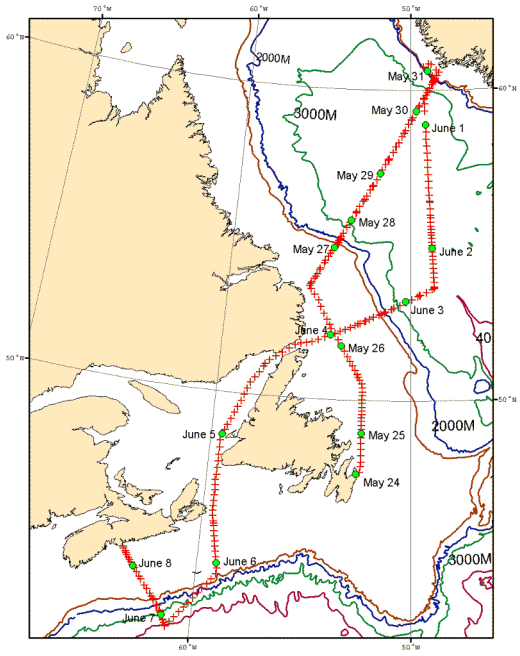
CRUISE REPORT: AR07W

(updated MAR 2010)

A. CRUISE NARRATIVE



1. Highlights

WOCE Designation	**AR07W (Labrador Sea)**
Expedition Designation	**18HU20060524**
Chief Scientist	**Ross Hendry/BIO**
Ship	CCGS Hudson
Ports of Call	May 24, 2006 St. John's, NL, Canada
	June 8, 2006 BIO, Dartmouth, NS, Canada
Cruise Dates	May 24 to June 8, 2006
Geographic Boundaries	60° 50.09' N 63° 26.79' W 48° 13.66' W 42° 1.7' N
Moorings	2: 1 recovery, 1 deployment
Floats and Drifters	5 APEX floats deployed

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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	Salanity
	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

