Number
SBE Carousel	3215631-0165
Pinger	Unknown
Lowered ADCP	1576
Irradiance	SPQA280-LI-193SA/0002-PN90310-CH1
Fluorometer	088172
Altimeter	222

Table C.1.6. Other instrumentation on the rosette frame.

The Seabird CTD was mounted vertically within a custom designed and built CTD/Rosette frame. All the pressure cases as well as the sample bottles are mounted vertically to improve the package's stability as it descends through the water column. In the centre of the frame is an aluminum tube, which contains at its upper end a Seabird Carousel 24 bottle rosette unit. The frame itself is subdivided into four quadrants. In one quadrant is a RDI 150 kHz Broadband ADCP in a shortened pressure case. In the next quadrant is the pressure case for the Seabird CTD and fluorometer. The third quadrant contains the battery pack for the LADCP, the Benthos altimeter and a General Oceanics model 6000 12 kHz pinger unit. The last quadrant contains the dual CTD sensors and pumps.

b. Sampling Procedure and data processing techniques

The rosette frame and CTD were deployed with a lowering rate of 60 meters/min (40 meters/min in the upper 200 meters). The package was recovered at a rate of 75 meters/min depending on the wire tension.

The CTD data is recorded onto disk by a PC computer using SEABIRD Seasave for Windows. Processing was conducted using Seasoft Version 4.999 software. IMS software was used for communication with the winch operator and for providing CTD readout to the metering block display.

After each station we process the recorded data files (raw data – *019a###.dat*, instrument configuration - *019a###.con*, header file - *019a###.hdr*, bottle position file containing scan of the records when each bottle was tripped - *019a###.bl*) to create 1 and 2 dbar processed data files and other CTD-derived files designed for specific tasks, like the *.qat* files, which are based on the rosette summary files merged with unique for each bottle trip identifiers of sea water samples.

All the raw and processed data files associated with the station are then transferred to the ship's file servers for archive and subsequent access and distribution to various users on the vessel.

Over the past ten years we developed, tuned and used a set of processing scripts to generate high quality CTD profiles during and after WOCE and CLIVAR cruises (*processing scripts and algorithms of additional modules are available from Igor Yashayaev*). This processing was executed in Command Prompt window (MS-DOS-compatible) and provided flexible capabilities for multiple file processing, producing up and down trace fully processed profiles. It also provided operational stability avoiding processing errors caused by insufficiency in file structure, etc. However, with Seabird Electronics switching to windows based processing and trying to take advantage of a better resource management provided by Windows, the CTD support group (BIO) has developed a Windows based CTD data processing system. The ship board version of this system that will be used as the BIO standard uses our MS-DOS version as its prototype and a model. We worked in contact with the informatics support group providing this development to accommodate all of our processing needs in this system and provide an efficient and reliable working environment. The Windows based processing system that was used in 2006-011 and 2006-019 Hudson missions was released shortly before the cruises and installed on the CTD acquisition and processing computer. It was routinely used through both trips for after-station processing and batch reprocessing. There were many comments and suggestion brought up in the course of operations.
The major inconveniences of the existing package are:
1) Redundancy in the multiple windows and menu collections, causing the operator to repeat the same confirmations and filling up the same queries with the same answers; the windows should be redesigned / restructured to provide simplicity and logic.
2) Inability to “memorize” the working pathways – working on the same project implies that we use the same folder, use the same file with sample IDs, I would suggest to improve a system of hints – e.g. use some predefined names or extensions for first bottle sample Ids – if the file exists and there is a sample ID typed in already – provide automatic retrieval of such, would be nice to have an *.ini* or *.cfg* or other configuration or setup files remembering last station processed. Also if the system can find newer data files then they show up into the processing list or scan the folder of completed files and check which are yet to be processed. This would add some intuitive intelligence to the system, save time and provide a neat way to control accomplished tasks.
3) I didn’t like the instrument configuration on the first panel – this file has nothing else but sensor settings and we have a *.con* file supplied with each data file. It is an unusual case when the processing will be done with some external *.con* file when there is a real

file accompanying each *.dat* file – sometimes we simply don't have this one for all *.con* files. The other point is that we usually store this group-specific *.con* outside of the main data folder, so you need to switch folders at each query – this is time consuming and you must concentrate every time so to not make mistakes.
3) Its inability to mix different configurations of CTD sensors in the same batch process, even if it may be possible this is a big "NO" in the system simply because you need to enter a specific *.con* file at the start of each session. It is kind of tricky to tell it to use sensor systems 9 & 10 for all stations but some have different configurations.
4) We had a station when the CTD connection shorted and so the cast stopped before we reached the bottom; so only the down trace was produced. The default file version caused an error, so I had to manually turn off the up-cast processing part. It would be nice to implement more flexible conditional logic.
5) The system sometimes froze – the cause was unknown – after restart it worked fine on the same file.
6) Leave the "Zip file" option unchecked as the default.
7) Very slow file exchange – in the MS-DOS version it was never an issue.
8) Redundant confirmation buttons appear in the middle of processing.
9) Text box – I never read it and I am not sure if anybody read it – I am not saying we don't need it – just put it on a button somewhere.
10) Files are not removed from CTDDATA.
11) Most of the checkboxes can be hidden under "options" button – the whole process can be well places at the same level with buttons for tuning up Seabird and BIO modules.
12) Oxygen sensor delay times are not 5 seconds – my crude estimate is close to 8.
There were other comments, some of which I forgot but will provide as soon as recall. There are definite advantages in the system – but for now we want to boil it down to the level when the processing can be done easy, quickly and somehow in a more intuitive way – I am very enthusiastic about it and put trust into it – the fact that I never considered switching back to quick and simple DOS talks for itself.

c. Pre-mission tune-up of the CTD sensors

There are two types of coefficients used in instrument configuration files – one is sensor specific supplied by Seabird Electronics and applied to raw frequency and/or voltage readings (I call these hardware coefficients). The other set of coefficients is determined by external processes affecting the sensors – aging, drift, pressurizing, etc. (I call these dynamic coefficients). Although there is no strict separation between these groups (if we send a sensor back to Seabird they recalibrate it and derive new hardware coefficients – turning optimal slope and offset to 1 and 0), I only play with the dynamic coefficients. All coefficients used to calculate CTD physical values from sensors readouts are stored in stations specific .con files and can be easily viewed or change by using *Seacon*. Before I accumulate enough values water sample salinity, I use the previous history of laboratory and in-situ calibrations. Using most recent laboratory calibrations and coefficients determined for the previous year data I determine the values for slope and offset in each sensor reading and apply this numbers directly to the *.con* files.
The following table and screenshot are examples of output of the program that I developed for handling laboratory calibrations.
System 9 conductivity sensor failed during 2006-011 we decided to replace it with system 8. Since we don't have consistent in-situ trial for this system (8) I used the slope and offset values based on laboratory calibrations. For system 10 I used the slope and offset valued that were found as the best choice for 2005 data processing.

