CRUISE REPORT

HUDSON 2000009

LABRADOR SEA

WOCE LINE AR7W

20 May - 8 June, 2000

A. CRUISE NARRATIVE

1. Highlights

a. WOCE Designation: WOCE Line AR7W
Atlantic Circulation Experiment

b. Expedition Designation: HUD2000009

c. Chief Scientist: Glen Harrison
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d. Ship: CCGS Hudson

e. Ports of Call: May 20 BIO, Dartmouth, NS, Canada
June 8 BIO, Dartmouth, NS, Canada

f. Cruise Dates: May 20 to June 8, 2000

2. Cruise Summary Information

a. Cruise Track

A cruise track is shown in Figure 1. Ship position at 0000Z on each day of the cruise is indicated with a date label.

The WOCE cruise station summary file outlines the science operations conducted during the cruise. Note that additional cast types have been defined as: NET – Biological net tow; AGT – alongtrack temperature-salinity measurements; SAP – alongtrack shipboard ADCP measurements. As well, additional time codes have been defined as: BD – Begin Descent; EA – End Ascent. These codes are used during Lowered ADCP casts. Finally, in the Comment section of the SUM file there is frequent mention of operation notes indicated by “Op Note”. These notes will be included in the final cruise report.

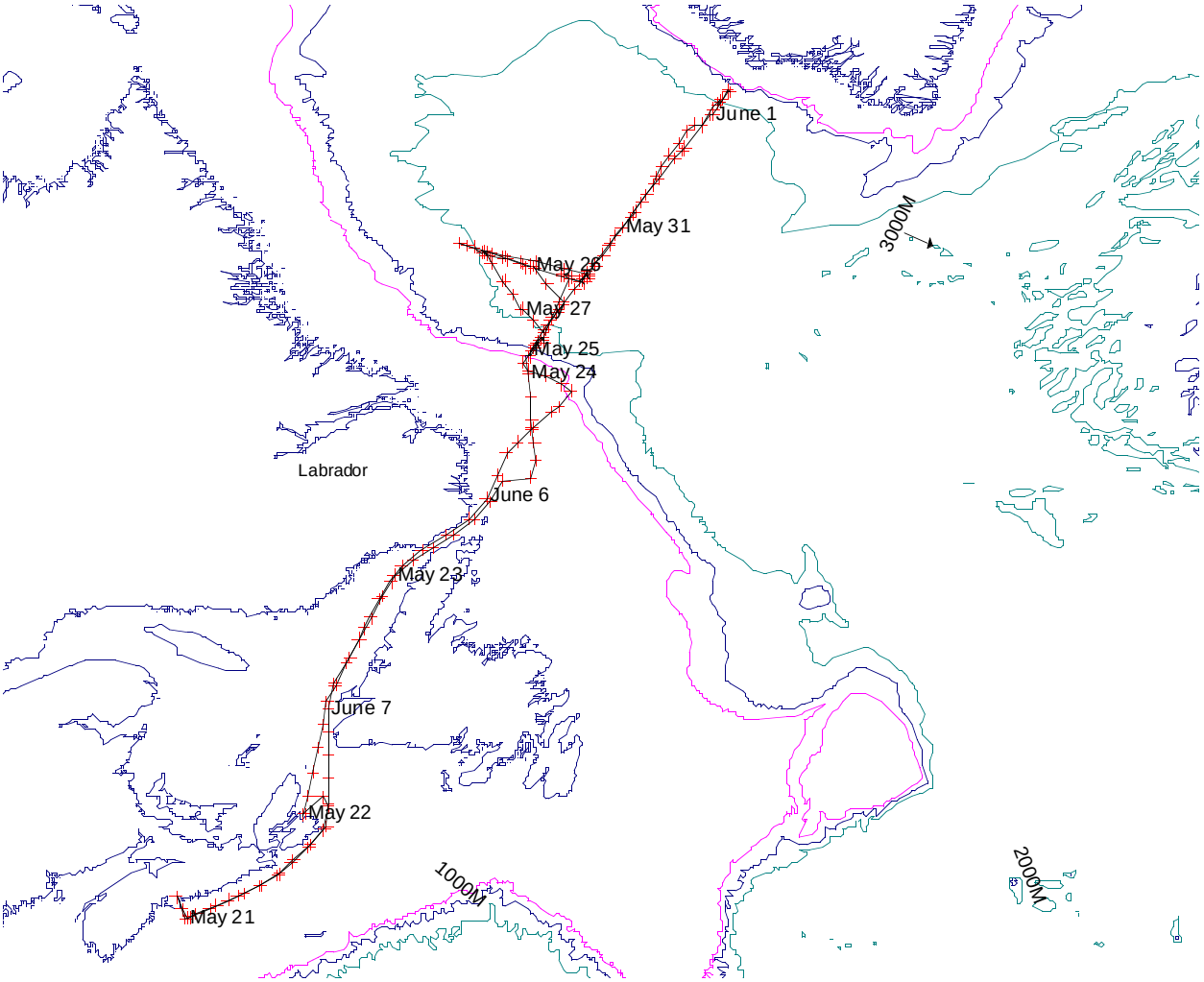

Figure 1. Cruise track for HUD2000009. The date labels indicate the ships position at 0000Z.