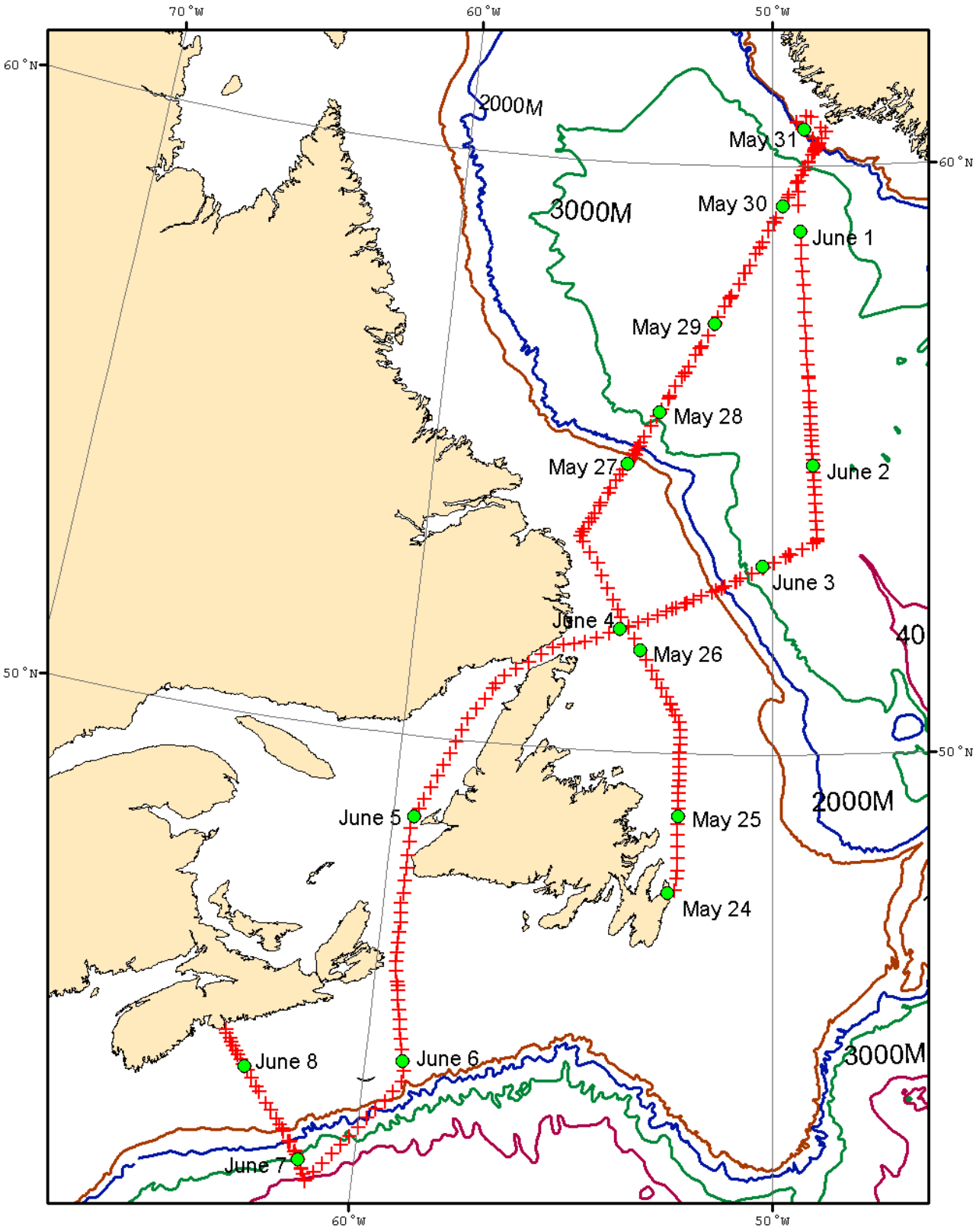

Figure A.2.1 Cruise track for 18HU2006019/1. The date labels indicate the ship's position at 0000 UTC.

2. Cruise Summary Information

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.

b. Total Number of Stations Occupied

The CTD / ROS station positions are shown in Figure A.2.2. The WOCE Hydrographic Program (WHP) -style stations are all contained in the box defined by 42-61°N and 48-64°W. (?????) Table A.2.1 lists the science operations for 18HU2006019.

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 carbonate, 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.

Table A.2.1 Science operations conducted on 18HU2006019/1.

Cast Type	No. of Ops.	Detailed Division	Operation Numbers
Rosette & CTD	32	28 regular AR7W Sites (L3 line) plus Sites 8.5, 25.3, 25.5 and 25.7	see Table A.2.2
	12	7 regular Halifax Line plus sites 5.5, 6.5, 8 – 10	256, 264, 269, 275, 281, 287, 292, 300, 310, 320, 326, 327
	11	Biology Casts not included in other tables	56, 91, 135, 190, 211, 221 (failed operation), 222, 228, 250, 253, 255
	3	Misc. CD01, CD02 and LS	5, 198, 200
	9	L4N Line (3, 4, 5, 5.9, 6.2, 7.1, 8.5,10 and 11)	225, 229, 233, 236, 237, 240, 243, 246, 249
Moorings	2	1 recovery, 1 deployment	52, 53
	1	Release test	4
Floats	5	APEX floats deployed	68, 114, 192, 213, 226

Biology	108	71 (75 cm 200 micron net tows)	1, 3, 6, 8, 11, 17, 19, 24, 26, 31, 35, 39, 44, 49, 51, 54, 59, 64, 66, 73, 79, 88, 90, 99, 101, 110, 112, 123, 132, 134, 141, 143, 151, 164, 166, 178, 180, 187, 189, 193, 195, 197, 199, 201, 202, 206, 207, 209, 215, 217, 219, 223, 227, 230, 232, 234, 238, 241, 244, 247, 251, 254, 263, 268, 274, 280, 286, 291, 299, 309, 319
		37 (30 cm 64 micron net tows)	2, 7, 12, 18, 25, 32, 36, 40, 45, 50, 55, 60, 65, 74, 80, 89, 100, 111, 124, 133, 142, 152, 165, 179, 188, 202, 210, 216, 220, 224, 231, 235, 239, 242, 245, 248, 252,
Chemistry		^{129}I surface	13, 20, 41, 56, 102, 136, 167, 194, 196, 198, 204
		^{129}I profile	67, 92, 125, 153, 212, 256, 269
Other		358.25 Hrs Ship Board ADCP	No number assigned
	144	XBT Deployments	10, 14 - 16, 21 – 23, 28 – 30, 34, 38, 42, 43, 57, 58, 62, 63, 69 – 72, 76 – 78, 82 – 87, 93 – 98, 103 – 109, 115 – 122, 126 – 131, 137 – 140, 145 – 150, 154 – 163, 168 – 177, 182 – 186, 257 – 262, 265 – 267, 270 – 273, 276 – 279, 282 – 285, 288 – 290, 293 – 298, 301 – 308, 311 – 318, 321 - 325

Table A.2.2. AR7W (L3) sites and rosette and CTD operation numbers for 18HU2006019/1.

AR7W Site Number	2006019 Deep Cast Operation Number	AR7W Site Number	2006019 Deep Cast Operation Number
1	9	16	113
2	13	17	125
3	20	18	136
4	27	19	144
5	33	20	153
6	37	21	167
7	41	22	218
8	46	23	181
8.5	48	24	212
9	47	25	191
10	61	25.3	205
11	67	25.5	214
12	75	25.7	208
13	81	26	204
14	92	27	194
15	102	28	196