Output of Laboratory Calibration management and analysis software (sensors' statistics):

```
--------------------------------------------------------------------------------
  Request #9 of 20-May-2006, 17:14:30
  C sensor #8
  Calibration History:    2005 - 2006
  C CTD values range:     2.74 - 4.83
  C Bath-CTD values range: 0.0014 - 0.0035
--------------------------------------------------------------------------------
  File_Name, YYYY, MM, ##,    Slope,   Offset,     Mean,      StD,   Median
2005_MAR_S08, 2005,  3, 16,  0.000929, -0.001031,  0.002198,  0.000689,  0.001992
2006_JAN_S08, 2006,  1, 16,  0.000993, -0.001153,  0.002270,  0.000727,  0.001968
--------------------------------------------------------------------------------


--------------------------------------------------------------------------------
  Request #11 of 20-May-2006, 17:15:23
  T sensor #8
  Calibration History:    2005 - 2006
  T CTD values range:     -1.75 - 20.17
  T Bath-CTD values range: -0.0004 - 0.0009
--------------------------------------------------------------------------------
  File_Name, YYYY, MM, ##,    Slope,   Offset,     Mean,      StD,   Median
2005_MAR_S08, 2005,  3, 16,  0.000025,  0.000148,  0.000300,  0.000378,  0.000400
2006_JAN_S08, 2006,  1, 16, -0.000002,  0.000580,  0.000569,  0.000130,  0.000550
--------------------------------------------------------------------------------
```

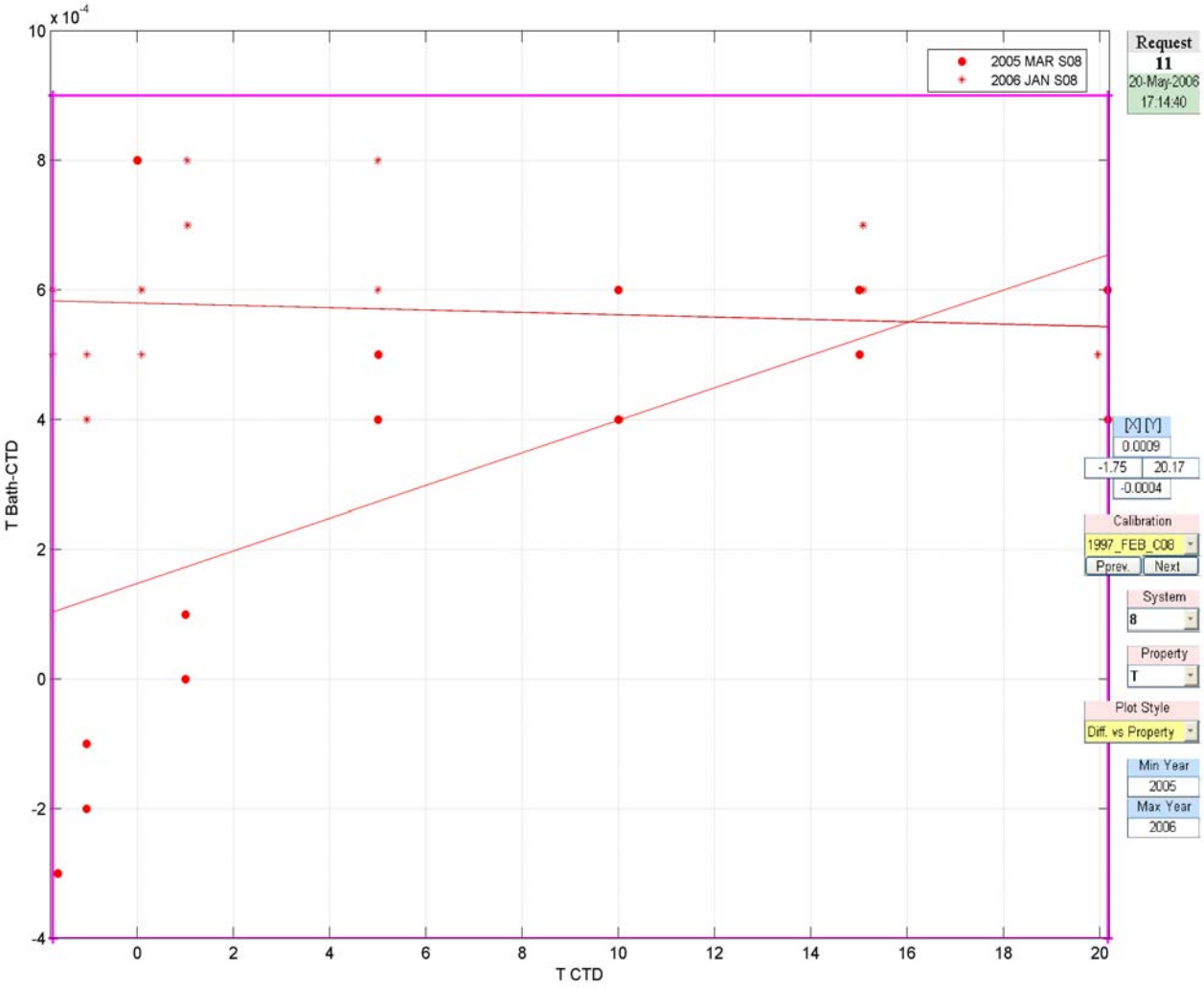


Figure C.1.1. Output of Laboratory Calibration management and analysis software: Laboratory calibrations of system #8 temperature sensor