Additional parameter codes have also been defined and appear in the parameter column of the WOCE SUM file. These codes are: 510 – extracted chlorophyll; 511 – phytoplankton count; 512 – High Pressure Liquid Chromatography (HPLC); and 513 – Absorption Spectra. Sections that follow in the cruise report describe these measurements.

b. Total Number of Stations Occupied

The CTD and ROS station positions are shown in Figure 2. The WHP stations are all contained in the box defined by 50-62°N and 43-60°W. Table 1 lists the science operations for HUD2000009.

Cast Type	Number of Operations	Detailed Division	Operation Numbers
Rosette & CTD	46	20 AR7W Sites	see Table 2
		2 Halifax Line Sites	see Table 3
		4 Seacat Calibrations	60, 124 (BIO) 85, 97 (Kiel) (2 in Table 2)
		10 Biology Casts	see Table 2 plus 59,77,148
		12 Other Deep Casts	12,36,39,46,47,48,50,66,93 95,123,138
		1 Basin test	1
Moorings	35	15 recoveries	17,18,19,20,22,29,30,31,33,34,35,53,54,55,68
		16 deployments (K31 recovery had two operation numbers assigned. See Note for Operation ID 29).	25,51,52,61,62,63,67,74,113, 116,117,118,125,126,127,128
		4 Release tests	23,73, 108,109
Biology	69	48 shallow net tows	5,6,10,11,13,14,15,27,28,37,38,40,42,56, 57,64,65,69,70,71,76,78,79,81,83,84,88,89,91,92,94,96,100,102,106,107,111,121, 122,132,133,135,137,139,141, 146,151,152
		20 Light related measurements 1 test station	2, 8,9,21,24,32,44,49,58,75,86, 99,104,114,115,130, 131,143,

			144,149,150
Other	3	1 Ship Board ADCP	4
		1 Along track t, s, and fluorescence	3
		3 floats deployed	120 **

Table 1. Science operations conducted on HUD2000009. ** All three floats were deployed at the same location with a single operation ID number.