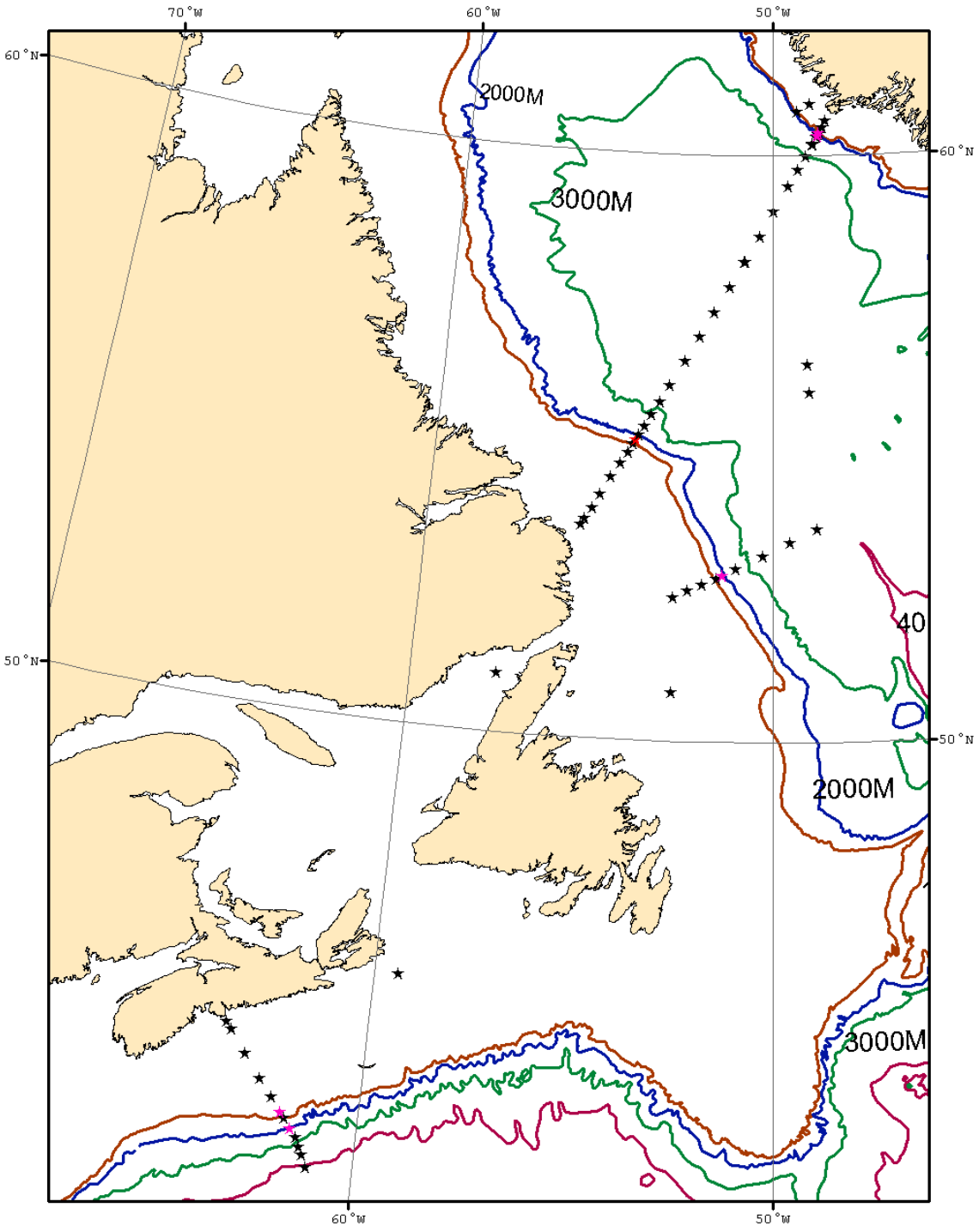

Figure A.2.2 This map shows the station positions for CTD only operations (red-filled stars) and rosette/CTD operations (black-filled stars) for Hudson 18HU2006019/1.

Two full depth Labrador Sea hydrographic sections and the Halifax Section were occupied during the 18HU2006019 mission. These survey lines combined with Orphan Basin and Laurentian Fan lines occupied within the same four week period on Hudson 2006011 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, four on the AR7W line and one at the most offshore station on the L4 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 6.

Table A.2.3 APEX float deployments on Hudson 2006019.

Apex Float		WMO #	Op. No.	Launch Position		Start Time	Launch Time
Type	SN			Latitude (N)	Longitude (W)		
APEX-SBE	2068	4900682	68	55.59	-53.65	27/05/2006 21:09:00	27/05/2006 22:05:00
APEX-SBE	2069	4900683	226	52.70	-48.70	02/06/2006 11:21:00	02/06/2006 12:34:00
APEX-SBE	2679	4900876	114	57.37	-51.78	28/05/2006 22:01:00	29/05/2006 00:21:00
APEX-SBE-Aanderaa	2688	4900879	213	60.18	-48.69	31/05/2006 10:31:52	31/05/2006 11:35:00
APEX-SBE-Aanderaa	2689	4900880	192	60.30	-48.58	30/05/2006 13:51:00	30/05/2006 15:32:00

d. Moorings deployed or recovered

The current meter mooring on the 1000 m depth contour off Hamilton Bank near AR7W station L3-8 was once again serviced on May 27, 2006. Mooring 1555 was recovered successfully under good sea conditions. The RCM8 appeared to have worked properly and all mooring tackle was in good condition. The replacement mooring 1601 was deployed without incident. A post-deployment positioning survey was carried out to provide a precise location for mooring 1601.

