CRUISE REPORT

HUDSON 99022

LABRADOR SEA

WOCE LINE AR7W

27 June - 13 July, 1999

A. CRUISE NARRATIVE

1. Highlights

a. WOCE Designation:	WOCE Line AR7W Atlantic Circulation Experiment
b. Expedition Designation:	Hudson 99022
c. Chief Scientist:	R. Allyn Clarke Ocean Sciences Division Department of Fisheries and Oceans Bedford Institute of Oceanography PO Box 1006 Dartmouth, NS, Canada B2Y 2A4 Internet clarkea@mar.dfo-mpo.gc.ca
d. Ship:	CCGS Hudson
e. Ports of Call:	June 27 BIO, Dartmouth, NS, Canada July 13 BIO, Dartmouth, NS, Canada
f. Cruise Dates:	June 27 to July 13, 1998

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 – along-track temperature-salinity measurements; SAP – along-track shipboard ADCP measurements; GOF – GO Flow bottle cast; PMP – pump cast; MNT – Biological multinet cast; CLG – Challenger pump cast. 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 are included in Appendix 3.

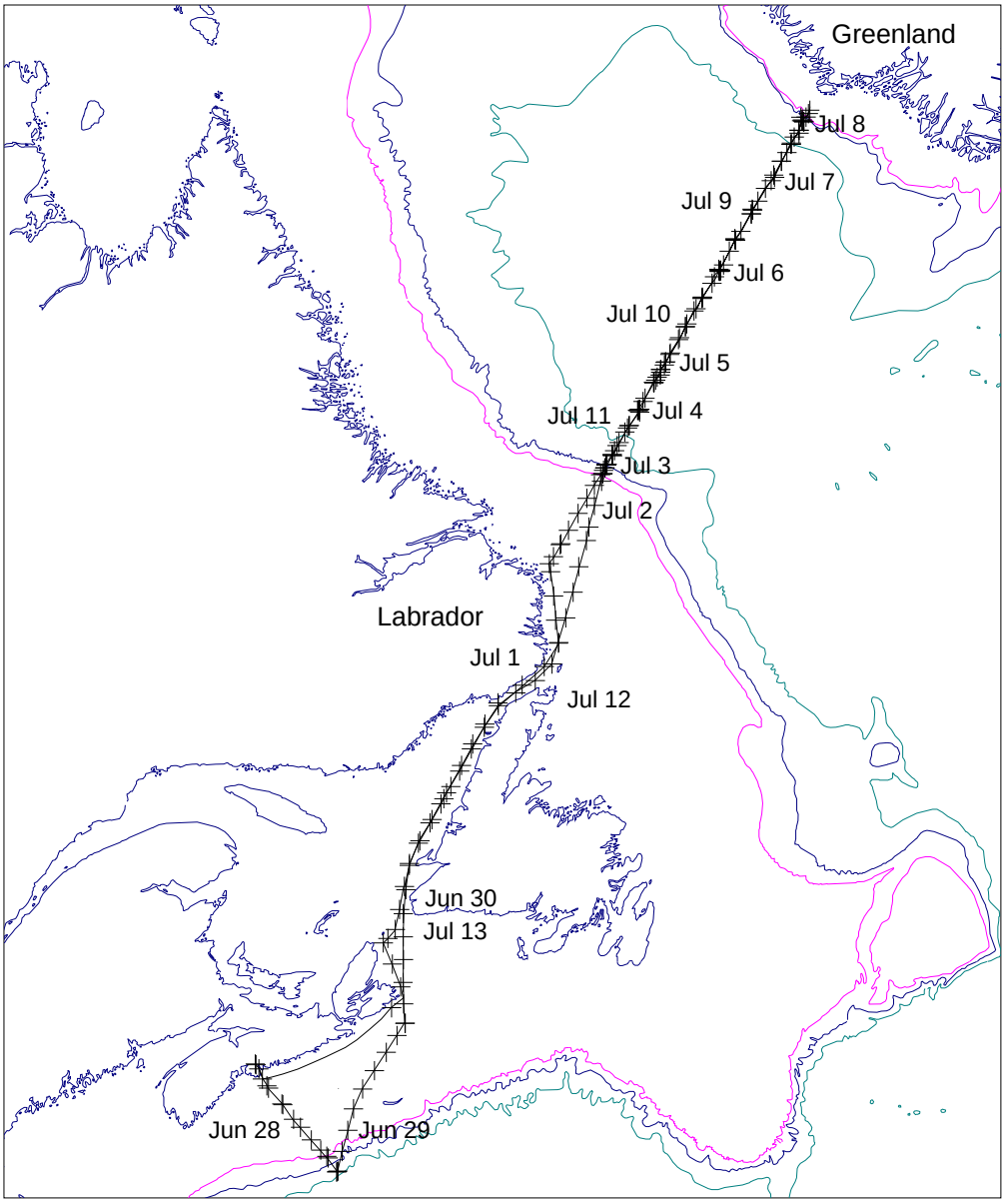

Figure 1. Cruise track for 18HU99022/1.
The date labels indicate the ship's position at 0000Z.

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); 513 – Absorption Spectra; 515 - Thorium (^{234}Th); 516 - Protactinium (^{231}Pa) ; 517 - Iodine (^{129}I) ; 518 - Technetium (^{99}Tc). 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 99022.

Cast Type	Number of Operations	Detailed Division	Operation Numbers
Rosette & CTD	56	27 regular AR7W Sites plus Site 8.5	see Table 2
		7 Halifax Line Sites	see Table 3
		2 Seacat Calibrations	61 (also in Table 2), 147
		19 Biology Casts	32,35,56,70,71,84,87,90, 99,109,111,112,124,126, 134,137,145,152,154
		1 Basin test	1
Moorings	5	2 recoveries	58, 144
		2 deployments	59, 146
		1 release test	136
Biology	72	64 shallow net tows	4-6,8-10,12-14,16-18,20,21,22,24,28,31,34,36,37, 39,41,43,45,47,49,51,55,60,67, 72,74,78,79,85,89,95,98,102, 103,105,106,110,119,121,123, 125,128,130,131,135,139,140, 148,150,151,153,155-160
		8 multinet tows	26,30,69,100,108,133, 142,143
Chemistry	25	8 Challenger Pump deployments at 4 locations	57,64,76,83,92,96,113, 118
		10 Go-Flo casts at 5 locations	33 (test), 53,54,63,66, 82,91,94,97,115
		7 surface pump casts at 4 locations	27 (test), 62,65,77,81, 114,117
		I, Tc sampling at CTD locations	38,42,46,50,52,56,70,73, 75,80,86,87,88,141,138, 137,93,99,132,134,104, 129,107,109,126,112,124, 120
		Th, Pa sampling at CTD locations	38,42,46,50,52,68,70,86, 87,129,134,107,109,112, 116,124,120
Other	2	Ship Board ADCP	2
		Along track t, s, and fluorescence	3

Table 1. Science operations conducted on 18HU99022/1.

AR7W Site Number	99022 Deep Cast Operation Number
1	38
2	40
3	42
4	44
5	46
6	48
7	50
8	52
8.5	149
9	61
10	68
11	73
12	75
13	80
14	86
15	88
16	141
17	138
18	93
19	101
20	132
21	104
22	129
23	107
24	127
25	116
26	122
27	120
28	not occupied

Table 2. AR7W sites and rosette operation numbers for 18HU99022/1.