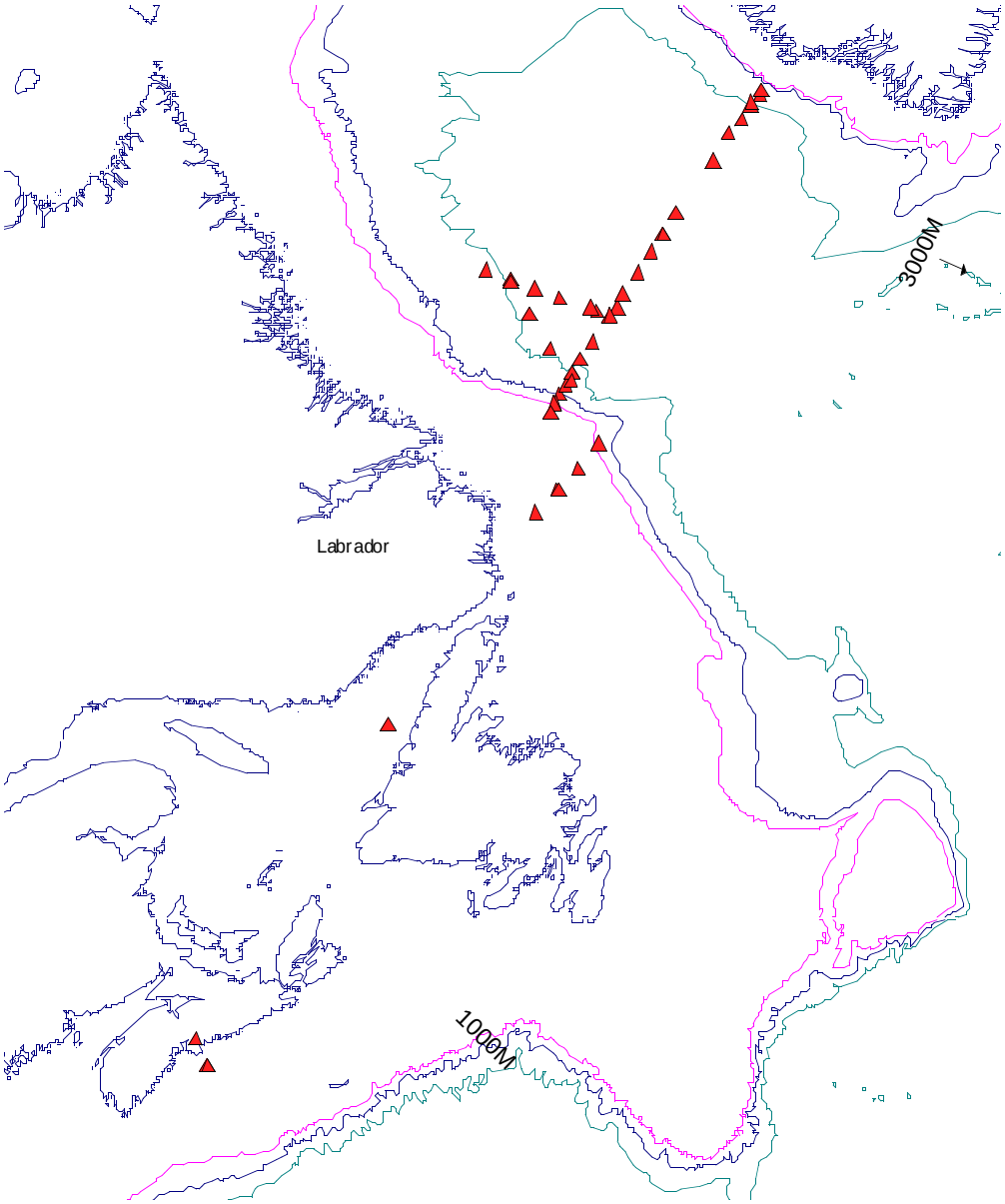

Figure 2. CTD, rosette and LADCP station positions on for Hudson HUD2000009.

AR7W Site Number	HUD2000009 Deep Cast Operation Number	HUD2000009 Biology Cast Operation Number
1	not occupied	
2	not occupied	
3	not occupied	
~ 4	147	
~ 5	145	142
~ 6	140	
7	136	
8	26	
9	134	
10	16	129
11	45	43
12	41	
13	not occupied	
14	72	119
15	112	
16	110	
16.5	80	
17	105	103
18	82	
19	not occupied	
20	85	87
21	101	
22	90	
23	97	
23.5	not occupied	98
24	not occupied	not occupied
25	not occupied	not occupied
26	not occupied	not occupied
27	not occupied	not occupied
28	not occupied	not occupied

Table 2. AR7W sites and rosette operation numbers for HUD2000009.

Halifax Line Number	HUD2000009 Deep Cast Operation Number
1	not occupied
2	7, 153
3	not occupied
4	not occupied
5	not occupied
6	not occupied
7	not occupied

Table 3. Halifax Line sites and rosette operation numbers for HUD2000009.

Along AR7W, the stations were full depth WHP small volume rosette casts with up to 24 rosette bottles. Depending on the station, water samples were analyzed for CFC's, carbon tetrachloride, methyl chloroform, total carbonate, alkalinity, oxygen, salinity, and nutrients.

c. Floats and Drifters deployed

A total of three floats were deployed as part of a test involving the tomographic sound source array. The three floats, deployed near mooring K41 (Operation ID #120), will park on the bottom until March 2001, when they are programmed to ascend to 700m and start their float mission. The three floats have serial numbers as follows:

IFM #	Manufacture #
518	#RF19
519	#RF20
520	#RF21

d. Moorings deployed or recovered

The Kiel mooring operations dealt with the recovery and servicing of 4 acoustic tomography moorings (K30, K31, K32 and K33) and their related set of 3 acoustic transponders for each tomography mooring. These mooring were serviced and replaced with similar moorings K40, K41, K42 and K43. In all, 29 operations were conducted during HUD2000009 related to the recovery and placement of the Kiel moorings (Figure 3).

A total of 6 BIO mooring related operations, consisting of 2 deployments, 2 recoveries and 2 release tests were conducted at various sites (see Figure 3). The following summarizes the mooring operations.