Deployment:

M 1601	55 07.19 N 54 05.33 W	Standard mooring consisting of one current meter positioned 20m above bottom near AR7W site L3_08 on the Labrador Slope (12-month deployment) at 1024 metres.

Recovery:

M 1555	55 07.18 N 54 05.31 W	Standard mooring consisting of one current meter positioned 20m above bottom near AR7W site L3_08 on the Labrador Slope (12-month deployment) at 1010 metres.

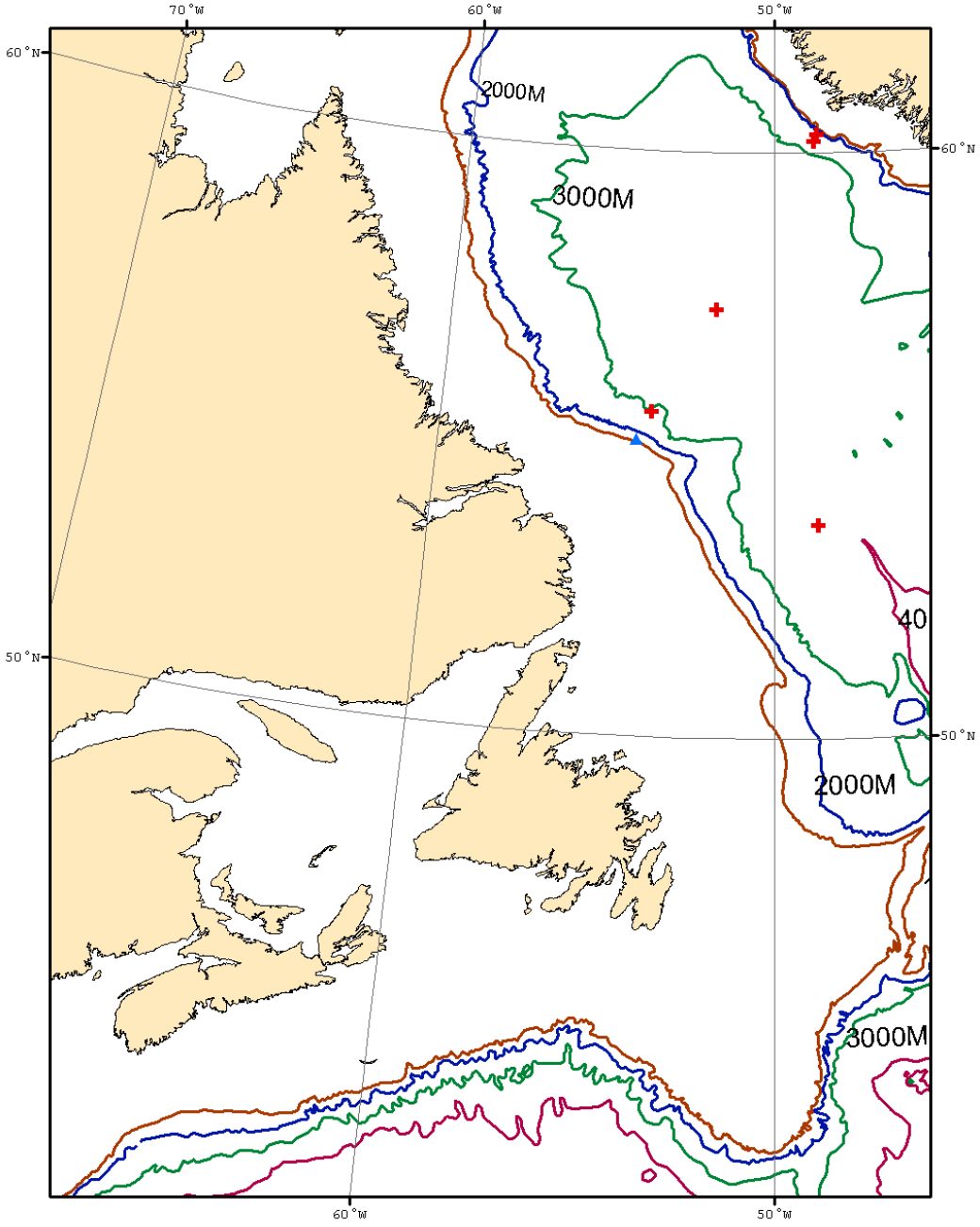

Figure A.2.10 Mooring operation (blue-filled triangle - a mooring was recovered and a new one deployed in the same location) and float deployment locations (red-filled crosses) for Hudson 18HU2006019/1.