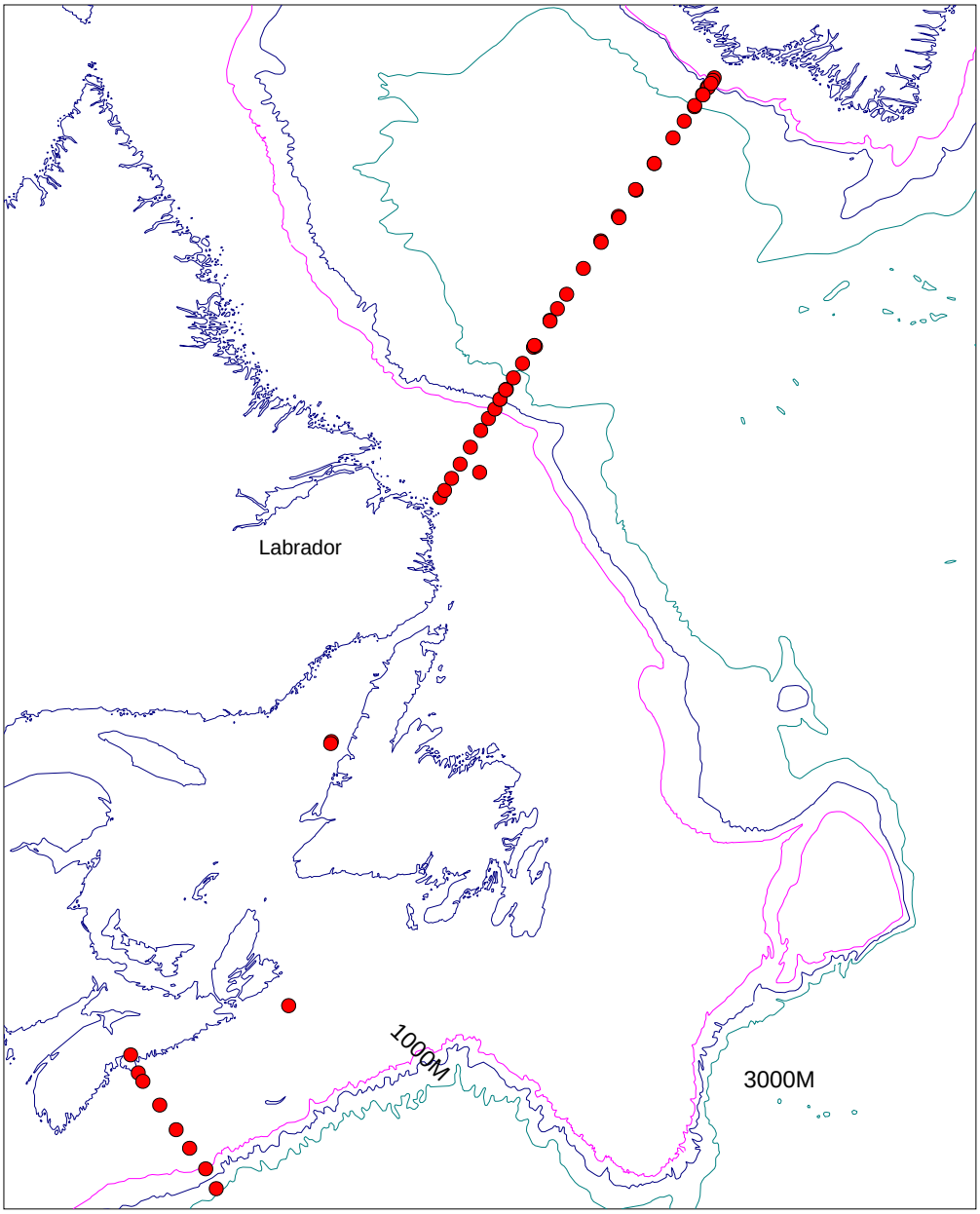

Figure 2. CTD, rosette and LADCP station positions on for Hudson 18HU99022/1.

Halifax Line Number	99022 Deep Cast Operation Number
1	7
2	11
3	15
4	19
5	23
6	25
7	29

Table 3. Halifax Line sites and rosette operation numbers for 18HU99022/1.

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, nutrients, oxygen isotopes, helium and tritium. On some casts, chemistry isotope sampling was also conducted for iodine, technetium, protactinium and thorium.

c. Floats and Drifters deployed

No floats or drifters were deployed.

d. Moorings deployed or recovered

A total of 5 mooring related operations, consisting of 2 deployments, 2 recoveries and 1 release test were conducted at various sites. The following summarizes the mooring operations.

Deployments:

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.
1	M1325 multi-instrument mooring near OWS Bravo on AR7W. This mooring consisted of 4 microcats, 3 Seacat temperature/conductivity recorders, and 6 Aanderaa current meters

Recoveries:

1	M1276 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 18HU98023.
1	M1275 multi-instrument mooring near OWS Bravo on AR7W. This mooring consisted of 7 Seacat temperature/conductivity recorders, 6 Aanderaa current meters, and 3 SBE39 (two with temperature and one with temperature and pressure). This mooring was deployed on 18HU98023.

3. List of Principal Investigators

Name	Affiliation	Responsibility
Allyn Clarke	BIO clarkea@mar.dfo-mpo.gc.ca	Senior scientist Overall co-ordination
Bob Gershey	BDR Research rgershey@fox.nstn.ns.ca	Alkalinity, carbonate, CFC's
Glen Harrison	BIO harrisong@mar.dfo-mpo.gc.ca	Coordinator biological program nitrate and ammonium utilization by phytoplankton
Erica Head	BIO heade@mar.dfo-mpo.gc.ca	Macrozooplankton distribution, abundance and metabolism
Robert Houghton	LDEO houghton@ldeo.columbia.edu	Oxygen isotopes
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
Peter Rhines	UW rhines@killer.ocean.washington.edu	Moored instrument data
John Smith	BIO smithjn@mar.dfo-mpo.gc.ca	Chemistry isotopes

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 scientific initiatives.

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 1998/99 and 1999/2000.

The second initiative is the Labrador Sea project of the Canadian Joint Global Ocean Flux Study (JGOFS). The biological program is designed to characterize the late spring biological processes in the Labrador Sea and its shelf regions. The purposes of the program are 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 Sea Wifs. The physical oceanographic program is observing total carbonate, alkalinity and CFC's over the entire water column in support of these JGOFS objectives.

The third objective is to occupy the Halifax Section in support of DFO Atlantic Zone's monitoring strategy.

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.

4.2 Biological Program

a. Narrative

The biological program conducted as part of cruise 99022, with some modifications, was a continuation of studies began 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 program - conducted most years by Jeff Anning (this year included Brian Irwin),
(2) a microbial program conducted by Bill Li or Paul Dickie,
(3) a mesozooplankton program conducted by Erica Head or Les Harris (this year including Tim Perry) and
(4) a dissolved organic carbon/community respiration program conducted by Paul Kepkay or Jay Bugden.

The ultimate aim of these studies is twofold:
(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 OSD'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 OSD's fisheries-related research.

New studies during this cruise included a more detailed investigation of microbial plankton (pico-phytoplankton, bacteria and viruses), measurements of phytoplankton utilization of nitrate and ammonium and more detailed studies of deep meso/macrozooplankton populations using the Multinet system.

In addition to the Labrador Sea study, phytoplankton, mesozooplankton and nutrient samples were collected at the seven stations along the Halifax line and three zooplankton tows were taken on the Cabot Strait line in support of OSD's obligations to the Atlantic Zone Monitoring Program.

b. 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. Carbon (CO_2), nitrate and ammonium utilization rates from eight depths in the photic zone (i.e. the 1% light level ranged from 35-60 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 for comparison. A total of 14 experiments were conducted (see Table 5); 10 stations were occupied along the AR7/W line and four in transit to and from the line. Four of the stations occupied were those where the chemistry *in-situ* pumps were deployed. Carbon-based primary productivity rates at these locations will be compared with vertical fluxes of particulate biogenic carbon derived from the thorium/carbon analyses to estimate fraction biogenic carbon export in the region.

Date	Site	Operation Number	LAT (N)	LON (W)	Photic Depth (m)	15N/13C	14C
29-Jun-99	LL3	32	45.48	-59.51	50	x	
30-Jun-99	NE-GSL#1	35	49.74	-59.39	50	x	
1-Jul-99	L3_1	38	53.68	-55.54	45	x	
2-Jul-99	L3_9	56	55.26	-53.97	35	x	
3-Jul-99	L3_10	70	55.42	-53.82	45	x	
4-Jul-99	L3_13	84	56.12	-53.05	40	x	
5-Jul-99	L3_18	90	58.20	-50.88	50	x	x
6-Jul-99	L3_19	99	58.63	-50.42	45	x	x

7-Jul-99	L3_25	111	60.29	-48.56	60	x	x
8-Jul-99	L3_24	126	60.17	-48.68	60	x	x
9-Jul-99	L3_17	137	57.82	-51.34	50	x	x
10-Jul-99	Mooring 1275	145	56.72	-52.48	40	x	x
11-Jul-99	Hamilton Bank	152	54.08	-54.51	55	x	
12-Jul-99	NE-GSL#2	154	49.71	-58.41	40	x	

Table 5. Sampling for stable isotopes.

c. 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, which dominate the zooplankton in this region.

Vertical net tows were taken at 42 stations (11 on or near the Scotian Shelf, 2 in the Gulf and 29 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 stratified deep tows (2500 meters to the surface) were taken at 7 of the stations (1 off the Scotian Shelf and 6 in the Labrador Sea) using a multinet. Samples will be analysed for species composition, copepod stage structure and biomass. Vertical net tow and multinet tow locations are shown in Figure 3.

d. Measurements Of Copepod Metabolic Rates — L. Harris

Respiration rates (CO2 production) of the copepod communities were determined at 7 stations in the Labrador Sea.

Egg production rates of *Calanus finmarchicus*, the dominant copepod species, were measured at 6 stations in the Labrador Sea.