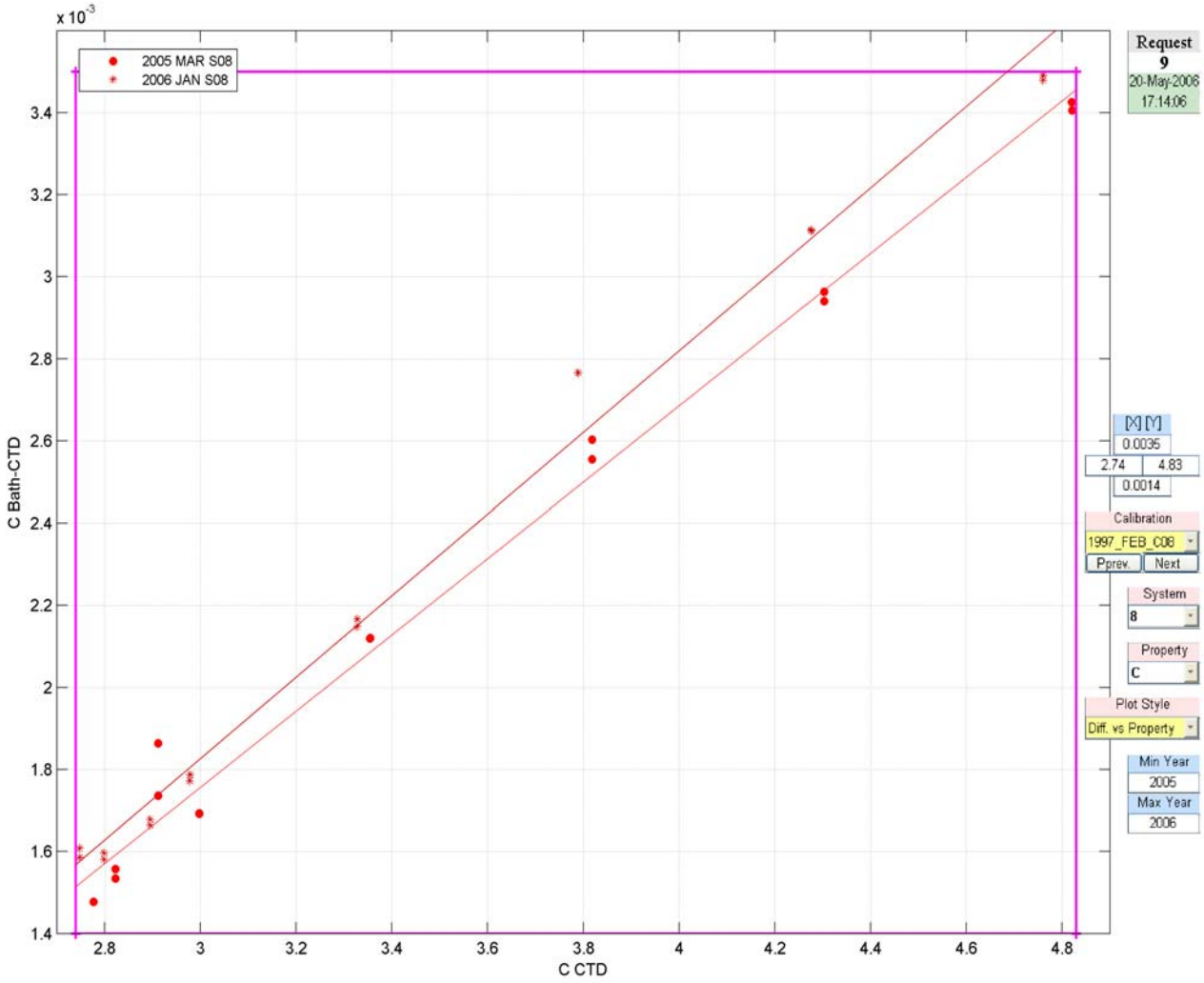


Figure C.1.2. Output of Laboratory Calibration management and analysis software: Laboratory calibrations of system #8 conductivity sensor

2. Salinity — Rick Boyce

a. Description of Equipment and Technique

Salinity samples were analyzed using a Guildline Autosal 8400B salinometer, serial number 60968. Samples were drawn into 200 ml bottles. Once the sample bottle was rinsed three times and filled to the shoulder, the neck and threads of the bottle were dried using paper towel and a new dry cap was installed. Once the bottles reached room temperature, the caps were retightened. The drying of the neck of the bottle and installing a dry cap has been a technique used since the HUD2000009 cruise and prevents salt crystals from forming under the cap.

The salinometer cell was filled and rinsed numerous times with sample water before readings were recorded. When three consecutive readings of conductivity agree to within 0.00001,

this value was recorded for the sample. This value was then entered into the water sample database as the conductivity ratio for the water sample.

b. Data Processing Technique

Conductivities were entered into the ODIN database. Conductivities were used to compute salinities using the water sample conductivity ratio and the standard IAPSO formula applied in an ODIN module. Any changes in the salinometer readings between successive standardizations were assumed to have occurred as a linear drift of the instrument. Thus, the program applied a correction to the ratios, which varied linearly with the samples analyzed. An offset was also applied if the initial standardization was different from the quoted value given on the ampoule label. The computed salinity data was then placed in the water sample database.

c. Laboratory and Sample Temperatures

Full cases of samples were taken from the winch room to the Drawing Office where they were left for a period of at least 10 hours to equilibrate to room temperature before being analyzed. The temperature in this area ranged between 23º to 25 ºC. The bath temperature was maintained at 24º for all samples.

d. Standards Used

The salinometer was standardized during the mission using IAPSO standard water, Batch P147 dated June 6, 2006 having a K15 value of 0.99982 and a salinity of 34.993. Typically, standardization checks were performed at the beginning and end of a run. A sub-standard was used to check the performance of the instrument at some times during a run.

e. Performance of the Autosal salinometer

Overall the salinometer worked well during the mission. The lab temperature was stable during all runs which is an important factor when trying to optimize the performance of the instrument. Historically the Autosal was setup in the General Purpose (GP) lab onboard Hudson. Air temperature was difficult to control in this area. For this mission the Autosal was installed in the Drawing Office where the operator can control the ambient air temperature much better than in the GP lab.

3. Oxygen — Eva Falik / Carol Anstey

a. General

This report concerns the second leg of the HUD2007-011 Labrador Sea Cruise. Samples for the determination of dissolved oxygen were collected along the AR7W L3 and L2 lines plus the Halifax Line on the Scotian Shelf. Samples were drawn from 87% of the rosette bottles deployed (823 of 991 bottles). Replicate samples were collected for 32 bottles or approximately 4% of the oxygen samples analyzed.

The samples were analyzed using an automated system developed at the Scripps Institute of Oceanography based on a modified Winkler titration technique.

b. Sampling Procedures

Sub-samples were drawn from 10L bottles attached to a 24-bottle Rosette Sampler. Oxygen sub-samples were drawn after chlorofluorocarbon (CFC) and total organic carbon (TOC) samples. The oxygen sampling bottles were 125 mL Iodine flasks with matched custom ground stoppers (Levy et al., 1977). The flask volumes were predetermined gravimetrically (volume data saved to titration program). The matched flasks and stoppers are etched with identification numbers.

Each oxygen sub-sample was drawn through a silicone tube attached to the spigot of the Rosette bottle. The flask was thoroughly rinsed and filled to overflowing; the flow was then allowed to continue until two to three flask volumes overflowed. The sampling tube was slowly retracted with continuous low flow to ensure that no air was trapped in the flask. The flask stopper was also rinsed. The draw temperature of each sample was taken. This method deviated from previous years where the CTD recorded temperature was used as draw temperature. Samples were oxidized immediately with the addition of 1.0 mL each Alkaline Iodide and Manganous Chloride. The flask stopper was carefully inserted to avoid introducing air. The flask was then thoroughly shaken. The resulting precipitate was allowed to settle for approximately 30 minutes before analysis once the bottles reached the GP lab.

c. Analysis Equipment and Technique

The oxygen samples were analyzed using an automated procedure developed by the Ocean Data Facility of the Scripps Institute of Oceanography (OSD/SIO, 2000). This procedure is a modified Winkler titration from Carritt and Carpenter (1966). The oxygen in seawater is made to oxidize iodide ion to iodine quantitatively in the presence of an alkaline solution of manganese (II) ion. Once the resulting precipitate has settled, it is dissolved by the addition of 1.5 mL of 5M sulphuric acid. Dissolved oxygen content is determined by an automated Thiosulphate titration using the UV (350nm) absorption of the tri-iodide ion for end-point detection. A Potassium Iodate solution was used as the working standard. The temperatures of the samples (taken from the CTD wet deck sheets), potassium iodate and thiosulphate (taken by temperature probe integrated with titration system) are logged in the program for each determination to allow for temperature related volume corrections.

Standards, titre, acid and pickling agents were prepared just before the cruise. The second lot of Alkaline Iodide used had developed a colloidal black precipitate during cruise storage. The reagent was filtered through cleaned glass wool before use. This

removed most of the precipitate but not all. Its presence did not seem to affect the titrations.

d. Replicate Analysis

Replicate samples were drawn from 32 rosette bottles, about 4% of the total number samples for oxygen. Differences from the mean in oxygen concentration for the replicate pairs are plotted for each day of analysis in Figure 1 below. Average deviation (precision) for all replicate samples: ±0.009 mL/L.