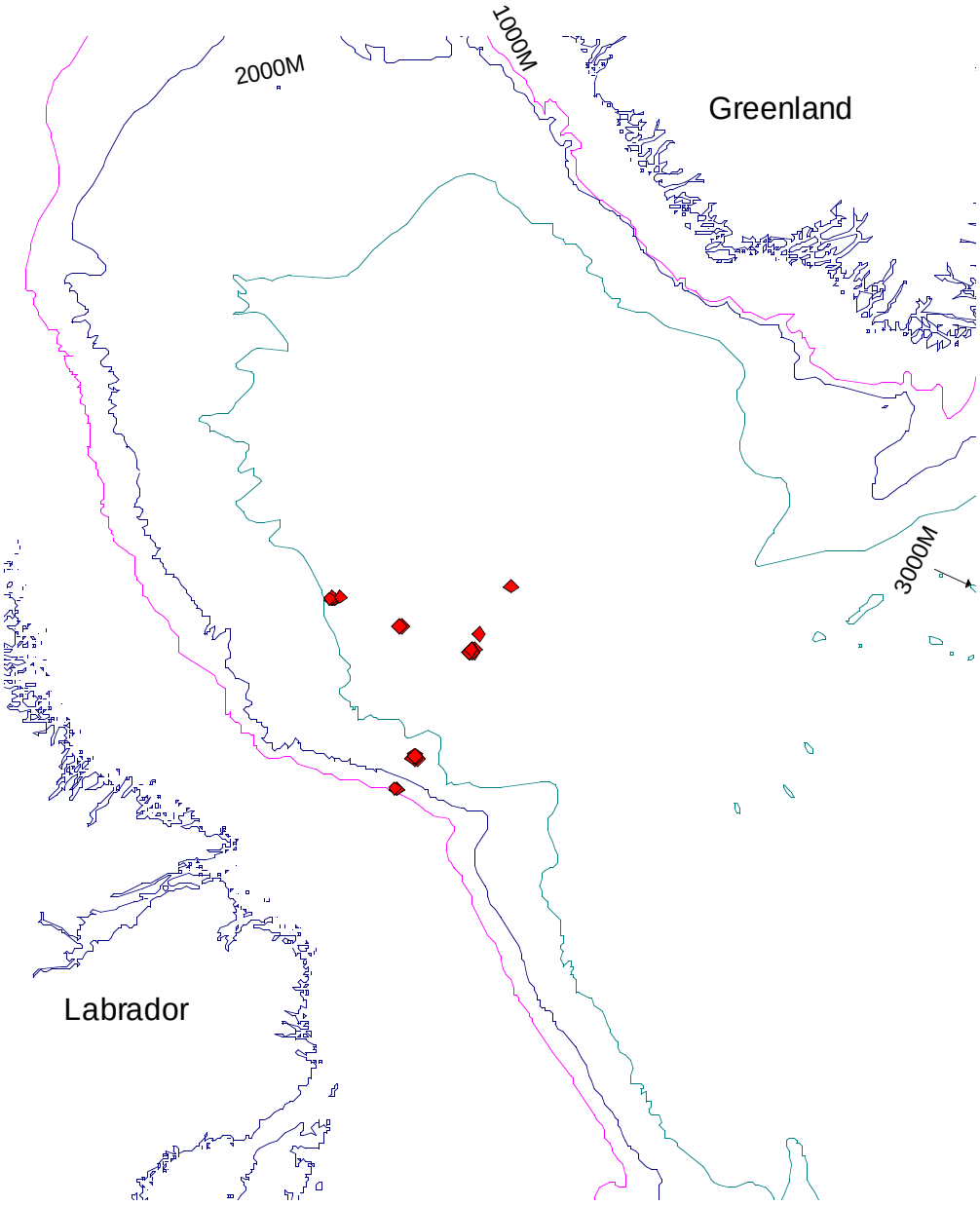

Figure 3. Mooring deployment and recovery positions for HUD2000009.

Deployments:

1 M1350 standard mooring consisting of one current meter positioned 20m off bottom along AR7W on the Labrador Slope (12 month deployment) along the 1000m isobath.

1 M1349 multi-instrument mooring near OWS Bravo on AR7W. This mooring consisted of 7 Seacat temperature/conductivity recorders, 6 Aanderaa current meters, 2 sediment traps and 3 acoustic releases.

3 Acoustic tomography moorings (K41, K42, K43), each with 3 acoustic transponders (12 operations plus 2 release tests for a total of 14 operations)

1 Traditional instrumentation mooring (K40) (1 operation)

Recoveries:

1 M1326 standard mooring consisting of one current meter positioned 20m off bottom along AR7W on the Labrador Slope (12 month deployment) along the 1000m isobath. This mooring was deployed on 18HU99022.

1 M1325 multi-instrument mooring near OWS Bravo on AR7W. This mooring consisted of 3 Seacat temperature/conductivity recorders, 6 Aanderaa current meters, and 4 Microcats SBE37 (two with temperature, and one with temperature and pressure). This mooring was deployed on 18HU99022.

3 Acoustic tomography moorings (K31, K32, K33), each with 3 acoustic transponders (12 operations)

1 Traditional instrumentation mooring (K30) (1 operation)

3. List of Principal Investigators

Name/Affiliation	Responsibility
Allyn Clarke/BIO clarkea@mar.dfo-mpo.gc.ca	senior scientist overall co-ordination
Glen Cota/ODU cota@ccpo.odu.edu	ocean optics
Bob Gershey/BDR Research rgershey@fox.nstn.ns.ca	Alkalinity, carbonate, CFC's
Glen Harrison/BIO harrisong@mar.dfo-mpo.gc.ca	Co-ordinator biological program nitrate and ammonium utilization by phytoplankton
Erica Head/BIO heade@mar.dfo-mpo.gc.ca	macrozooplankton distribution, abundance and metabolism
Paul Kepkay/BIO kepkayp@mar.dfo-mpo.gc.ca	dissolved organic carbon, colloid chemistry and plankton respiration
Peter Jones/BIO jonesp@mar.dfo-mpo.gc.ca	alkalinity, carbonate, CFC's
John Lazier/BIO lazierj@mar.dfo-mpo.gc.ca	CTD data, moored instrument data
Bill Li/BIO lib@mar.dfo-mpo.gc.ca	pico-plankton distribution and abundance, bacteria
Robert Pickart/WHOI pickart@rsp.whoi.edu	lowered ADCP
Trevor Platt/BIO plattt@mar.dfo-mpo.gc.ca	primary production, ocean colour
Peter Rhines/UW rhines@killer.ocean.washington.edu	moored instrument data
Uwe Send/Kiel usend@ifm.uni-kiel.de	Tomography Moorings

Table 4. List of Principal Investigators. See Section 7 for addresses.