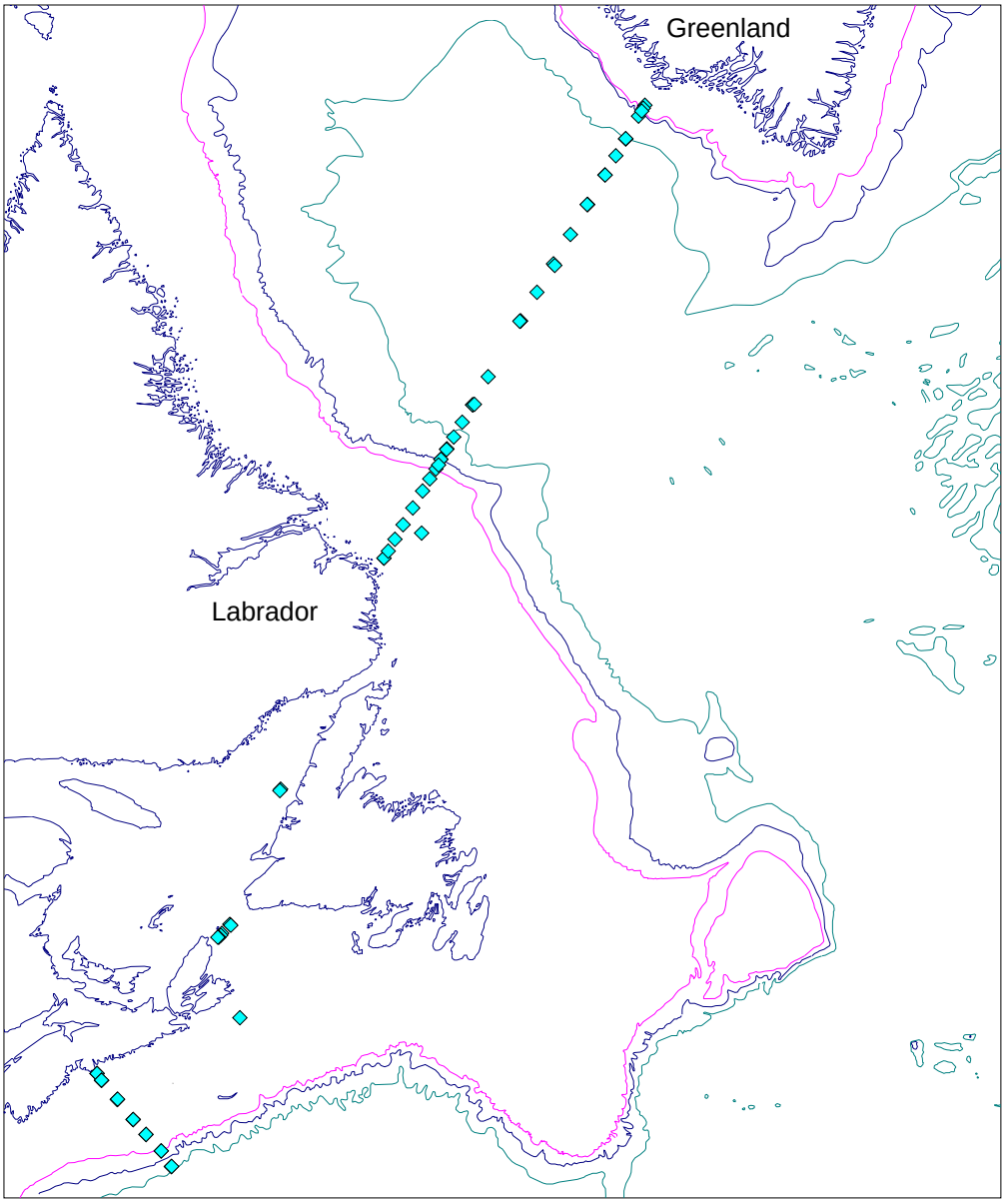

Figure 3. Net tow and multinet tow locations for 18HU99022/1.

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

Samples for DOC profiles, size fractionation of DOC (ultrafiltration) and microbial community respiration were collected at 27 sites on the AR7W line (see Table 6). Ultrafiltration and rates of respiration of seawater samples were carried out at the time of collection (the ultrafiltration samples were frozen for later laboratory analysis), while samples for the DOC profiles were collected and frozen for later analysis.

Station	Respiration	Ultrafiltration	DOC Profile

Site 1 (AR7W Line)	X	X	X
Site 2			X
Site 3			X
Site 4	X	X	X
Site 5			X
Site 6			X
Site 7			X
Site 8			X
Site 9	X	X	X
Site 10	X	X	X
Site 11			X
Site 12			X
Site 13	X	X	X
Site 14			X
Site 15			X
Site 16			X
Site 17	X	X	X
Site 18	X	X	X
Site 19	X	X	X
Site 20			X
Site 21			X
Site 22			X
Site 23			X
Site 24	X	X	X
Site 25	X	X	X
Site 26			X
Site 27			X

Table 6. Ultrafiltration, respiration and DOC sample collection.

f. Primary Production Measurements **Brian Irwin / Jeff Anning**

Photosynthesis Irradiance (PI) measurements were done at fourteen (14) stations – one at Louisbourg Line 3, two in the Gulf of St Lawrence, one on Hamilton Bank and ten on AR7W (Table 7). Water samples were collected from three depths in the upper 40 meters of the water column. Depth selection depended on the depth of the chlorophyll maximum and the shape of the chlorophyll profile. High Pressure Liquid Chromatography (HPLC) and Absorption Spectra samples were also collected at these depths.

At seven of the PI stations on AR7W water column primary production was measured with C^{14} at eight depths using deck incubators. These results will be compared with estimates of primary production measured with C^{13} at the same depths.

At all fourteen stations chlorophyll and CO_2 samples were collected at 10 metre interval from 100m to surface where depth permitted.

Station Label	Operation Number	ID	Depth	Latitude (N)	Longitude (W)	Date
LL3	32	213544	10	45 29.06	59 30.50	29-Jun-99
LL3	32	213542	20	45 29.06	59 30.50	29-Jun-99
LL3	32	213538	50	45 29.06	59 30.50	29-Jun-99
Gulf	35	213563	10	49 44.99	59 23.65	30-Jun-99
Gulf	35	213561	20	49 44.99	59 23.65	30-Jun-99
Gulf	35	213558	40	49 44.99	59 23.65	30-Jun-99
AR7W 01	38	213585	10	53 40.76	55 32.95	01-Jul-99
AR7W 01	38	213582	20	53 40.76	55 32.95	01-Jul-99
AR7W 01	38	213579	40	53 40.76	55 32.95	01-Jul-99
AR7W 09	56	213723	10	55 16.06	53 58.60	02-Jul-99
AR7W 09	56	213721	20	55 16.06	53 58.60	02-Jul-99
AR7W 09	56	213718	30	55 16.06	53 58.60	02-Jul-99
AR7W 10	70	213788	10	55 25.07	53 49.82	03-Jul-99
AR7W 10	70	213786	20	55 25.07	53 49.82	03-Jul-99
AR7W 10	70	213784	30	55 25.07	53 49.82	03-Jul-99
AR7W 13	84	213884	10	56 05.00	53 03.87	04-Jul-99
AR7W 13	84	213882	20	56 05.00	53 03.87	04-Jul-99
AR7W 13	84	213879	30	56 05.00	53 03.87	04-Jul-99
Flo Thru		191944	4	57 53.75	51 13.23	05-Jul-99
AR7W 18	90	213975	10	58 12.80	50 53.76	05-Jul-99
AR7W 18	90	213973	20	58 12.80	50 53.76	05-Jul-99
AR7W 18	90	213969	40	58 12.80	50 53.76	05-Jul-99
AR7W 19	99	214023	10	58 38.05	50 25.84	06-Jul-99
AR7W 19	99	214021	20	58 38.05	50 25.84	06-Jul-99
AR7W 19	99	214018	40	58 38.05	50 25.84	06-Jul-99
AR7W 25	111	214135	10	60 18.14	48 34.45	07-Jul-99
AR7W 25	111	214133	20	60 18.14	48 34.45	07-Jul-99
AR7W 25	111	214129	40	60 18.14	48 34.45	07-Jul-99
AR7W 24	126	214244	5	60 10.76	48 34.45	08-Jul-99
AR7W 24	126	214239	10	60 10.76	48 34.45	08-Jul-99
AR7W 24	126	214236	20	60 10.76	48 34.45	08-Jul-99
AR7W 22	129	210502	0	59 45.06	49 10.01	08-Jul-99
AR7W 17	137	214359	10	57 49.81	51 21.18	09-Jul-99
AR7W 17	137	214355	30	57 49.81	51 21.18	09-Jul-99
AR7W 17	137	214353	40	57 49.81	51 21.18	09-Jul-99
Mooring	145	214428	10	56 43.47	52 28.83	10-Jul-99
Mooring	145	214426	20	56 43.47	52 28.83	10-Jul-99
Mooring	145	214424	30	56 43.47	52 28.83	10-Jul-99
Ham Bank	152	214449	10	54 04.98	54 30.91	11-Jul-99