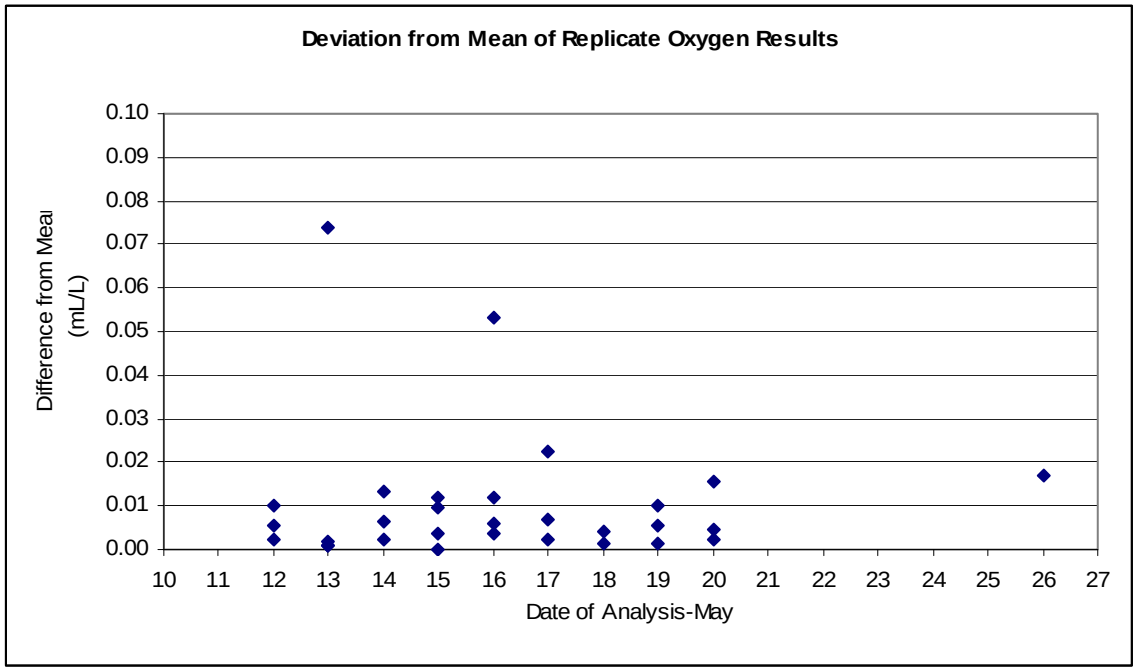


Figure 1. Difference from mean of the analysis of each replicate pair vs. date of analysis.

e. Standards and blanks

Standards are determined by the titration of 10.0 mL volume of KIO_3 solution. Blanks are determined by titration an initial 1.0 mL volume of $KIO_{3\ followed}$ by addition and titration of a second 1.0 mL volume. The blank is the difference between the two volumes. The usual protocol followed is to obtain at least three replicate standards and blanks within ±0.0003. Many standardization replicates did not agree this closely. Standardizations were run at the beginning of each calendar day instead of before each batch of samples due to a shortage of reagents. The oxygen analysis software allows the operator to edit out any individual blank or standard titration considered an outlier. The average values of valid standards and blanks for each set of titrations are used by the analysis program to compute oxygen concentration. The individual titration volumes and auxiliary information are stored for possible re-processing. The means of the daily accepted standard and blank values are plotted in Figures 2 and 3 below.

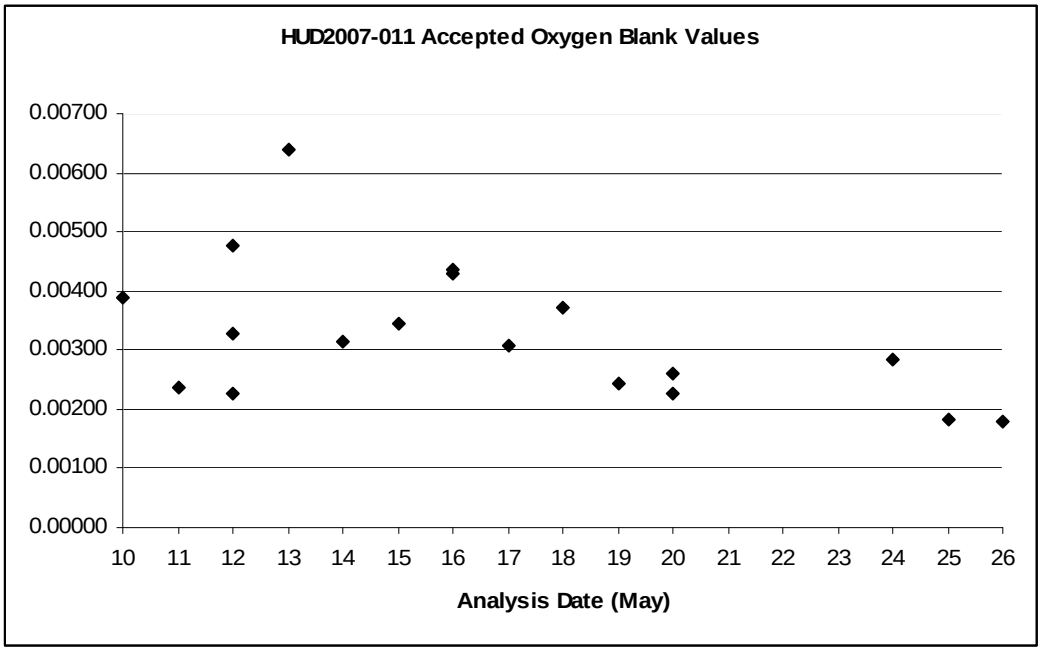


Figure 2. Accepted values for oxygen blanks for each analysis day.

The blank values in Figure 2 have an overall average of 0.00327 mL and overall average deviation of 0.00089 mL.

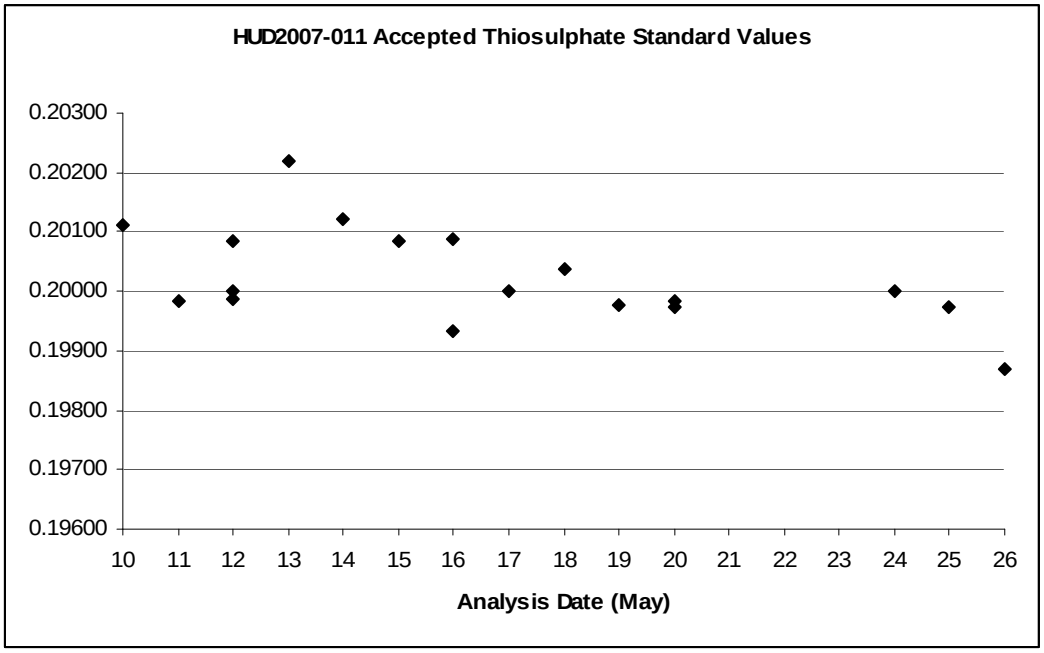


Figure 3. Accepted values for thiosulphate standards for each analysis day.