3. List of Principal Investigators

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

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
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
Ryan Murphy	MUN RMMurphy@mta.ca	Prokaryotic microbial community studies
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

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 2005/2006 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.

4.2 Biological Program

a. Narrative

The biological program conducted as part of cruise 2006019, 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 53 stations (9 on the Halifax Line, 31 on the L3 line, 8 on the L4 line, 2 on the CD line and 3 transit locations). At all stations, tows were made from 100 meters to the surface using a 200 μmeter ring net, except on the Halifax Line where tows were from 1000 meters or the bottom, whichever came first. An additional tow was made using a using a 76 μmeter ring net at 27 stations on the L3 line, 7 stations on the L4 line and 3 at transit locations. 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 11 stations on the L3 Line, 2 stations on the L4 Line and Transit_01.

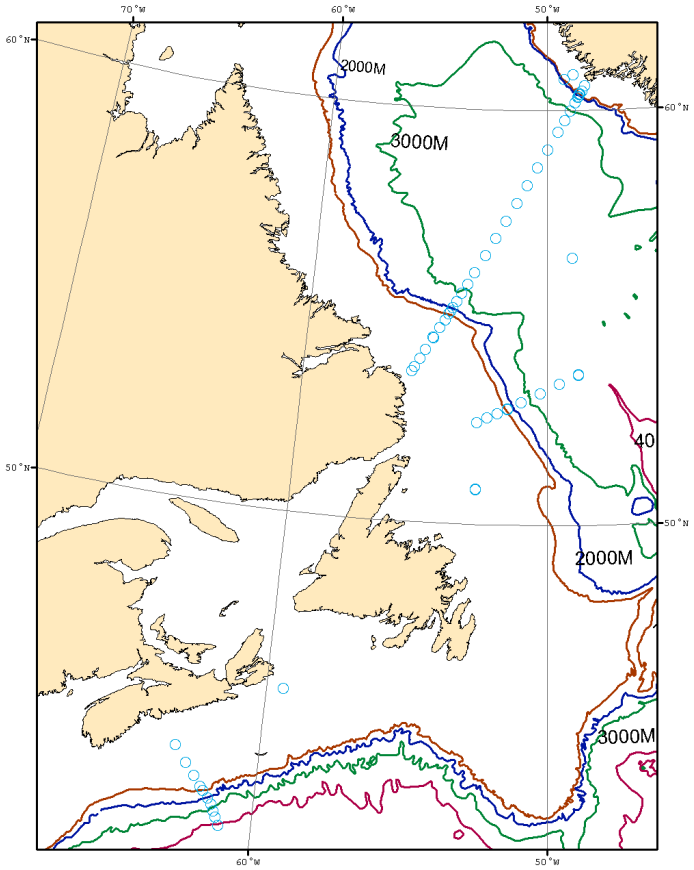

Figure A.4.2.1 Net tow (blue open circles) locations for 18HU2006019/1.

d. 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 2006019 TOC depth profiles were also collected from all stations of the AR7W line as indicated in the table below.

Table A.4.2.2 TOC sampling on CCGS Hudson cruise 2006019.

Station	TOC Profile
AR7W site 1	X
AR7W site 2	X
AR7W site 3	X
AR7W site 4	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	X

e. Primary Production Measurements
(Jeff Anning / Glen Harrison)

Water samples for photosynthesis-irradiance (P-I) experiments were collected from the rosette at 10 stations. For each incubation experiment, 33 aliquots were inoculated with ^{14}C of 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 three occasions (transit stations), parallel P-I experiments from a single depth were done using the stable isotope ^{13}C 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. At stations L3_01, L3-09, L3-14, L3-18 and L3-24, additional samples for taken for particulates at 2-9 selected depths (surface to bottom) for analysis of stable isotope abundances of ^{13}C and ^{15}N back at BIO to evaluate the capabilities of ERD's new isotope mass spectrometer.

Table A.4.2.3. Photosynthesis/Irradiance incubations were conducted at the above stations.