Station Label	Operation Number	ID	Depth	Latitude (N)	Longitude (W)	Date
Ham Bank	152	214447	20	54 04.98	54 30.91	11-Jul-99
Ham Bank	152	214445	25	54 04.98	54 30.91	11-Jul-99
Gulf	154	214463	5	49 24.75	58 24.49	12-Jul-99
Gulf	154	214461	10	49 24.75	58 24.49	12-Jul-99
Gulf	154	214459	20	49 24.75	58 24.49	12-Jul-99

Table 7. Sampling for primary production.

g. Distribution of Microbial Plankton — William Li

Samples were collected from the CTD rosette for cryogenic preservation and for onboard shipboard flow cytometric enumeration of microbial plankton (Table 8). Plankton were fixed using 1% paraformaldehyde and then cryogenically stored in liquid nitrogen. These samples will be analyzed on shore for abundance of picophytoplankton, heterotrophic bacteria, and viruses. Picophytoplankton are detected on the basis of autofluorescence from chlorophyll a and from phycoerythrin. Heterotrophic bacteria and viruses are detected after staining with the nucleic acid binding fluorochrome SYBR Green 1. Preliminary examination using shipboard flow cytometry has revealed high abundances of heterotrophic bacteria (up to 3 million cells per millilitre) in the upper mixed layer of the central Labrador Sea.

Event	Station	Cast	Samples	Cryo-storage	Picophytoplankton	Bacteria
7	Hfx-1	Shallow	9	X	X	
11	Hfx-2	Shallow	9	X	X	
15	Hfx-3	Shallow	13	X		
19	Hfx-4	Shallow	8	X	X	
23	Hfx-5	Shallow	9	X	X	
25	Hfx-6	Shallow	8	X	X	
29	Hfx-7	Deep	23	X	X	
32	Louisburg-3	Shallow	14	X	X	
35		Shallow	10	X	X	X
38	L3-01	Shallow	14	X	X	X
40	L3-02	Shallow	12	X		X
42	L3-03	Shallow	13	X		X
44	L3-04	Shallow	11	X		X
46	L3-05	Shallow	15	X		
48	L3-06	Shallow	14	X		
50	L3-07	Deep	18	X		
52	L3-08	Deep	23	X		
56	L3-09	Shallow	17	X	X	X
61	L3-09	Deep	18	X		
68	L3-10	Deep	24	X		X
70	L3-10	Shallow	16	X	X	X
73	L3-11	Deep	18	X		
75	L3-12	Deep	22	X		
80	L3-13	Deep	23	X		X
84	L3-13	Shallow	17	X	X	X
88	L3-15	Deep	24	X		
90	L3-18	Shallow	16	X	X	X
93	L3-18	Deep	24	X		X
99	L3-19	Shallow	16	X	X	X
101	L3-19	Deep	24	X		
104	L3-21	Deep	24	X		
107	L3-23	Deep	15	X		X
109	L3-23	Shallow	19	X		X
111	L3-25	Shallow	12	X	X	X
119	L3-28	Shallow	6	X		X
121	L3-27	Shallow	6	X		X
123	L3-26	Deep	17	X		X
126	L3-24	Shallow	11	X	X	X
127	L3-24	Deep	24	X		X
132	L3-20	Deep	19	X		X
133	L3-20	Shallow	15	X		X
137	L3-17	Shallow	13	X	X	X
138	L3-17	Deep	24	X		
140	L3-16	Deep	24	X		X
145	M-1275	Shallow	15	X	X	X
152	HamiltonBank	Shallow	14	X	X	X
154	GukfStLawr	Shallow	10	X	X	X

Table 8. Sampling for microbial plankton.

h. Metals and Radioisotopes Sampling Program H. Edmonds, J. Dalziel, R. Nelson

Samples for dissolved and particulate metals, isotopes and particulate organic carbon were collected at several stations during this expedition. The data will be used to determine the flux of particulate metals and particulate organic carbon (POC) in the Labrador Sea. The samples were collected from three sources: Challenger pumps, 12 litre Go-Flo bottles and CTD rosette bottles. The following is a description of the samples processed from each of the sampling sources. Figure 4 indicates the location of chemical sampling.

Challenger Pump Sampling:
The pumps were used at four stations (9, 13, 18 and 25) on the AR7W line to sample for dissolved/particulate metals, Thorium (^{234}Th) and POC. At each station, the pumps were deployed twice, to four depths (25, 50, 100, 250 m). One cast was deployed to sample for particulate and dissolved ^{234}Th and POC. The pumps were deployed again to the same depths to collect a particulate sample for metals, ^{230}Th and Protactinium (^{231}Pa). At all stations, the pumps were programmed to sample for 2 to 2.5 hours. While the Challenger pumps were deployed, a surface pumping system was deployed to 1-2 m to collect a corresponding sample from the surface. At station 18, sea and weather conditions prohibited the deployment of the surface pump.

Go-Flo Sampling:
At each of the four pumping stations, water samples were collected at matching depths i.e. surface, 25, 50, 100, 250 m for total mercury, dissolved - metals, ^{230}Th, and ^{231}Pa and particulate - metals, ^{230}Th, ^{231}Pa. The 12 litre Go-Flos were deployed on stainless steel hydrowire from the foredeck and subsampled in a clean area of the forward lab. All materials used to handle the water samples have been acid cleaned and all filter manipulations required on board were conducted in a positive air laminar flow “clean bench”. Salinity and nutrient samples were collected from each Go-Flo as a check of the sampling depth. At stations 9 and 18, in addition to the sampling at the Challenger pump depths, the water column was also sampled at depths >250 m coincident with depths chosen for CTD samples. A total of 24 samples were collected for total Hg, 36 for dissolved/particulate metals and 32 samples each for ^{230}Th and ^{231}Pa.

CTD Sampling:
Water samples were collected from the CTD at 25 stations on the AR7W line. A total of 118 samples were collected for Iodine (^{129}I) from 25 stations and 8 samples for Technetium (^{99}Tc) at 4 stations. These samples were collected to measure the extent of the “Sellafield” reprocessing signal flowing in and out of the Labrador Sea. Samples for ^{230}Th and ^{231}Pa were also collected at 12 stations with a total of 80 samples collected for each of these isotopes.