The thiosulphate standard values in Figure 3 have an overall average of 0.20024 N and overall average deviation of 0.00065 N.

f. Comments

A log book was kept with a daily record of raw data results and any problems encountered. Analysis of the samples posed few technical problems. There was a substantial decrease in bubbles forming in the reagent lines as compared to last year. This was probably due to cooler and less erratic lab temperatures. Results from standard and blank calibrations were not as precise as earlier years. Protocol calls for precision to be ±0.0003; this was rarely achieved. There was a shortage of reagents prepared as the L2 line was added without letting the lab know prior to loading the Hudson. Calibrations were done only once a day when the next day's data collection file was set up and as few as possible in order to conserve reagents. A computer or 'systems' crash occurred a few times. The reason this happens has not yet been determined. Fortunately this resulted in the loss of only a few samples. The Dosimats both worked smoothly. It was noted last year that the thiosulphate Dosimat failed to stop dispensing several times when the flushing function was invoked. This problem did not reoccur for this cruise.

Samples were drawn by experienced and well trained winch room personnel. Problems with switched stoppers or bubbles in the samples were not noted. It was noted that the Alkaline Iodide dispenser may not have been delivering 1.0 mL May 18 as it needed cleaning.

4. Nutrients — Carol Anstey

a. Description of Equipment and Technique

Samples were analyzed for silicate, phosphate, and total nitrate (nitrate plus nitrite) using a Technicon Autoanalyzer II. The chemistries were standard Technicon for Seawater Analysis (Silicate 186-72W, Phosphate 155-71W, Nitrate/Nitrite 158-71W) except for Phosphate which has been modified by separating the Ascorbic Acid (4.0 gm/l) from the Mixed Reagent. This modification was achieved by introducing the modified Mixed Reagent instead of water at the start of the sample stream at 0.23 ml/min. and introducing Ascorbic Acid into the stream between the two mixing coils at 0.32 ml/min. (Strain and Clement, 1996).

b. Sampling Procedure and Data Processing Technique

Duplicate nutrient samples were drawn into 30 ml HDPE (Nalge) wide mouth sample bottles from the 10 L Rosette bottles. The sample bottles were pre-washed in 10% HCL, rinsed three times with Alpha-Q (deionized water) and oven dried at >100 Degrees F.

A sample run included six Calibration Standards, analyzed in duplicate, at the beginning and end. The standards, wash water and blanks were made up in 33 ppt NaCl (Sigma, ACS Reagent. The second most concentrated Calibration Standard was used as a Check Standard every 16 samples followed by blanks as a baseline check. The standards were checked against an Intercalibration Reference Material MOOS-1 for nutrients produced by NRC, Ottawa.

The raw analog data was converted to digital data, processed and concentrations calculated, including statistics, by an in-house Pascal 7.0 program (AAII) on a PC. Chart recordings, hard copy and disk copies of the data were archived.

c. Replicate Analysis

Total number of duplicate samples analyzed for HUD2007-011: 1942. Samples were analyzed as soon as possible after collection. Any samples collected off watch were kept refrigerated (-4ºC) and analyzed within eight hours of collection.

There were no technical problems encountered during this cruise. All sample runs were excellent: stable baselines and very good calibration RMS – 'fit to curve'. Only the phosphate baseline for May 26, 2007 analysis was unstable. This was soon addressed by changing the pump tubes and an extra acid cleaning of the phosphate heater to remove molybdate build up. There were some problems during the first few analyses with air bubbles slipping into the flow cells causing erroneous air peaks. This was fixed by tilting the colorimeters by 20º. The air peaks did not interfere with the final voltage data as the program has been written to edit these out. Since the problems encountered last year on HUD2006-019, we have been able to replace old equipment. The nitrate and phosphate colorimeters have been replaced with rebuilds from Pulse Instrumentation. The voltage regulators replaced with new. Data was still being collected using the last spare IO board. The search for a replacement is ongoing. Last year's problems with white Azo-dye precipitate continuously building up in the nitrate line and the degassing of the ascorbic acid reagent for silicate forming bubbles which would get caught in the flowcell were not encountered. The high, and difficult to regulate, lab temperatures which may have contributed to these problems last year were much more stable and cooler. Average lab temperatures stayed between 22ºC to 26ºC as compared to sometimes 35ºC last year. This was probably due to cooler temperatures outside. Fans were still used to help cool the whole lab along with keeping portholes and deck doors open during calm weather.

The data quality parameters, determined with check standards, MOOS-1 Intercalibration Reference Standard and RMS offset from the calibration curve, came well within accepted values. Frequent flushing of the system with 1N HCl followed by Alpha-Q water helped to prevent sample flow problems and build-up of molybdate coating of the flow cells. A summary of QC/QA MOOS-1 data as follows:

QC/QA MOOS-1		Silicate µM	Phosphate µM	Nitrate µM
Accepted Values	**from**	**25.00**	**1.490**	**22.80**
	to	**27.00**	**1.630**	**24.60**
Analytical Results		26.60	1.610	25.26
		26.54	1.595	25.30
		26.09	1.641	24.99
		26.00	1.607	24.94
		25.52	1.572	23.99
		25.67	1.562	24.07
		26.50	1.624	25.18
		26.61	1.624	25.23
		26.20	1.614	25.27
		26.36	1.621	25.90
		26.13	1.624	24.05
		26.10	1.607	24.16
		26.15	1.611	23.92
		26.31	1.620	24.35

RMS offset from the predicted calibration curve is a measure of how acceptable the calibration was for a specific analysis run. There is no firm cutoff for 'good' or 'bad' data. The following table lists acceptable limits for RMS fit determined by averaging 34 runs of data deemed to be acceptable by peak shape, stability of the baseline and precision between duplicates.

RMS Offset from Curve:

	SILICATE	PHOSPHATE	NITRATE
Mean (µM) n=34	0.115	0.042	0.089
Std. Deviation (µM)	0.115	0.020	0.043
Maximum (µM)	0.695	0.111	0.271
Cruise Average	0.102	0.013	0.074

RMS Values for Individual Analysis Runs:

Analysis Date	SILICATE		PHOSPHATE		NITRATE	
	Initial	Final	Initial	Final	Initial	Final
MAY1007	0.038	0.047	0.009	0.010	0.040	0.014
MAY1107	0.052	0.094	0.013	0.013	0.038	0.050
MAY1207	0.044	0.054	0.009	0.013	0.023	0.108
MAY1307	0.008	0.059	0.008	0.006	0.053	0.010

MAY1407	0.027	0.015	0.008	0.008	0.042	0.024
MAY1507	0.012	0.107	0.009	0.014	0.021	0.133
MAY1607	0.048	0.070	0.005	0.008	0.020	0.008
MAY1707	0.075	0.042	0.014	0.008	0.055	0.054
MAY1807	0.029	0.031	0.024	0.012	0.032	0.019
MAY1907	0.211	0.520	0.014	0.025	0.117	0.345
MAY2007	0.016	0.061	0.010	0.012	0.026	0.047
MAY2107	0.040	0.019	0.007	0.011	0.050	0.027
MAY2407	0.061	0.045	0.010	0.010	0.011	0.081
MAY2507	0.036	0.360	0.011	0.019	0.031	0.222
MAY2607	0.051	0.489	0.022	0.023	0.064	0.294
MAY2707	0.486	0.013	0.023	0.011	0.279	0.021

The conversion to mass units for the analytical precision and detection limits used a standard density corresponding to 33 ppt. and 15ºC.