Station	Event	Lat.	Long.	Date	Time	Depth	ID
CTD Test	5	50.857	-52.787	May 25 2006	17:48:57	4	298742
L3-01	9	53.683	-55.557	May 26 2006	11:27:33	31	298750
L3-01	9	53.683	-55.557	May 26 2006	11:31:23	2	298754
L3-04	27	54.224	-55.038	May 26 2006	17:40:25	31	298790
L3-04	27	54.224	-55.038	May 26 2006	17:42:16	5	298795
L3-09	56	55.263	-53.979	May 27 2006	14:32:15	20	298881
L3-09	56	55.263	-53.979	May 27 2006	14:33:45	4	298884
L3-14	91	56.537	-52.679	May 28 2006	10:19:08	30	298989
L3-14	91	56.537	-52.679	May 28 2006	10:21:10	3	298993
L3-18	135	58.221	-50.869	May 29 2006	08:53:32	31	299100
L3-18	135	58.221	-50.869	May 29 2006	08:55:54	3	299104
L3-25	190	60.291	-48.550	May 30 2006	13:05:31	29	299235
L3-25	190	60.291	-48.550	May 30 2006	13:07:35	3	299239
L3-24	211	60.179	-48.677	May 31 2006	09:00:43	30	299326
L3-24	211	60.179	-48.677	May 31 2006	09:02:38	3	299330
Bio 1_JUN	222	56.021	-48.877	Jun 01 2006	14:27:39	30	299388
Bio 1_JUN	222	56.021	-48.877	Jun 01 2006	14:29:18	2	299392
L4-10	228	53.456	-49.504	Jun 02 2006	15:40:36	29	299427
L4-10	228	53.456	-49.504	Jun 02 2006	15:43:03	3	299431
L4-05	243	52.732	-52.000	Jun 03 2006	12:53:01	20	299534
L4-05	243	52.732	-52.000	Jun 03 2006	12:54:28	3	299537
Bio 4_JUN	250	51.029	-57.604	Jun 04 2006	11:12:03	23	299573
Bio 4_JUN	250	51.029	-57.604	Jun 04 2006	11:14:44	2	299577
HL-10	255	42.029	-61.078	Jun 06 2006	14:13:48	30	299599
HL-10	255	42.029	-61.078	Jun 06 2006	14:15:21	2	299603

f. Bacterial Abundance and Production of Microbial Plankton

(Tim Perry)

At every depth a sample was collected for bacterial counting by flow cytometry. Duplicate chlorophyll samples were collected in the surface waters (100m to surface) and a single sample for both HPLC and Absorption spectrum analysis were collected from the surface.

Water samples were collected from all depths at 7 stations and incubated for between 1-3 hours after inoculation with ^{3}H labelled leucine. The cells were collected by centrifugation and prepared for scintillation counting back on shore.

Table A.4.2.4. Microbial production incubations were conducted at the above stations.

Station	Event	Lat.	Long.	Date	Time
L3-01	9	53.683	-55.557	May 26 2006	11:27:33
L3-08	46	55.110	-54.133	May 27 2006	02:32:58
L3-14	91	56.537	-52.679	May 28 2006	10:19:08
L3-24	211	60.179	-48.677	May 31 2006	09:00:43
L3-27	194	60.448	-48.361	May 30 2006	17:16:53
L4-10	228	53.456	-49.504	Jun 02 2006	15:40:36
L4-05	243	52.732	-52.000	Jun 03 2006	12:53:01

g. Prokaryotic Microbial Community Studies

(Ryan Murphy)

This project consisted of two sampling schemes to investigate the ecosystem processes of phylogenetically-defined prokaryotic populations. These samples make up the first half of my master's project in which I will optimize the qPCR technique to detect and quantify members of the Euryarchaea, SAR11 and SAR 86 clusters, β-proteobacteria, and the CFB group.

The first sampling scheme used samples collected from 1-2m, 10m, 20m, and 30m on the AR7W line to measure stratification of prokaryotic community structure with qPCR. The second sampling scheme used water samples collected from the surface (1-2m) layer of 7 stations—mostly on the AR7W line—and incubated for 96 hours as part of nutrient enrichment, temperature-shift, and grazing experiments. Samples for bacterial abundance (Acridine Orange: t=0, 24, 48, 72, 96 and FCM: t=0, 24, 96), and community structure (qPCR: t=0, 96 and CARD-FISH: t=96) measures were collected from these experiments for analysis at the OSC in Logy Bay.

5. Major Problems and Goals Not Achieved

No major problems were encountered and all scientific goals were achieved. The ship's speed was reduced during several periods of low visibility due to fog, but operation on three engines

during extended transits in favourable conditions made up for any time lost. The absence of coastal sea ice allowed a full occupation of the AR7W line, the 17th annual realization of this section by DFO Maritimes Science. Two inshore stations on the neighbouring Cape Desolation line on the West Greenland shelf and slope were also occupied. Favourable weather and lack of any major equipment problems allowed most of the planned contingency work to be completed. The L4 line off the northern Newfoundland slope was surveyed with nine CTD stations. The full Halifax Line was occupied and enhanced with five additional stations, including three in deeper waters offshore.

6. Other Incidents of Note

The Technicon AutoAnalyser used for nutrient analyses failed just before the start of the Halifax Line due to a short circuit in one of the colorimeters. Samples from the Halifax Line were frozen for analysis on shore.