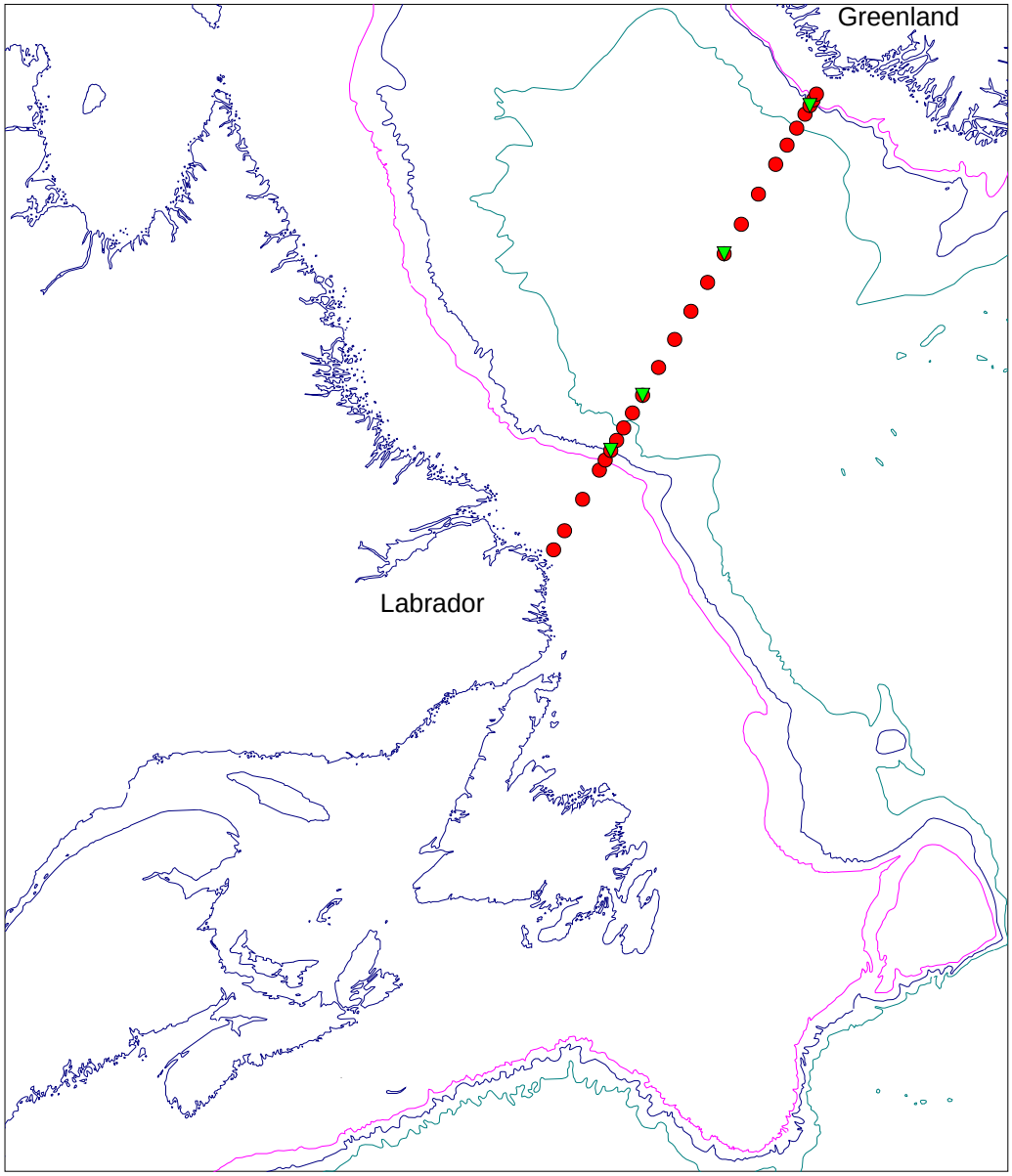

Figure 4. Chemical sampling for 18HU99022/1. Red circles indicate I, Tc, Th, or Pa sampling from the rosette, while green triangles indicate Go-Flo, Challenger pump or surface pump sampling.

5. Major Problems and Goals Not Achieved

none

6. Other Incidents of Note

This was the first deep ocean cruise to use the recently acquired HP NT NetServers (Model LH3 PII 400). These servers have replaced the MicroVAX systems first used in 1986. The HP servers provide Science staff with 12 gigabytes of disk space, are mirrored internally and operate in parallel. Science backups on the servers were easy and rapid using the HP DAT tapes.

This was also the first 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 beta tested last year, during 18HU98023/1 in the Labrador Sea. The system was implemented on 99022 as an operational system. Our standard paper based system was maintained in parallel to ODIN.

7. List of Cruise Participants

Name	Responsibility	Affiliation
Jeff Anning	Underway Sampling, photosynthesis	BIO
Jay Bugden	DOC Levels, respiration rates	BIO
Allyn Clarke	Senior Scientist	BIO
Pierre Clement	Nutrients	BIO
John Dalziel	Tracers	BIO
Jennifer Dixon	CO_2, CFC's, Alkalinity	BDR
Henrietta Edmonds	Tracers	URI
Bob Gershey	Scientist, CO_2, CFC's, Alkalinity	BDR
Jean Hanley	Helium, Tritium	LDEO
Les Harris	Zooplankton, Net Tows	BIO
Glen Harrison	Assistant Scientist	BIO
Albert Hartling	Winch Room, moorings	BIO
Brian Irwin	Primary Production	BIO
Anthony Isenor	Data Manager	BIO
Jeffrey Jackson	Computer Room	BIO
John Lazier	Oxygens	BIO
Bill Li	Bacterial abundance and activity	BIO
Richard Nelson	Tracers	BIO
Tim Perry	Zooplankton, Net Tows	BIO
Bob Ryan	CTD Technician, Moorings	BIO
Murray Scotney	Moorings, instrumentation	BIO
Igor Yashayaev	Scientist	BDR
Frank Zemlyak	Technician, CO_2, CFC's, Alkalinity	BIO

BIO	Bedford Institute of Oceanography PO Box 1006 Dartmouth, NS, B2Y 2A4 Canada
BDR	BDR Research Ltd. Box 652, Station 'M' Halifax, NS, B3J 2T3 Canada
LDEO	Lamont-Doherty Geological Observatory Columbia University Palisades, NY 10964 USA
URI	University of Rhode Island Graduate School of Oceanography South Ferry Road Narragansett, RI 02882 USA
UW	University of Washington Seattle, WA 98195 USA
WHOI	Woods Hole Oceanographic Institution Woods Hole, MA 02543 USA

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 ship's network at about 1 Hz. The navigation data are then logged at one minute intervals on a PC. This PC was running the AGCNAV software package, 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 consisted of a Raytheon Line Scan Recorder, Model LSR 1811-2 (serial number A117) 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 (ADCP). The transducer (serial number 177) had VM ADCP electronics (serial number 607). Logging, using Transect software on a 486 PC, was started on June 27 at 1535 Z in Halifax Harbour. Two different configurations were used for logging. On the Halifax Line, 30 second averages were logged. From the Louisbourg Site (on July 29, 1999 at 1522 Z), 5 minute averages were logged. The configuration of the equipment results in a bin length of 4 metros and a total of 128 bins. The averaged data are stored to disk and backed up every few days. ADCP logging was stopped on July 13 at 2247 Z 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.

C. HYDROGRAPHIC MEASUREMENTS - DESCRIPTIONS, TECHNIQUES AND CALIBRATIONS

1. CTD Measurement — Anthony Isenor

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 and two model 13-02 dissolved oxygen sensors. 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
9	Temperature	3-02/F	03P2298
	Conductivity	4-02/0	041873
10	Temperature	3-02/F	03P2303
	Conductivity	4-02/0	041874

Table C1. System numbers and sensor serial numbers.

Model	Serial Number
13-02	130265
13-02	130266

Table C2. Oxygen sensors used during 99022.

BIO Deck Unit Number	Model	Serial Number
2	11 plus	11P5676-0243
4 (spare, never used)	11 plus	11P7032-0268

Table C3. Seabird deck units for 99022.

BIO CTD Probe Number	Model	Serial Number	Pressure Sensor
6	9 plus	09P15349-0475	69009
3 (spare, never used)	9 plus	09P7356-0289	51403

Table C4. Seabird CTD units for 99022.

Stations	Circuit	Probe	Pressure	Temp.	Cond.	Oxygen	Pump
all	Primary	6	6	9	9	130265	051775
	Secondary			10	10	130266	051776

Table C5. CTD and sensor combinations used during 99022.

Instrument	Serial Number
SBE Carousel	3215631-0165
Pinger	unknown
Lowered ADCP	1576 (stations > 40) 1359 (stations < 40)
Irradiance	SPQA327 (station up to #33) SPQA280
Fluorometer	088172
Altimeter	222

Table C6. 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 directly below the CTD probe is a Benthos altimeter. The third quadrant contains the battery pack for the LADCP, the fluorometer and a General Oceanics model 6000 12 kHz pinger unit. The last quadrant contains the dual CTD sensors and pump.

One unique aspect of this frame is that it has adjustable legs. The base of the frame is circular with six vertical tubes, or legs, extending upward from the base. These legs end, and can slide within, a slightly larger tube at the base of a second circular frame. Each vertical leg has two

fixed positions within the larger tube, and is held in these positions by stainless steel pins. In the deployment position, the legs are retracted. When personnel are drawing water samples, the legs are extended thus raising the frame by about 40 cm. This makes drawing the water samples much easier.

The Physical and Chemical Oceanographic Data Facility of the Scripps Institution of Oceanography (SIO) made the rosette bottles. Each bottle collects 10 litres of water.

b. Sampling Procedure and data processing techniques

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

The CTD data is recorded onto disk by a P300 computer using SEABIRD Seasave for Windows NT/95 version 1.10. Processing was conducted using Seasoft Version 4.232 software. The multiple plotting options of Seasave for Windows provided welcomed flexibility during CTD data logging (see Appendix **).

At the end of each station, the Seasoft software is used to create 1 and 2 dbar processed data files. Other in-house software creates an inflection point file of the downcast T,S data which is later delivered to the Marine Environmental Data Service where it is converted to an IGOSS TESAC message and put on the GTS. In-house software also produces a processed rosette trip file consisting of 3 seconds of averaged data immediately following the rosette trip. All the raw and processed data files associated with the station are then transferred to the ship's HP Servers (see Appendix **) and Sun SPARC computers for archive and subsequent access and distribution to various users on the vessel.