4. Scientific Program and Methods

4.1 Physical - Chemical Program

a. Narrative

This expedition was conducting operations in support of three ongoing DFO scientific initiatives and a collaborative project with IFM, Kiel.

The first initiative is in support of the North Atlantic Oscillation and the Atlantic Thermohaline Circulation Principal Research Areas of the Climate Variability and Predictability (CLIVAR) project of the World Climate Research Programme (WCRP).

The occupation of the Labrador Sea section and the recovery and replacement of the two Labrador Sea moorings provide a measure of the winter cooling and water mass transformations over the winters of 1999/2000 and 2000/2001.

Related recovery and replacement mooring work conducted by Kiel personnel consisted of servicing four tomography moorings as part of the German initiative 'Dynamics of Thermohaline Circulation Variability'. These moorings address the convection activity in the Labrador Sea and its connection to deep water formation, export and transport.

The second initiative is the Labrador Sea project in support of DFO's greenhouse gas (GHG) research. This biological program is designed to characterize the late spring biological processes in the Labrador Sea and its shelf regions both to determine the role of the biological pump to sequester carbon and to develop the regional algorithms that will allow primary productivity estimates to be made using data from Ocean Colour satellite sensors such as SeaWiFS and MODIS. The chemical oceanographic program is observing total carbonate, alkalinity and CFC's over the entire water column to determine the sequestration of anthropogenic carbon.

The third objective is to occupy station #2 on the Halifax Section in support of DFO's Atlantic Zonal Monitoring Program (AZMP).

During this cruise, an ADCP was added to the CTD/rosette package to provide an estimate of the full depth velocity profile at each CTD station. This data will be useful for the detection and definition of various subsurface currents such as the deep western boundary undercurrents.

The hydrographic program consisted of three full depth sections in the Labrador Sea, station #2 on the Halifax line and daily stations in support of biological observations. One task of the program was to occupy the section across the Labrador Sea, surveyed by the Bedford Institute of Oceanography since 1990, which is known as the WOCE AR7W line.

The oceanographic data collected in the cruise reveal significant changes in the water mass structure and properties since the last occupation of the Labrador Sea line in 1999. The following summarized the unique features of the sea water properties of the Labrador Sea as it was seen in the first cruise of the XXI century:

Labrador Sea Water (LSW) formed as the result of deep convection due to a series of severe winters between 1988 and 1993 is still present in 2000. However, since 1994 the core of this water is steadily getting warmer and saltier with a rate about 0.07 °C/year and 0.008, respectfully. In 2000 it was warmer and saltier than in the previous years (2.9 °C and 34.86).

The Northeast Atlantic Deep Water (NEADW, underlying the deep LSW) and Denmark Straight Overflow (DSOW, bottom water) substantially freshened and became colder

over the last four years. Noteworthy that this tendency was steady through the years. DSOW is the freshest (34.86) and coldest (at places below 1.1 ℃) in the history of deep observations in the Labrador Sea. Due to the opposite tendencies in the deep LSW and NEADW the difference between properties of these waters is the smallest since the late 1980's.

The convection that took place in the winter (Feb-Mar) of 2000 wasn't as intense as that in the early 1990's. Nevertheless, the water originating as the result of the 2000 convection dominates the layer between 200 m and 1000 m, indicating that the convection of the last winter penetrated on average 300 m deeper than that of the winter before. This resulted in the further reduction of the volume of the deep LSW. The recent formation of the LSW is 0.02 fresher than its analogue found the previous year (1999).

On *site 16* (the central Labrador Sea) we found the most recent formation of the LSW about 600 m deeper than the neighbouring stations, spanning between 1000 m to 1600 m. High horizontal density gradient around the station suggests that this structure is associated with an intense anticyclonic eddy. There was another relatively homogeneous mixed layer between 100 m and 900 m with temperature and salinity - 3.3 ℃ and 34.83, respectfully. This layer was not typical for the other stations. It could be produced at the time when the eddy was formed as the result of convergence and mixing of relatively warm and salty water (presumable from the eastern part of the region) with the fresher surface water. This extends to the bottom, causing temperature near the bottom to increase. However, the eddy didn't have a significant affect on the deep LSW.

4.2 Biological Program

a. Narrative

The biological program was a continuation of studies begun in 1994 to describe the large-scale (spatial and temporal) variability in plankton biomass and productivity in the Labrador Sea.