The nutrient detection limits noted in the table below are an average of all analytical runs for the cruise. Individual daily detection limits were applied to the corresponding data set.

	Silicate	Phosphate	NO2+NO3
Number of Samples	971	971	971
Number of Duplicates	1942	1942	1942
Mean concentration (μ moles/kg)	9.30	0.937	13.51
Detection Limit (μ moles/kg)	0.29 ±0.14	0.02 ±0.01	0.10 ±0.04

5. Total Inorganic Carbon in Seawater — Kumiko Azetsu-Scott

a. Description of Equipment and Technique

The total dissolved inorganic carbon content of seawater is defined as the total concentration of carbonate ion, bicarbonate ion and unionized species of carbon dioxide. Before analysis, the sample is treated with acid to convert all ionized species to the unionized form, which is then separated from the liquid phase and subsequently measured using a coulometric titration technique. This involves the reaction of carbon dioxide gas with a dimethysulfoxide solution of ethanolamine to produce hydroxyethylcarbamic acid. The acidic solution is titrated with hydroxide ion formed by the electrolytic decomposition of water. The progress of the titration is followed through colorimetric measurement of the absorbance of a pH indicator dye (thymolphthalein) in the ethanolamine solution.

A known volume of seawater is dispensed into a stripping chamber from a pipet of known volume and temperature controlled to within 0.4 °C. It is then acidified with ten percent its volume of a 10% solution of carbon dioxide-free phosphoric acid. The

solution in stripped of carbon dioxide gas by bubbling with a stream of nitrogen gas directed through a glass frit. The carrier gas exiting the stripper passes through a magnesium perchlorate trap to remove water vapour and acidic water droplets. The gas stream is then directed into the coulometric titrator where the total amount of carbon dioxide gas is quantified.

b. Sampling Procedure and Data Processing Technique

Samples for total inorganic carbon were collected and analyzed from all bottles tripped at standard hydrographic depths on all sites on the AR7/W except station 12 (no bottles available for TIC measurements), on L-2 line stations 6.5, 8, 10, 12, 13, 14, 15.5, 18, 19 and 20 and on Halifax line stations 2, 3, 6, 7, 8, 9, 10 and 11.

Samples are drawn from the rosette immediately following the drawing of the oxygen samples in order to minimize exchange of carbon dioxide gas with the head space in the sampler. This exchange will typically result in a loss of carbon dioxide. It is desirable that the samples be drawn before half the sampler is emptied and within ten minutes of recovery. Clean borosilicate glass bottles are rinsed twice with 30 - 50 ml of the sample. The bottle is then filled from the bottom using a length of vinyl tubing attached to the spigot of the sampler. The sample is overflowed by at least a half of the volume of the bottle (typically 250 ml). A head space of 1% is left to allow for expansion without leakage.

Theoretically, the coulometer should give a direct measurement of the amount of carbon titrated based on calculations using the Nernst equation. In practice, the coulometer's calibration is checked using Certified Reference Materials obtained from the Scripps Institute of Oceanography, LaJolla, California. These samples are treated in the same manner as a seawater sample. Values are reported in units of μmol/kg. The overall precision of the analysis should be at least 1.5 μmol/kg for samples with concentrations in the range of 1800-2300 μmol/kg.

6. Alkalinity — Kumiko Azetsu-Scott

a. Description of Equipment and Technique

The total alkalinity of seawater is defined as the number of moles of hydrogen ion equivalent to the excess of proton acceptors (bases formed from weak acids with dissociation constants of less than $K=10^{-4.5}$) over proton donors (acids with $K>10^{-4.5}$) in a one kilogram sample. An automated potentiometric titration system is used to determine this quantity. During the course of the titration the pH is measured using a Ross combination electrode standardized using a Hansson seawater buffer. A known volume (~25ml) of sample is measured in a calibrated, thermostated pipette and dispensed in to an open cup. The alkalinity of the sample is estimated from its salinity and acid equivalent to 0.7 of this amount is added and the pH measured. A further three aliquots of

acids are added to bring the titration to 90% completion. The Gran Function F3 (Stumm and Morgan) is then applied to these points to obtain a more refined estimate of the alkalinity. Five additional aliquots are then added to complete the titration.

b. Sampling Procedure and Data Processing Technique

Samples for alkalinity were collected and analyzed from all bottles tripped at standard hydrographic depths on whole-number sites on the AR7W line with the exception of station 12 (no bottles available for alkalinity measurements), on L-2 line stations 6.5, 8, 10, 12, 13, 14, 15.5, 18, 19 and 20 and on Halifax line stations 2, 3, 6, 7, 8, 9, 10 and 11. Samples are collected using the same procedure as for Dissolved Inorganic Carbon (see Section 5b).

The pH values for the last five points of the titration are used to evaluate the Gran Function F1 from which the final estimate of the equivalence point is obtained. Hydrochloric acid used in the titrations is calibrated is two ways: against a standard solution of sodium borate using an acid base titration and against postassium iodate using an iodometric titration with sodium thiosulphate. In addition, the calibration is checked using Certified Reference Materials obtained from the Scripps Institute of Oceanography, LaJolla, California. Values are reported in units of μmol/kg. The precision of the analysis was not good at the beginning of the cruise (suspected acid problem and laboratory temperature fluctuation), but after modification it improved to be 0.1% for samples with concentrations in the range of 1900-2400 μmol/kg.

7. Halocarbons — Brian Robinson / Rick Nelson

a. Description of Equipment and Technique

The series of halocarbon compounds that are analysed includes the chlorofluorocarbons CFC-12, CFC-11, CFC-113 and the halocarbons carbon tetrachloride and methyl chloroform. The analyses are carried out on two identical purge and trap systems developed at the Bedford Institute of Oceanography. Water samples are injected into the systems directly from the syringes used to collect the samples. The sample pipette is rinsed with a minimum of two volumes of water before the sample passes into the purge chamber that is held at 80°C. The halocarbons are purged from the sample for four minutes with ultra high purity nitrogen at a flow rate of 80 ml/min. The purged gasses are trapped in a Porapak-N trap that is cooled to a temperature of less than 10°C. The halocarbons are then desorbed by heating the trap to 170°C. A Varian 3300 Gas Chromatograph equipped with a 75m DB-624 megabore column and electron capture detection is used for the separation and quantification of the halocarbons.

b. Sampling Procedure and Data Processing Technique

Due to the length of time required for a single sample analysis (approx. 25min) and the frequency at which the deep stations were sampled, it was not possible to collect halocarbon samples at all stations during the cruise. On AR7W line, halocarbons were sampled at all stations except for L3-12, L3-21 and L3-27. On the L2 line, samples were taken at stations 6, 8, 10, 12, 14, 15.5, and 18, while all stations were sampled on the Halifax Line.