The data processing takes the following steps:

DATCNV	Converts the raw data to physical parameters.
SPLIT	Splits the data into DOWN and UP cast.
WILDEDIT	For every block of 12 scans, flags all scans whose pressure, temperature, conductivity and oxygen values differ from the mean by more than 2 standard deviations. Recomputes mean and standard deviation from unflagged data then marks as bad all scans exceeding 4 standard deviations from these new values.
FILTER	Low pass filter pressure and conductivity channels. Time constant used for conductivity is 0.045 seconds, for pressure 0.150 seconds.
LOOPEDIT	Marks as bad, all cycles on the down trace for which the vertical velocity of the CTD unit is less than 0.1 metres/sec.
ALIGNCTD	Aligns the temperature, conductivity and oxygen values relative to the pressure values accounting for the time delays in the system. Time offsets for the primary sensors are: 0.010 secs for conductivity, 0.000 secs for temperature and 3.000 secs for oxygen. Time offsets for secondary sensors are: 0.080 seconds for conductivity, 0.000 seconds for temperature and

	3.000 seconds for oxygen (NOTE: Primary conductivity is adjusted by 0.073 seconds in the Deck Unit while the secondary conductivity is not adjusted in the Deck Unit).
CELLTM	A recursive filter used to remove the thermal mass effects from the conductivity data. Thermal anomaly amplitude and time constants of 0.0300 and 9.0000 were used.
DERIVE	Computes oxygen values.
BINAVG	Averages the down cast data into 1 and 2 dbar pressure bins.
DERIVE	Computes salinity, potential temperature and $sigma_{theta}$.
ROSSUM	Averages 3 seconds of CTD data after every bottle trip. Used in comparison with water sample data.

c. Calibration data

The CTD calibrations used during this cruise were supplied by Seabird Electronics. The applied calibrations are as follows:

BIO SEABIRD System # 9 Sensors ----------

Temperature Sensor 03P2298

$$T = 1/\{a + b[\ln(f_o/f)] + c[\ln^2[f_o/f] + d[\ln^3(f_o/f)]\} - 273.15$$

where ln indicates a natural logarithm, f is the frequency

a = 3.68017202 E-03
b = 6.00214054 E-04
c = 1.62501356 E-05
d = 2.2489128 E-06
f_o = 2918.321 (Seabird calibration dated December 3, 1997)
slope = 1, offset = 0

Conductivity Sensor 041873

$$\text{Conductivity} = (g + hf^2 + if^3 + jf^4)/[10(1 + \delta t + \varepsilon p)]$$

where f is the frequency, p is pressure in dbars, t is the temperature

g = -4.13982358
h = 5.40882425 E-01
i = -8.15812766 E-04
j = 6.91367207 E-05
δ = Ctcor = 3.25 E-06
ε = Cpcor = -9.5700 E-08 (Seabird calibration, February 21, 1997)
Slope = 1, offset = 0

BIO Probe # 6 Pressure Sensor ----------

Pressure Sensor 69009

$$\text{pressure} = c\,(1 - T_o^2/T^2)\,(1 - d[1 - T_o^2/T^2])$$

where T is the pressure period

$c = c_1 + c_2\,U + c_3\,U^2$
$d = d_1 + d_2\,U$
$T_o = T_1 + T_2\,U + T_3\,U^2 + T_4\,U^3 + T_5\,U^4$
U is the temperature
c_1 = -5.396574 E+04 psia
c_2 = -1.037259 E-01 psia/deg C
c_3 = 1.543670 E-02 psia/deg C^2
d_1 = 3.88 E-02
d_2 = 0
T_1 = 2.985151 E+01 micro sec
T_2 = -3.761054 E-04 micro sec/deg C
T_3 = 3.763920 E-06 micro sec/deg C^2
T_4 = 3.18753 E-09 micro sec/deg C^3
T_5 = 0
AD590M = 1.2816400 E-02
AD590B = -9.148718 E+00 (Seabird calibration, December 5, 1996)
slope = 1, offset = 0

BIO SEABIRD System # 10 Sensors ----------

Temperature Sensor 03P2303

$$T = 1/\{a + b[\ln(f_o/f)] + c[\ln^2[f_o/f] + d[\ln^3(f_o/f)]\} - 273.15$$

where ln indicates a natural logarithm, f is the frequency

a = 3.68017216 E-03

b = 5.98773888 E-04
c = 1.58179382 E-05
d = 2.20940238 E-06
f_o = 2896.732 (Seabird calibration, December 3, 1997)
slope = 1, offset = 0

Conductivity Sensor 041874

$$\text{Conductivity} = (g + hf^2 + if^3 + jf^4)/[10(1 + \delta t + \varepsilon p)]$$

where f is the frequency, p is pressure in dbars, t is the temperature

g = -4.08770679
h = 5.15866320 E-01
i = -1.06080083 E+00
j = 7.93277368 E-05
δ = Ctcor = 3.25 E-06
ε = Cpcor = -9.5700 E-08 (Seabird calibration, February 21, 1997)
Slope = 1, offset = 0

Oxygen Sensor 130266

oxygen = A B C

where A = {Soc [oc + Tau d(oc)/dt] + Boc}
oc is the current from the oxygen sensor
d(oc)/dt is the time derivative of oc
Soc = 2.1015
Tau = 2.0
Boc = -0.0646

oc = Mv + b
m = 2.4692 E-07
b = -4.1977 E-09

B = OXYSAT(t,s)
t is temperature
s is salinity

$C = e^{\{tcor\ [T + wt\ (To-T)] + pcor\ p\}}$
e is natural log base
tcor = -0.033
pcor = 0.00015
p is the pressure
wt = 0.670
To oxygen sensor internal temperature
T is the water temperature, where T = kv + c
k = 8.8993
c = -7.0715
v is the oxygen temperature sensor voltage signal

Oxygen Sensor 130265

oxygen = A B C

where A = {Soc [oc + Tau d(oc)/dt] + Boc}

oc is the current from the oxygen sensor
d(oc)/dt is the time derivative of oc
Soc = 2.4323
Tau = 2.0
Boc = -0.0397

oc = Mv + b
m = 2.4608 E-07
b = -4.9216 E-10

B = OXYSAT(t,s)
t is temperature
s is salinity

$C = e^{\{tcor [T + wt (To-T)] + pcor p\}}$
e is natural log base
tcor = -0.033
pcor = 0.00015
p is the pressure
wt = 0.670
To oxygen sensor internal temperature
T is the water temperature, where T = kv + c
k = 8.9939
c = -6.8210
v is the oxygen temperature sensor voltage signal

Fluorometer 088172

VB = 0.212
V1 = 1.974
Vacetone = 0.334
Scale Factor = 1
Slope = 1
Offset = 0

Irradiance Sensor SPQA327

Log Amp SBE90310(0002)CH1
M = -0.773222
B = -3.536591
Calibration Constant = 4.37
Multiplier = 1

Irradiance Sensor SPQA280

Log Amp SBE90310(0002)CH1
M = -0.773222
B = -3.536591
Calibration Constant = 4.43
Multiplier = 1

Altimeter 222

Scale factor = 15

2. Salinity — A. J. Hartling

a. Description of Equipment and Technique

Salinity samples were analyzed using a Guildline Autosal model 8400B salinometer, serial numbers 61083 and 60968. Samples were drawn in a new 200 ml bottle fitted with plastic caps and removable liners. The caps and liners were re-used on each subsequent sample drawn. The liners were removed from the cap after the sample was analyzed and rinsed in distilled water. This is a change from the past practice of replacing the cap for each sample drawn.

The salinometer cell is filled and rinsed numerous times with sample water before readings are recorded. When three consecutive readings of conductivity ratio agree to within 30.00001 are obtained, this value is recorded for the sample. This value is then entered into the water sample database as the conductivity ratio for the water sample.

b. Sampling Procedure and Data Processing Technique

A sample is drawn into a bottle after the bottle, cap and liner are thoroughly rinsed with the collected water from the rosette bottle. The bottles are filled up to slightly below the neck shoulder and then capped off. Once the bottle reached room temperature, the caps were retightened.

Conductivities were entered into the ODIN (See Appendix **) database. Conductivities were used to compute salinities using the WOCE Toolbox modules. The Toolbox is a PC based program running under a commercial DBMS that computes the salinity using the water sample conductivity ratio and the standard IAPSO formula. Any changes in the salinometer readings between successive standardizations are assumed to have occurred as a linear drift of the instrument. Thus, the program applies a correction to the ratios, which varies linearly with the samples analyzed. An offset is also applied if the initial standardization is different from the quoted value given on the ampoule label. The computed salinity data is then placed in the water sample database.

c. Laboratory and Sample Temperatures

Full cases of samples are taken from the winch room to the GP lab where they are left for a period of at least 10 hours to equilibrate to laboratory temperature before being analyzed. Laboratory temperature, salinometer bath temperature and sample temperature were tracked to ensure they were within the operating range of the salinometer. Salinometer operating range is

+4 to –2 °C of the salinometer bath temperature setting. Operating outside this range can result in the sample failing to equalize to the bath temperature and giving incorrect conductivity ratios.

Salinometers and bath temperatures used for analyzed samples are as follows:

Date	Salinometer	Bath Temperature	Samples Analyzed
From 28 June 99	S/N 61083	21	212925 to 212995 213501 to 213740
From 3 July 99	S/N 60968	24	213741 to 213935 214601 to 214634
From 6 July 99	S/N 61083	24	213936 to 214434 214641 to 214708
To the end of the cruise			

d. Replicate Analysis

A total of 51 duplicate salinity samples were drawn and processed within normal time frame. The statistics of the differences between these duplicates are as follows:

Number of Points = 51
Median = 0.0008
Mean = 0.0066
Minimum = 0
Maximum = 0.2614
Standard Deviation = 0.0364

e. Standards Used

The salinometer was standardized during the cruise using IAPSO standard water, Batch P133, dated November 11, 1997. A check on the standardization was carried out using a new ampoule of Standard water at the beginning and end of every sample run or checked using sub-standard water at intermediate points throughout the run if instrument drift was suspected.

f. Comments on sampling and analysis techniques:

a. Sample Bottles

Rinsing and fitting the caps, liners and bottles without more hands and fingers proved to be a problem.