The program has consisted of essentially four elements:

(1) a phytoplankton biomass/primary productivity project - conducted by G. Harrison, and J. Anning and B. Irwin (for Trevor Platt),
(2) a bacterial metabolism project - conducted by P. Dickie (for Bill Li),
(3) a mesozooplankton project - conducted by L. Harris (for Erica Head) and
(4) a dissolved organic carbon/community respiration project - conducted by J. Bugden (for Paul Kepkay).

The objectives of these studies are two-fold:

(1) to provide a description of the inventories of biogenic carbon in the Labrador Sea, their turnover rates and variability in space and time as part of DFO's 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 ecosystem-fisheries research.

A new project was begun this year (G. Harrison, J. Anning, B. Irwin) to investigate the vertical flux of biogenic particulate matter in the central Labrador Sea using time-series sediment traps deployed on the "BRAVO" mooring.

In addition to the DFO biological projects, a collaborative study with Dr. Glenn Cota (Old Dominion University, Norfolk, Virginia, USA) on the bio-optical properties of Labrador Sea waters was conducted. This information is being used in Dr. Cota's and Dr. Platt's laboratories for the development of algorithms to derive phytoplankton biomass and productivity from satellite-based ocean colour data.

b. Stable isotope studies of carbon and nitrogen (nitrate and ammonium) utilization by phytoplankton **Glen Harrison/Jeff Anning**

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. 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 30-60 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. At a few stations, ^{14}C incubations were done in parallel for comparison. A total of 7 experiments were conducted (see Table 5); 6 stations were occupied along the AR7/W line and one at a Kiel mooring site (K33) NW of the line. Carbon and nitrogen-based primary productivity rates at these locations will be related to vertical fluxes of particulate biogenic carbon and nitrogen derived from our sediment traps deployed (175 & 1,053 m) on the "Bravo" mooring (M1349) during this mission and to be recovered next year.

Date	Site	Op#	LAT (N)	LON (W)	Photic Depth (m)	15N/13C	14C
28-May-00	K33	59	57.13	55.29	60	x	x
30-May-00	M1349	77	56.67	52.48	45	X	x
31-May-00	L3_20	87	59.06	49.95	30	X	x
01-Jun-00	L3_23	98	59.98	48.90	30	X	x
02-Jun-00	L3_17	103	57.87	51.25	50	X	
04-Jun-00	K42	129	55.45	53.72	60	X	
05-Jun-00	L3_05	142	53.68	54.05	55	X	

Table 5. Sampling of stable isotopes.

c. Sediment traps **Glen Harrison / Brian Irwin/Jeff Anning**

Supplemental funding was provided by DFO's Ocean Climate Program in 1999 for the fabrication and deployment of particle interceptor "traps" in the Labrador Sea during the 2000 field season. The trap design employed was developed at BIO (Bioflux traps), has a 24-cup capacity and internal Tattletale computer for programming particle collection intervals. Two traps were built and deployed on the BIO "BRAVO" station mooring (M1349) at depths of 175m and 1053m. Cups were programmed to collect material for two-week intervals starting 12:01AM (GMT), 01 June, 2000. The traps will be recovered, refurbished or replaced and redeployed next spring to collect a follow-up year of data. The samples collected next spring will be processed back at BIO for particulate and dissolved biogenic (organic) carbon and nitrogen content as well as other constituents. These particle fluxes will provide the first direct estimates of seasonal variability and annual magnitude of the "Biological Pump" and its contribution to carbon sequestering in the region.

d. Zooplankton Sampling **L. Harris**

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, who dominate the zooplankton in this region.

Vertical net tows were taken at 30 stations (2 on the Scotian Shelf and 28 from the Labrador Shelf/Labrador Sea) using a 3/4 meter 200 um mesh ring net. At all stations, tows were made from 100 meters to the surface. Additional deep tows (1500 meters to the surface) were taken at 2 of the stations. Samples will be analysed for species composition, copepod stage structure and biomass.

e. Measurements Of Copepod Metabolic Rates **L. Harris**

Egg production rates of *Calanus finmarchicus*, the dominant copepod species, were measured at 14 stations in the Labrador Sea.

f. Dissolved Organic Carbon (DOC) and Microbial Community Respiration **Jay Bugden/Paul Kepkay**

To better understand the cycling of carbon and the mechanisms controlling it in the Labrador Sea, it is necessary to examine the pool of dissolved organic carbon (DOC), and look at the activity of the microbial community in those water columns. By examining the rate of respiration and size fractionating the DOC, information on the fate of carbon in this marine environment may be elucidated.

During CCGS Hudson cruise 2000-009 eight (8) stations were sampled, at a 10m and 40m depth, for gross microbial community respiration, and at 10m only ultrafiltrations were performed for size fractionation of DOC. The stations sampled are listed in Table 6. DOC depth profiles were also collected from twenty-three (23) stations listed below.