Samples are collected directly from the rosette using 100 ml syringes to avoid contact of the sample with the atmosphere. The syringes are rinsed three times before they are filled. To prevent contamination, the CFC samples are the first samples collected from the bottles. The samples are then stored in a water bath of continuously flowing surface seawater until analysis. The analysis of the samples is always completed within 24 hours after they have been drawn. The purge and trap system is also susceptible to contamination whenever it is open for maintenance and repairs. For this reason, blanks are run after the system has been open until a stable baseline can be achieved.

Chromatograms are analyzed using a commercial software package. Concentrations of the various components are evaluated from baseline-corrected peak areas. Calibration is carried out using working gas standards made up at Brookhaven National Laboratories. These standards have been calibrated in turn against a standard air sample ALM-64975 provided by CMDL/NOAA, Boulder Colorado. Standard volumes are corrected for lab temperature and pressure. Results are reported in units of pmol/kg of seawater. Clean air samples are also analyzed at several stations as a check on the standardization.

F. APPENDICES

Appendix 1. Cruise Report Images

Appendix 2. Operation Notes Report **Jeff Jackson**

(sorted by Operation ID Number)

Note Number: 1	**Entry Time:** 04/Jun/2006 23:04:25	**Note Made By:** Jeff Jackson	**Operation ID**: 221
Biology CTD cast was aborted due to CTD system freeze. Package was brought back on board. The problem was a lose connection from a faulty splice.			

Appendix 3. Mooring Details — Rick Boyce

Recovery

Mooring No: _1601_____
Ship: _CCGS Hudson_ Cruise No:_2007-011__ Date:__May 13, 2007___
Mooring Tech: __R. Boyce__
Type of Nav: ___GPS____
Sea State: ____2_____ Weather Conditions:__Wind 20 Kt. 4 m swell___
Cancel Notship: Yes__Y__ No ____

Recovery Log

Time(Z)	Instrument	Remarks
1315		On site Mooring Calibration successful (MCal)
1316		Release command sent. No apparent response
1317		Release command sent. No apparent response
1321		Release command accepted
1325		Slant range 629 meters
1331		Indicated on surface
1336		In sight off starboard quarter
1337		ELAC sounder switched from 0-5000 m to 0-2000m
1351		Manoeuvring to grapple mooring
1353		Hooked on HIAB crane
1355		RCM 4154 on board. Rotor spinning
1358		Hauling on mooring winch
1400		4 BUB packages and release on deck. End of recovery
		R. Hendry 13 May 2007

Performance

Include below if the mooring was successful or not, any corrosion, Guard buoys missing, release operation, partial recovery, mooring not in original position, dragging, any equipment damaged or any other information.

Mooring No: __1601_____

Successful mooring deployment and recovery.
All mooring tackle and instrumentation in good shape
RCM 4154 appeared to have worked with the correct amount of data

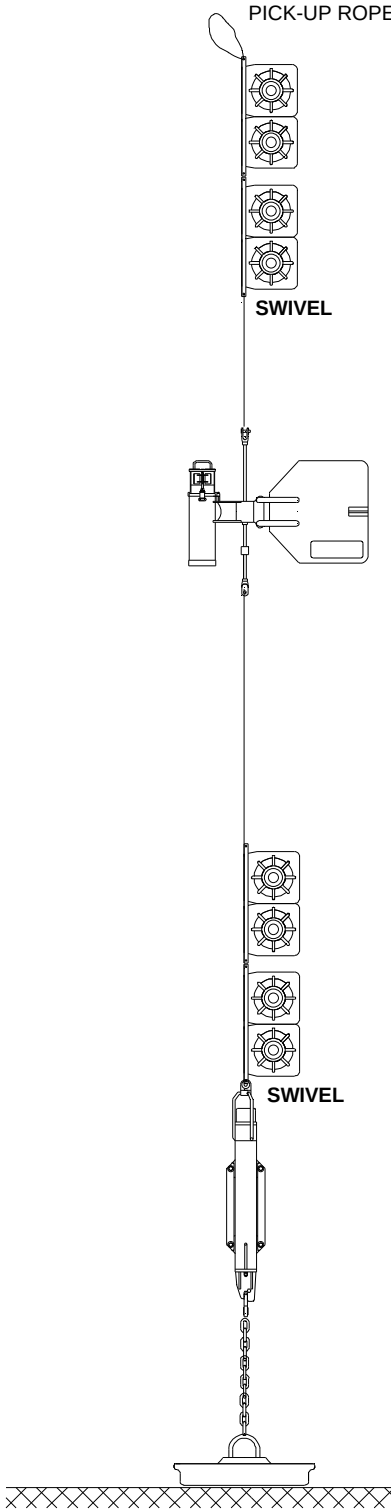
Placement

Mooring No. 1640
Geographic Area: Labrador Sea Intended Duration 1 Year
Ship: CCGS Hudson Cruise No: 2007-011 Date: May 13, 2007
Sea State: 2 about 4m swell Weather Conditions: Wind 20 kt, partial cloud
Mooring Technician: R. Boyce Navigation Inst. DGPS
Notship # N070509 Date Made May 15, 2007 Date Cancelled
All Areas: Tel: 902-564-7751 or 1-800.686-8676
Fax: 902-564-2446 Email: notshipssyd@mar.dfo-mpo.gc.ca
Latitude: 55º 07.1427' N Longitude: -054º 05.3383' W Time of Fix: 1511 Z
Depth: Raw: 550 Fathoms Corrected: 1019 meters
Main Float: Type: BUB Packages Markings: Yellow
Beacon: Type: None I.D. # n/a
Mooring Line: Type: 3/16" galvanized jacketed Colour: Yellow
Release: Type: Benthos 865A S/N: 40083 Release Code: "H" 9.00 KHz

Placement Log

Time (Z)	Instrument	Remarks
1420	RCM 5569	On deck, rotor spinning
1430	Anchor	Lashed outboard
		Westerly winds
		Upwind = east to west
1511		Anchor away 55º 07.1 N 54º 05.2 W
1523		On bottom
		Start mooring calibration and logging (MCal)
1530		Locked on calibration
		Preliminary position from MCal
		55º 07.1 N 54º 05.3 W
		Based on 1489 m/s gives
		Depth 1026 m, rms 32m
1630		End of survey. End of deployment

MOORING # 1640 HENDRY LAB SEA MAY 2007



Appendix 4. APEX Float Log Sheets **Rick Boyce**

Serial No.	**3269**
Argos ID	**33319**
Argos Hex	**03F2D79**
WMO Code	**4901075**

APEX Float Launch

Float was started. Date: May 14, 2007 Time: 2037 UTC
i.e. you sweep a magnet over the reset point and it beeps.

Float deployed. Date: May 14, 2007 Time: 2202 UTC
Float should be deployed within 6 hours of start time.