A significant amount of water and salt crystals were apparent when the cap was removed for sample analysis on the salinometer. The liner would come out with the cap 75 % of the time. Contamination of the sample with the salt crystals or water from the cap is very possible.

b. Salinometers

Salinometer S/N 60968 suffered from hard to remove air bubbles in the entrance to the arms of the cell making the instrument hard to use. Readings would always be changing by a couple of numbers and never really stabilize the way they did on S/N 61083. Standardization drift of 10 units over a sample run was typical with S/N 60968 compared to only a couple units with S/N 61083

c. Novice Users:

As a Novice user

- The relationship between bath, lab and sample temperatures was not fully appreciated at the start of the cruise.
- The accuracy of the CTD system and the precision of the Salinometer reading necessary to calibrate the CTD were not appreciated.
- Caps, liners, rinsing techniques, salt crystals, water in the cap threads, the relation of liners that come off with the cap verses those that have to be picked off all count to give an accurate reading. To change bottles and fix the associated problems that occur during the cruise need a knowledgeable operator who can spot these problems early.
- Details of the operational techniques are important. Several operational questions remain: Why don't some samples ever settle down to a stable reading? Do air bubbles in the contact area impact the reading? Is the hunting for a reading on S/N 60968 typical or a sign of a fault? How much do you shake a bottle to mix the contents? Shaking too much generates very small air bubbles that may or may not effect the reading? How often do you change the Kimwipe used to dry the sample hose? How often do you wash your hands to remove the salt that builds up handling the bottles? All these details are important when attempting to obtain the greatest possible accuracy of results.

3. Oxygen — Frank Zemlyak

a. General

Samples for the determination of dissolved oxygen were drawn from each rosette water sampling bottle on most casts. The samples were analyzed using the Winkler titration technique with a computer driven automated system developed at the Scripps Institute of Oceanography (primary system). A second oxygen titration system, the Bedford System, has been widely used by the Marine Chemistry Division and during this cruise was used as a back-up. A small number of samples were analyzed using the Bedford system, mostly for comparison.

In total 523 samples were run, of which 40 were duplicates. Although some figures are presented in this summary, they are preliminary.

b. Description of Equipment and Technique

The oxygen samples are analyzed using an automated procedure developed by the Ocean Data Facility of the Scripps Institute of Oceanography. This procedure is a modified Winkler titration from Carritt and Carpenter (1966), using a whole bottle titration. To maintain historical records, the same Fisher Scientific Potassium Iodate standard was used as the working standard.

This oxygen titration system differs from the Bedford Institute's titration system in several ways. Most significant is the 365nm UV light source, followed by different standard and titer concentrations. Standards and blanks are run at least once a day, or whenever the system had been idle for a number of hours.

Before titrating, the top of the oxygen flask is washed a minimum of two times with deionized water before the glass stopper is withdrawn. At that point, a 1.5ml shot of sulphuric acid is added to the sample, a magnetic stir bar is introduced, the sample is then titrated immediately.

During the titration, the oxygen flask is immersed in a water bath and is held firm in the centre of the 365nm UV light path. Starch as an indicator is not needed and the addition of a wetting agent to minimize the formation of micro bubbles is unnecessary.

c. Sampling Procedure and Data Processing Technique

The sampling bottles are 125ml Iodine flasks with custom ground stoppers (Levy et al. 1977). The flask volumes are determined gravimetrically. The matched flasks and stoppers are etched with Identification numbers and entered into the Oxygen program database.

For this cruise 10 litre rosette bottles were used to obtain the original sample. The oxygen subsamples are drawn following the drawing of the CFCs, DOC and Helium subsamples. The oxygen subsamples are drawn through the bottle spigots with a silicone tube attached so as to

introduce the water to the bottom of the flask. The flask and its stopper are thoroughly rinsed and filled to overflowing. The flow is allowed to continue until at least two to three flask volumes overflowed. The flask is then slowly retracted with continuous low flow to ensure that no air gets trapped in the flask. Immediately thereafter, one ml each of the Alkaline Iodide and Manganous Chloride Reagents are added and the stoppers carefully inserted, again ensuring that no air gets into the flasks. The flasks are thoroughly shaken, then carried to the lab for analysis.

d. Replicate Analysis

The series of 40 duplicate samples taken throughout the cruise had a maximum difference of -0.112 to 0.21 ml/l, however, 88.75% of the values fell within -0.05 and +0.05 ml/l.

Many more standards and blanks were run during this cruise than in the past. Of the 120 blanks analyzed, the standard deviation was 0.0019 ml/l, of the 107 standards, 0.0024 ml/l of thiosulphate.

During one of the biology casts, a series of Niskin bottles were dedicated to an oxygen comparison between the Scripps and the Bedford Oxygen Titration systems. Five Niskins were sampled, up to five subsamples each were analyzed using both titration systems. The maximum differences ranged from a low of 0.033 to a high of 0.124 ml/l for the Scripps system and a low of 0.014 to a high of 0.142 ml/l for the Bedford system.

e. Conclusions

Although this is an automated computer controlled titration system, this cruise has shown that with operator care, the precision of titrations can be improved enormously. This was demonstrated by the primary operator who had never used the system before. For example, in the case of blanks, the standard deviation went from 0.0025 to 0.0005 ml/l, this from the first days of the cruise to the last days. With standards, the standard deviation went from 0.0040 to 0.0007 ml/l of thiosulphate. The secondary operator showed the same enhanced precision with the blanks.

A very strong effort should be made to adopt a universal Oxygen Titration Standard to ensure more accurate oxygen determinations from year to year and institution to institution. The benefits of such a standard are obvious when one looks at other commonly measured parameters, such as salinity, nutrients, CFC's, and carbonate.

4. Nutrients — Pierre Clement

a. Description of Equipment and Technique

Samples were analyzed for silicate, phosphate, and total nitrate (nitrate plus nitrite) using a Technicon Autoanalyser II. The chemistries are standard Technicon (Silicate 186-72W, Phosphate 155-71W, Nitrate/Nitrite 158-71W) except for Phosphate which is modified by separating the Ascorbic Acid (4.0 gms/l) from the Mixed Reagent. This alteration is achieved by

introducing the modified Mixed Reagent instead of water at the start of the sample stream at 0.23 ml/min. and the Ascorbic Acid is pumped 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 subsamples are drawn into 30 ml HDPE (Nalge) wide mouth sample bottles from 10 L Niskins. The bottles are 10% HCL washed, rinsed three times with Super-Q and oven dried at >100 Degrees F.

A sample run includes six Working Standards run at the beginning and end. Duplicate Check Standards are run every 16 samples followed by blanks as a Baseline Check. These Standards are made up in 33 ppt NaCl (VWR,Analar grade) as is the wash water. The Standards are tested against CSK Solution Standards (Sagami Chemical Center, Japan).

Analog data is converted to digital, processed and statistics calculated by a Pascal 7.0 in house program (Logger) on a PC. Chart recordings, hard copy and disk copies of the data are kept for reference.

c. Replicate Analysis

A duplicate sample is drawn from every Niskin. This has resulted in a total of ** duplicate samples for the nutrients.

Samples were collected in duplicate from the rosette bottles into 30 ml acid washed HDPE screw-capped bottles. These were refrigerated until analysis, typically within 12 hours of collection. The water samples were transferred to acid washed 7 ml cups for analysis with the AutoAnalyzer.

Precision is a measure of the variability of individual measurements and in the following analysis two categories of precision are determined; field and analytical precision. Analytical precision is based on the pooled estimate of the standard deviation of the check standards over the course of a complete autoanalyzer run and is a measure of the greatest precision possible for a particular analysis. Field precision is based on the analysis of two or more water samples taken from a single Niskin sampling bottle and has an added component of variance due to subsampling, storage and natural sample variability.

Both categories of precision are determined by computing the variance, σ_i^2, of each replicate set, where i is the index of the replicate set. In the case of analytical (field) precision, a replicate set consists of all the check standards (duplicate samples). Given p replicate sets and n samples within any replicate set, the mean standard deviation, $\overline{\sigma}$, is determined from

$$\overline{\sigma} = \sqrt{\frac{\sum_{i=1}^{p}(n-1)_i \sigma_i^2}{\sum_{i=1}^{p}(n-1)_i}}$$

The precison expressed in percent is based on the mean concentration, M, of the check standards (analytical precision) or water samples (field precision) and is given by

$$P_{\%} = \frac{\overline{\sigma}}{M} \times 100\%$$

The following table indicates the analytical and field precision obtained for this cruise.