Station	Respiration	Ultrafiltration	DOC Profile
L3-4			X
L3-5	X	X	X
L3-6			X
L3-6A			X
AR7W site 7			X
AR7W site 8			X
AR7W site 9			X
AR7W site 10			X
AR7W site 11	X	X	X
AR7W site 12			X
AR7W site 13			X
AR7W site 14			X
AR7W site 15			X
AR7W site 16B			X
AR7W site 16.5			X
AR7W site 17	X	X	X
AR7W site 18			X
AR7W site 20	X	X	X
AR7W site 21			X
AR7W site 22			X
AR7W site 23	X	X	X
AR7W site 24			X
AR7W site 24.5			X
K32	X	X	
K33	X	X	
M1325	X	X	

Table 6. DOC sampling.

g. Primary Production Measurements — Brian Irwin/Jeff Anning

Water samples for Photosynthesis/Irradiance experiments were collected from the rosette and from the flowthrough system (depth 4m) in the forward lab. A total of 21 samples were collected from the flow through system and 28 from the rosette (see Table 7). Aliquots of the samples were innoculated with 14C sodium bicarbonate and

incubated for three hours in a temperature controlled incubator, at 30 different light levels, and then filtered onto glass fibre filters.

The level of radioactivity on each filter was measured on board with a scintillation counter. Aliquots were also filtered for chlorophyll, HPLC, absorption spectra and POC analysis. A filtered sample was frozen for DOC analysis. At biology CTD stations chlorophylls and CO2 samples were collected at 100, 80, 60, 50, 40, 30, 20, 10 and 1m.

Sample ID #	Depth	Date	Lat	Long
173049	4	May 21	44 55	61 15
173051	4	May 21	45 44	59 53
173053	4	May 22	48 06	59 36
173055	4	May 22	49 31	58 44
203367	4	May 23	52 26	54 55
203368	4	May 23	53 07	53 52
203369	4	May 24	55 26	53 43
203371	4	May 24	55 27	53 42
203373	4	May 25	56 34	52 38
203375	4	May 25	56 34	52 37
203378	4	May 26	55 50	53 24
229334	20	May 26	55 36	53 37
229336	10			
229337	20	May 27	57 06	55 18
229388	10			
203381	4	May 27	57 01	54 49
203383	4	May 28	57 07	55 17
229394	40	May 28	57 07	55 16
229397	20			
229399	10			
203386	4	May 29	57 03	55 14
203387	4	May 29	57 03	54 46
203389	4	May 30	56 41	52 30
229442	40	May 30	56 40	52 27
229445	20			

Sample ID #	Depth	Date	Lat	Long
229447	10			
203392	4	May 31	58 38	50 25
229529	40	May 31	59 04	49 54
229532	20			
229534	10			
229640	40	June 1	60 02	48 53
229643	20			
229645	10			
173060	4	June 2	58 33	50 36
229679	40	June 2	57 52	51 14
229682	20			
229684	10			
173062	4	June 3	56 31	52 33
173063	4	June 3	56 33	52 38
229798	40	June 4	55 28	53 41
229801	20			
229803	10			
229883	40	June 5	53 40	54 02
229886	20			
229888	10			
173069	4	June 6	50 35	57 57
229916	40	June 6	49 51	58 32
229919	20			
229921	10			

Table 7. Primary production sampling.

h. Bio- Optical measurements **Dave Ruble/Jian Wang**

Instruments:

1. Satlantic SeaWIFS profiling Multichannel Radiometer (profiler and reference)
2. Satlantic SeaWIFS Aircraft Simulator (SAS)
3. MictroTops II Sunphotometer
4. SIMBAD Radiometer
5. Shimadzu UV-2401PC UV-Vis Recording Spectrotometer

Optical measurements of spectral light (radiance and irradiance) were made at 16 stations. Triplicate profiles were done at 9 of the stations with the SPMR Profiler (free falling) and Reference (13 channels, 400 to 700nm) to +80m in most cases. Above water records were done at all the stations with the SAS (13 channels, 380 to 865nm) for 10 minutes or longer. The SAS was mounted above the bridge over looking the profiling area. During SAS underway measurements the ship aligned with the sun and slowed to eliminate viewing of the ship's wake. This data will be processed to calculate values of the water-leaving radiance and remote sensing reflectance. Channel band ratios will be correlated with values of near surface chlorophyll to generate regional algorithms for remote sensing of biomass and production in the Labrador Sea. One or possibly two of the stations have a good possibility of being validation points. Additional spectral light measurements were made with a Microtops II Sunphotometer and SIMBAD radiometer.