7. List of Cruise Participants

Name	Responsibility	Affiliation
Jeffrey Anning	Biological	ERD, BIO
Carol Anstey	Nutrients, Oxygens	ERD, BIO
Andres Antico	Winch Room, XBT	McGill
Kumiko Azetsu-Scott	Scientist, Carbonate, Alkalinity	OSD, BIO
Richard Boyce	Salts, Mooring	OSD, BIO
John (Jay) Bugden	TOC Levels	ERD, BIO
Michael Dunphy	Winch Room	DAL
Carina Gjerdrum	Sea bird observer	EC, CWS
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
David Kellow	Oxygens	OSD, BIO
Ryan Murphy	Biological	MUN
Richard Nelson	CFCs	ERD, BIO
Timothy Perry	Biological	ERD, BIO
A. E. Friederike Prowe	Carbonate, Alkalinity	DAL
Brian Robinson	CFCs	BDR
Robert Ryan	CTD Tech., Winch Room	OSD, BIO
Igor Yashayaev	Scientist, Computer Room	OSD, BIO

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

1. Navigation and Bathymetry
(Jeff Jackson)

The navigation system onboard CCGS Hudson consists of a differential GPS receiver and AGCNAV. 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, which is running AGCNAV software, then rebroadcasts the NMEA strings to distribution units in the computer room, which provide 16 output lines for the working labs. The resulting broadcast navigation strings are at about 1 Hz. The navigation data are then logged at specified intervals on a PC. For this cruise the navigation was logged 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.

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
(Murray Scotney)

Hudson was equipped with a hull-mounted RDI Acoustic Doppler Current Profiler (ADCP). The transducer (serial number 177) had VM ADCP electronics (serial number 172). Logging, using Transect software on a 486 PC, was started on May 24 at 1345 UTC leaving the St. John's Harbour.

The configuration used for logging resulted in 5-minute averages in 4 meter bins. The averaged data are stored to disk and backed up every few days. ADCP logging was stopped on June 9 at 1204 UTC in Halifax Harbour.

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 a Northstar 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 HUD2006019 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).

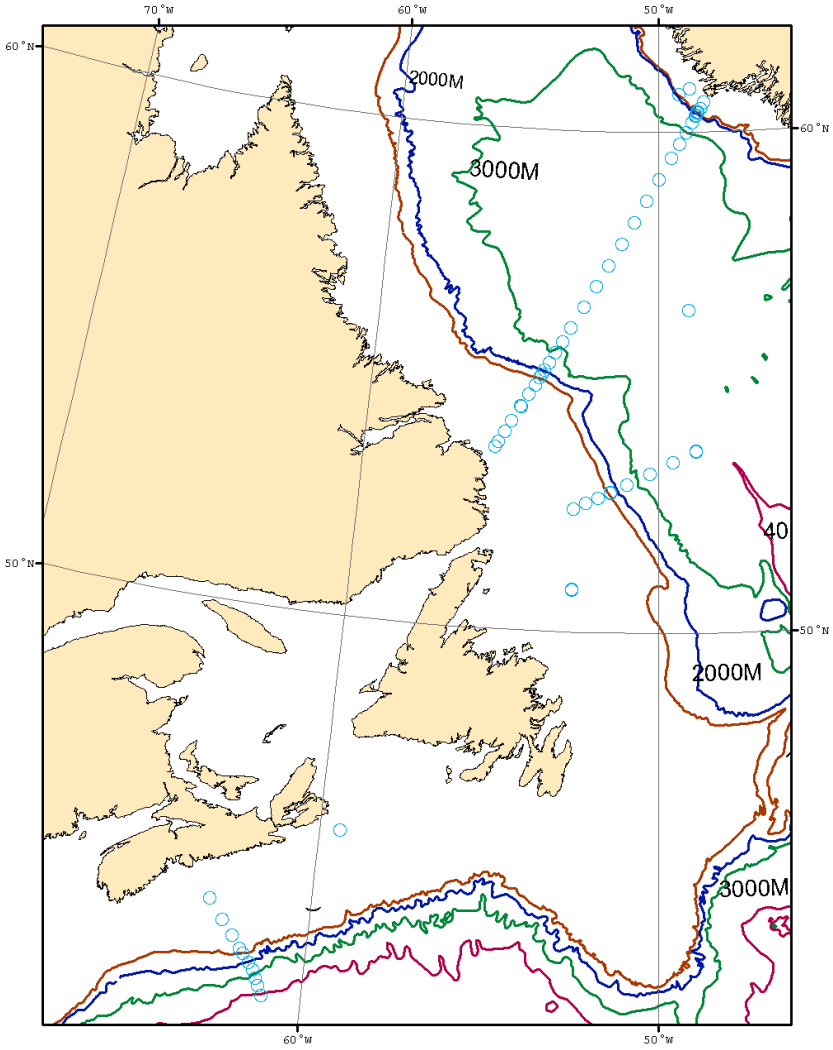

Figure B.4.1 XBT sites (indicated by blue hollow circles) during HUD2006019.

5. Thales Navigation ADU5 Attitude Determination Unit

(Adam Hartling)

An initial evaluation of a Thales Navigation ADU5 Attitude Determination Unit, Model # 800952 was carried out on Hudson 2006019. The ADU5 provides accurate real time heading, pitch, roll, velocity and three dimensional position measurements at data rates of up to 5Hz. This positioning information is needed to correct for ship motion that affects vessel-mounted acoustic doppler current measurements.