Deployed By: Richard Boyce

Mission: 2007011 Vessel: CCGS Hudson Event No 65

Latitude 56° 31.1869′N Longitude 052° 41.4244′W

Water Depth 3489 m (must be deeper than 2000 metres)

Nearest CTD / XBT cast (circle one) Event No of cast. 64

Date: May 14, 2007 Time: 1939 UTC

Latitude 56° 30.5510′N Longitude 052° 42.2020′W

Maximum Depth 3410 m

Any problems associated with the start up and deployment operation

OK

Please Fax or email this information,
within 24 hours of launch if possible, to:

Howard Freeland	cc:	Ross Hendry
Institute of Ocean Sciences		Bedford Institute of Oceanography
Fax: (250) 363-6690		Fax: (902) 426-3711
Email: FreelandHJ@pac.dfo-mpo.gc.ca		Email: HendryR@mar.dfo-mpo.gc.ca

Serial No.	**3270**
Argos ID	**33322**
Argos Hex	**03F2DAD**
WMO Code	**4901076**

APEX Float Launch

Float was started. Date: May 15, 2007 Time: 2309 UTC
i.e. you sweep a magnet over the reset point and it beeps.

Float deployed. Date: May 16, 2007 Time: 0040 UTC
Float should be deployed within 6 hours of start time.

Deployed By: Richard Boyce

Mission: 2007011 Vessel: CCGS Hudson Event No 113

Latitude 58° 14.9840′N Longitude 050° 57.5415′W

Water Depth 3580 m (must be deeper than 2000 metres)

Nearest CTD / XBT cast (circle one) Event No of cast. 112

Date: May 15, 2007 Time: 2159 UTC

Latitude 58° 13.0736′N Longitude 050° 53.1151′W

Maximum Depth 3593 m

Any problems associated with the start up and deployment operation

OK

Please Fax or email this information,
within 24 hours of launch if possible, to:

Howard Freeland	cc:	Ross Hendry
Institute of Ocean Sciences		Bedford Institute of Oceanography
Fax: (250) 363-6690		Fax: (902) 426-3711
Email: FreelandHJ@pac.dfo-mpo.gc.ca		Email: HendryR@mar.dfo-mpo.gc.ca

Serial No.	**3271**
Argos ID	**33323**
Argos Hex	**03F2DBE**
WMO Code	**4901077**

APEX Float Launch

Float was started. Date: May 17, 2007 Time: 2254 GMT
i.e. you sweep a magnet over the reset point and it beeps

Float deployed. Date: May 18, 2007 Time: 0015 GMT
Float should be deployed within 6 hours of start time.

Deployed By: Richard Boyce

Mission: HUD2007011 Vessel: CCGS Hudson Event No 183

Latitude 60º 15.5696' N Longitude -048º 42.0623' W

Water Depth 2768 meters (must be deeper than 2000 meters)

Nearest CTD / XBT cast (circle one) Event No of cast. 182

Date: May 17, 2007 Time: 2206 GMT

Latitude 60º 15.5334' N Longitude -048º 42.5030' W

Maximum Depth 2768 meters

Any problems associated with the start up and deployment operation

_____
_____
_____
_____
_____

Please Fax or email this information,
within 24 hours of launch if possible, to:

Howard Freeland	cc:	Ross Hendry
Institute of Ocean Sciences		Bedford Institute of Oceanography
Fax: (250) 363-6746		Fax: (902) 426-7827
Email: FreelandHJ@pac.dfo-mpo.gc.ca		Email: HendryR@mar.dfo-mpo.gc.ca

Serial No.	**3273**
Argos ID	**33327**
Argos Hex	**03F2DF2**
WMO Code	**4901079**

APEX Float Launch

Float was started. Date: May 25, 2007 Time: 0959 GMT
i.e. you sweep a magnet over the reset point and it beeps

Float deployed. Date: May 25, 2007 Time: 1154 GMT
Float should be deployed within 6 hours of start time.

Deployed By: Richard Boyce

Mission: HUD2007011 Vessel: CCGS Hudson Event No 234

Latitude 41º 47.7694' N Longitude -060º 54.5242' W

Water Depth 4000 meters (must be deeper than 2000 meters)

Nearest CTD / XBT cast (circle one) Event No of cast. 233

Date: May 25, 2007 Time: 0817 GMT

Latitude 41º 46.6845' N Longitude -060º 54.4900' W

Maximum Depth 4449 decibars

Any problems associated with the start up and deployment operation

OK

Please Fax or email this information,
within 24 hours of launch if possible, to:

Howard Freeland	cc:	Ross Hendry
Institute of Ocean Sciences		Bedford Institute of Oceanography
Fax: (250) 363-6746		Fax: (902) 426-7827
Email: FreelandHJ@pac.dfo-mpo.gc.ca		Email: HendryR@mar.dfo-mpo.gc.ca

Serial No.	**3274**
Argos ID	**33329**
Argos Hex	**03F7D13**
WMO Code	**4901080**

APEX Float Launch

Float was started. Date: May 25, 2007 Time: 2305 GMT
i.e. you sweep a magnet over the reset point and it beeps

Float deployed. Date: May 25, 2007 Time: 2354 GMT
Float should be deployed within 6 hours of start time.

Deployed By: Richard Boyce

Mission: HUD2007011 Vessel: CCGS Hudson Event No 240

Latitude 42º 14.5721' N Longitude -061º 11.8651' W

Water Depth 3783 meters (must be deeper than 2000 meters)

Nearest CTD / XBT cast (circle one) Event No of cast. 241

Date: May 26, 2007 Time: 0007 GMT

Latitude 42º 14.6547' N Longitude -061º 11.9223' W

Maximum Depth 3750 decibars

Any problems associated with the start up and deployment operation

OK

Please Fax or email this information,
within 24 hours of launch if possible, to:

Howard Freeland	cc:	Ross Hendry
Institute of Ocean Sciences		Bedford Institute of Oceanography
Fax: (250) 363-6746		Fax: (902) 426-7827
Email: FreelandHJ@pac.dfo-mpo.gc.ca		Email: HendryR@mar.dfo-mpo.gc.ca

G. REFERENCES

Carritt, D. E. and J. H. Carpenter. 1966. Comparison and evaluation of currently employed modifications of the Winkler method for determining dissolved oxygen in seawater. Journal of Marine Research, 24, 268-318.

Culberson, C. H. 1991. WHP Operations and Methods. Dissolved Oxygen. (http://whpo.ucsd.edu/manuals/pdf/91_1/culber2.pdf)

Levy, E. M., C. C. Cunningham, C. D. W. Conrad and J. D. Moffatt. 1977. The determination of dissolved oxygen in sea water. Bedford Institute of Oceanography Report Series, BI-R-77-9, August 1977.

SIO/ODF. 2000. Oxygen titration manual. Scripps Institute of Oceanography, Ocean Data Facility. Version 22-Feb-2000.

Strain, P.M. and P.M. Clement. 1996. Nutrient and dissolved oxygen Concentrations in the Letang inlet, New Brunswick, in the summer of 1994. Can. Data Rep. Fish. Aquat. Sci. 1004: iv + 33p.

Sea-Bird Electronics, Inc.
1808 136th Place NE
Bellevue, Washington 98005 USA
Telephone: 425-643-9866
Fax: 425-643-9954
E-mail: seabird@seabird.com 10/24/05
Website: www.seabird.com

Webb Research Corporation
82 Technology Park Drive
E. Falmouth, MA 02536-4441
(508) 548-2077 FAX (508) 540-1686