Particulate (a_p), dissolved (a_s), and non-pigmented (a_n) absorption spectrum were run on discrete samples at 15 stations with a Shimadzu scanning spectrophotometer. Water samples were obtained from the forward lab's flow-through system (4m) and from CTD rosette (1,10,20, and 50m). Triplicates were run for surface samples.

i. Bacterial and Phytoplankton Enumeration and Uptake of Trititiated Leucine into Bacterial Protein **Paul Dickie**

Samples were collected from all CTD depths on all CTD profiles for enumeration of bacteria and viruses by Flow Cytometry. An indication of bacterial productivity with depth was obtained at 10 locations using a new micro method of tritiated leucine added to seawater and incubated in micro centrifuge tubes in a dark refrigerator. The uptake of leucine into protein (an indication of increase in biomass) can then be obtained. Corresponding "leucine enrichment" and "predator dilution-time series" experiments were also performed. As well, integrated samples for each CTD profile were taken from surface to 50 meters for phytoplankton identification and counting by microscopy. These were preserved with acid Lugol.

5. Major Problems and Goals Not Achieved

Due to the 6.5 day delay in ship sailing date, a significant part of the Year 2000 enhanced program was not accomplished. This included 6 of the 7 biology stations on the Halifax Section, once daily biology stations on the transit to the Labrador Sea, 9 hydrographic stations on the Cape Farewell Section, 9 hydrographic stations on the Bonavista Section. In addition, 10 of the 28 standard hydrographic stations on the Labrador Sea Section were not sampled due to ice; 4 additional stations located south of the ice were added on the Labrador shelf side. The Halifax Section mooring was not ready at the time of sailing and thus was not deployed on this mission.

6. Other Incidents of Note

This was the second cruise to use the OSD Ocean Data and Information system (ODIN). ODIN is a shipboard database application for tracking and collecting the metadata and water sample data associated with an oceanographic cruise. ODIN was run in parallel with the historic system on 99022. As a natural implementation progression, ODIN was run as the sole system in the computer room during HUD2000009. Activities in the winch room were logged both within ODIN and on the historic decksheets.

7. List of Cruise Participants

Name	Responsibility	Affiliation
Jeff Anning	Underway Sampling, photosynthesis	BIO
Rick Boyce	Salts, Moorings	BIO
Jay Bugden	DOC Levels, respiration rates	BIO
Pierre Clement	Nutrients	BIO
Victoria Burdett-Coutts	CO_2, CFC's, Alkalinity	BDR
Paul Dickie	Bacterial abundance and activity	BIO
Bob Gershey	Scientist, CO_2, CFC's, Alkalinity	BDR
Les Harris	Zooplankton, Net Tows	BIO
Glen Harrison	Chief Scientist	BIO
Sabine Harms	Tomography Moorings	Kiel
Brian Irwin	Primary Production	BIO
Anthony Isenor	Data Manager	BIO
Detlef Kindler	Tomography Moorings	Kiel
Uwe Koy	Tomography Moorings	Kiel
Rudolf Link	Tomography Moorings	Kiel
Felix Morsdorf	Tomography Moorings	Kiel
Andreas Pinck	Tomography Moorings	Kiel
Dave Ruble	Optics	ODU

Bob Ryan	CTD Technician, Moorings	BIO
Murray Scotney	Moorings, instrumentation	BIO
Uwe Send	Tomography Moorings	Kiel
Jian Wang	Optics	ODU
Igor Yashayaev	Scientist	BDR
Frank Zemlyak	Technician, CO_2, CFC's, Alkalinity	BIO

BIO Bedford Institute of Oceanography
PO Box 1006
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B. UNDERWAY MEASUREMENTS

1. Navigation and Bathymetry — Anthony W. Isenor

The navigation system onboard CCGS Hudson consists of a differential GPS receiver and AGCNAV. The receiver also broadcasts navigation NMEA strings throughout the ships network at about 1 Hz. The navigation data are then logged at one second intervals on a PC, while ship speed, direction, etc. data are logged at 1 minute intervals. This PC was running the AGCNAV software package, a PC based display, and way-point setting software package developed at the Atlantic Geoscience Centre at BIO. This software graphically displays ship position, way-points, course, speed, etc. to the various science working areas.

The echo sounder system used for collecting bathymetric data at station locations consisted of a Raytheon Line Scan Recorder, Model LSR 1811-1 (serial number A101) connected to a hull mounted 12kHz transducer. The transducer beam width is 15 degrees. The sweep rate of the record 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

The Hudson was equipped with a hull mounted RDI acoustic doppler current profiler. The transducer (serial number 177) had VM ADCP electronics (serial number 172). Logging, using Transect software on a 486 PC, was started on May 20th at 2355 Z in Halifax Harbour. Ten minute averages were logged for the duration of the mission. The configuration of the equipment results in a bin length of 4 metres and a total of 128 bins. The averaged data are stored to disk and backed up every few days. ADCP logging was stopped on June 8th at 0845Z 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 was measured and logged every 30 sec. Temperature and conductivity were measured with Seabird sensors and the fluorescence by a Wetlabs follow-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. In addition discrete water samples were collected every 15 minutes by an auto sampler for later analysis for nitrate and silicate. The computer also logged the time and position of these samples.

4. XBT and XCTD

No probes were used.

5. Meteorological observations

The ship's crew logged routine reporting of meteorological variables.

6. Atmospheric Chemistry

There was no atmospheric chemistry program.