The ADU5 unit incorporates four GPS receivers mounted in a fixed portable antenna array provided by Thales Navigation. The array provides 1m separation between the GPS receivers. The Antenna array was mounted on the wheelhouse deck behind the mast approximately 1.5m above the deck. The array is mounted with antenna 1 to the bow of the ship. Antenna one and two must be parallel to the centerline of the ship. The vertical pipe supporting the array was bolted to the deck with one angled support to ensure a rigid platform. Four separate coaxial cables connect the ADU5 Unit to the GPS antennas. The cables were run from the antenna array across the deck and connected to the ADU5 unit mounted in the computer room.

Measurement data is output from two RS-232 ports capable of baud rates up to 115200. Port A and Port B are identical except for Pin 9. Port A pin 9 functions as a 1pps output. Port B pin 9 functions as an event trigger input. The ADU5 unit requires a 10-29V DC regulated power supply. Power to the unit was supplied with a 6200B HP bench top dc power supply set at 15V DC. A PC located in the computer room was connected to the ADU5 unit. Two com ports were used to connect to both Port A and Port B on the ADU5. Communication with the unit was accomplished using the Thales Navigation EVALUATE software package.

The attitude determination is calculated based on differential carrier phase measurements between the four receivers. An initial calibration procedure is used to calculate the relative positions of the receivers for each installation. The calibration process is time consuming (An hour minimum if conditions are good) and requires at least six GPS satellites to be continually available during the logging process. After this procedure the calibration data is downloaded to the ADU5 unit. Calibration is performed using CalibADU Software supplied with the ADU5 unit. Static calibration was completed while along side in St. Johns. Dynamic calibration was attempted previously while under way and was found to be error prone and required over a day of data logging to obtain suitable data. This is attributed to the continual motion of the ship in conjunction with the mast and other fixtures on the wheelhouse deck causing temporary loss of lock.

Error in the pitch and roll calculation was seen to increase in rough weather. This may be a result of the environment on the wheelhouse including the mast and other reflective objects.

Using The EVALUATE software package data was logged at a 1 Hz rate from St. John's to the end of the AR7W Line. Logging was implemented using the standard data strings required by the EVALUATE software. Both Raw Data and NMEA standard outputs were recorded. New files were created every 1000sec requiring approximately 730KB per file, or 447MB in total.

Raw Data	AT2 : Attitude, Flags, PDOP data
NMEA Output	POS : Position message SAT : Satellite information message SA4 : Satellite status message

Identical attitude and position data was also collected for the L4 Line.

Data logging was also attempted at rates up to 5Hz using the EVALUTE software. In general logging was unreliable due to the poor performance of the software package. The desired output would also be changed by the software if any of the real-time virtual instruments or displays were selected.

To allow experimentation with data formats and output rates the EVALUATE software was connected through COM1 to PORT A of the ADU5 unit. Hyper-Terminal was connected through COM2 to PORT B. Using the EVALUATE terminal commands were sent to the ADU5 unit to modify the output stream on PORT B. The PORT B output could then be logged and monitored using Hyper-Terminal. Hyper-Terminal does not feature a convenient means of sending commands. The use of EVALUATE on PORT A provided a very user friendly solution.

Output rates of 5Hz were successful using the Hyper-Terminal software at baud rates of 9600 and 115200. Hyper-Terminal does not allow new data files to be created at regular user defined intervals. Data was logged using standard NMEA outputs. 15 hours of logging required approximately 67MB of disk space.

PAT : Position and attitude message
ZDA : Time-Date Message
POS : Position Message

To this point the performance has only been investigated using ASCII output messages. Binary output is also available and may be used in the future for data output to an ADCP deck unit. No problems are predicted for this application concerning the ADU5 receiver.

Reference: Thales Navigation, ADU5 Operation and Reference Manual, 2004

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.

DATA PROCESSING NOTES

Date	Contact	Data Type	Action
2006-09-1	Jackson, Jeff	SUM/CruiseRpt	Submitted
	Action:Place Data Online		
2006-10-12	Jackson, Jeff	SUM	Submitted corrected sum file
	I found a few errors that were missed in the 2006 SUM file that I sent you, so I have attached an updated one for you.		
2006-10-17	Bartolacci	SUM	Website updated, edited .sum file online
	I have reformatted the sumfile sent by Jeff Jackson on 2006.10.11: • Edited expocode from 18HU2006019/1 to 18HU20060524. • Edited line number to reflect stations following WOCE line AR07W. This corresonded to all BIO stations labeled L3 according to the cruise report. • Edited all DATES from DDMMYY to MMDDYY. • Two time casts were not recognized by sumchk: BD is Begin Descent EA is End Ascent. Other than those warnings, sumfile was free of woce-formatting errors. File was renamed ar07w_20060524su.txt and placed in cruise's parent directory.		