	Silicate	Phosphate	NO2+NO3
Number of Samples			
Number of Duplicates			
Mean concentration (μ moles/kg)			
Field Precision (μ moles/kg)			
Field Precision (%)			
Analytical Precision (μ moles/kg)			
Analytical Precision (%)			
Detection Limit (μ moles/kg)			

The laboratory temperature during all analyses was between 18 and 23 °C.

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

The nutrient detection limits noted in the above table were applied to the dataset. All values at or below the detection limits were set to zero.

The following duplicate measurements were used to compute the values given in the SEA file. All values that follow are in micro moles/kg. Conversion to micro moles/kg used a sample temperature of 15°C.

5. Dissolved Inorganic Carbon in Seawater — Bob Gershey

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 an 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 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. If samples are not to be analyzed within four to five hours, the sample is poisoned with 100 μl/250 ml of 50% saturated mercuric chloride solution. The bottle is tightly sealed and stored preferably at the temperature of collection in the dark.

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 in two ways. Calibration using gas loops is accomplished by filling stainless steel sample loops (1.5, 2.5 ml) with 99.995% carbon dioxide gas and injecting these into the coulometer. The temperature and pressure of the gas within the loops must be known to within 0.05 °C and 20 Pa respectively. The system is also calibrated using Certified Reference Materials obtained from the Scripps Institute of Oceanography. 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 **Bob Gershey**

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 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. Values are reported in units of μmol/kg. The overall precision of the analysis is 1.5 μmol/kg for samples with concentrations in the range of 1900-2400 μmol/kg.

7. Halocarbons — Bob Gershey

a. Description of Equipment and Technique

The suite of halocarbon compounds analyzed include the chlorofluorocarbons: CFC-12, CFC-11, CFC-113 and the halocarbons carbon tetrachloride and methyl chloroform. The analyses are carried out on two purge and trap systems developed at the Bedford Institute of Oceanography. The water samples are injected into the systems directly from the syringes used to collect the samples. A minimum of two volumes of water are used to rinse the sample pipette. The samples are purged for four minutes with ultra high purity nitrogen at a flow rate of 80 ml/min. The components are trapped in Porapak-N trap which is cooled to a temperature of less than 10°C. They are then desorbed by heating the trap up to at least 170°C. The contents of the trap are then passed through a 75m DB-624 megabore column. The resolved components exiting the column are quanitified using electron capture detection.

b. Sampling Procedure and Data Processing Technique

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 which are collected from the bottles. The samples are then stored in a water bath of continuously flowing surface sea water until analysis. Air samples are taken in the winch room at the start of the cruise to ensure that it is not contaminated. The analysis of the samples is always completed within 24 hours after they have been drawn. Duplicates are taken at each station, with some of these being run on each system to ensure that the results are comparable.

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 gas standards made up at Brookhaven National Laboratories. The Brookhaven standard has been calibrated against a reference air standard prepared by NOAA/CMDL at Boulder, Colorado. Standard volumes are corrected for lab temperature and pressure. Results are reported in units of pmol/kg of sea water. Clean air samples are also analyzed with each station, as a check on the standardization.

8. Reversing Thermometers

Reversing thermometers were not used since the dual temperature sensors on the Seabird CTD provide a better in the field temperature calibration.

9. Helium/Tritium — Jean Hanley

Jean Hanley on behalf of Peter Schlosser of Lamont-Doherty Earth Observatory, Columbia University, collected a total of 214 He and 205 Tr samples.

a. Description of Equipment and Technique

He samples were collected through tygon tubing into copper tubes (40 g capacity) bolted into aluminum channels for support and protection. Tr samples were collected into one-litre brown glass bottles, directly from the Niskin spigot.

b. Sampling Procedure and Data Processing Technique

He samples were drawn after CFC's and DOC (WOCE parameter 43). Delivery was through tygon tubing, cured in seawater to reduce bubbles, which was monitored for air bubbles. All detected bubbles were worked out of the line. After this, the metal channel holding the copper sample tube was struck several times on one side with a ratchet in a pattern from the intake end towards the outflow end of the copper tube in order to pass any air bubbles out of the sample tube. Flushing of the copper tube took place during both parts of the bubble-removing procedure. When air removal and flushing were complete, both ends of the copper tube were sealed by tightening the two bolts at each end initially with a power drill with a socket adapter and then with a ratchet wrench for the final tightening starting at the outflow end. GMT time of sampling was routinely noted for each sample. These samples will be shipped to Lamont for analysis. Duplicates were drawn on some stations.

Tritium samples were collected into bottles without rinsing or flushing, after all other samples were collected from the rosette. The bottle caps were secured with electrical tape at the completion of each station. These samples will be shipped to Lamont for analysis. Occasionally, the Niskins were drained before the tritium was collected. Careful rinsing of all samples helped alleviate this problem.

Rainwater was collected in a bucket on the ship's flying bridge while the ship was in the Labrador Sea. Two rainwater samples were collected and placed in two Tr bottles with appropriate labels.

Replacement watches were handed out to all persons in the scientific party and the winch drivers who normally wore luminous-dial watches, and a sign was posted at each rosette room door to avoid wearing luminous-dial watches inside the room.

10. Oxygen Isotopes — Jean Hanley

a. Sampling Procedure

Water samples were initially collected using a 10 litre rosette bottle. Samples for oxygen isotope analysis were collected last in the sampling. A total of about 240 isotope samples were drawn into 30 ml bottles. The bottles were sealed with electrical tape after each station. Samples are being sent to Peter Schlosser at Lamont-Doherty Earth Observatory, Columbia University, Palisades, NY.

D. MOORED MEASUREMENTS - DESCRIPTIONS, TECHNIQUES AND CALIBRATIONS

1. Current Meter Moorings — A. J. Hartling

a. Description of the Equipment and Technique

Description of the Moorings

The standard BIO deep sea mooring consists of a large main streamlined subsurface float having 2000 pounds buoyancy holding the mooring as vertical as possible in the water column with minimal drag. Back-up buoyancy is provided throughout the mooring length to float the remaining sections of the mooring should it break at any location. The mooring line consists of ¼ inch plastic impregnated galvanised wire rope terminated at selected locations to allow instruments to be inserted into the mooring. Instruments such as Aanderaa Current Meters, SBE CTD instruments and Benthos 965A deep-sea acoustic releases are installed on the mooring.

The upper two subsurface buoyancy packages are constructed using 17 inch glass balls supported in a streamlined shell. The lower buoyancy package contains similar glass balls in standard "yellow hardhats". Stainless steel shackles and swivels are used to connect the instruments and backup buoyancy packages to the wire lengths. All shackles are secured with a piece of jacketed seizing wire as the mooring is assembled and deployed except for the shackles between the BUB package which are secured with cotter pins. The moorings have been designed for a 12 month deployment.

The mooring is designed to ensure the lower release will remain on location for recovery if any part of the mooring fails and breaks away. Fishing activity, iceberg, or other mechanical failure of the mooring hardware are typical causes of mooring loss. Chain is used below the release to ensure that the mooring wire will part first leaving the release on site. Sufficient Backup buoyancy is provided at the release for recovery. This ensures that parts of the mooring can be recovered for post-mortem analysis of the problems and redesign of future moorings preventing other mooring losses.

A Siemac Argos Mooring Relocation beacon has been installed on the main float for tracking purposes if the mooring should part during the deployment.

b. Sampling Procedure and Data Processing Techniques

The Aanderaa current meters are set with a sampling interval of one hour; the one SEACAT temperature / conductivity recorders were set to 30 minutes, while the two SEACATs with temperature / conductivity / pressure recorders were set to 30 minutes. The four MICROCATS with temperature / conductivity / pressure were set to 15 minutes. On recovery, the data is processed using standard software packages within the BIO Oceans suite of programs.

c. Calibration Data

The temperature and direction sensors of the Aanderaa current meters are calibrated in the laboratory prior to deployment. The SEACAT and MICROCATS instruments are calibrated before and after deployment. These calibrations will not be included in this cruise report.

The deployed SEACATs were calibrated on station 61 of 99022. The recovered SEACATs were calibrated on station 147 or 99022.

d. Deployment and Recovery Logs

Recovery

Mooring No. **M1276**
Ship: Hudson Cruise No: 99 022 Date: 2 July 1999
Mooring Technician: Scotney/Hartling
Type of Nav: GPS
Sea State: 1 metre sea/swell Weather Conditions: light airs
Cancel Notship: Yes _____ No _____

Recovery Log

Time (Z)	Instrument	Remarks
14:32	release	at range of 8 cables sent enable command - no reply
14:34		at range of 7.5 cables sent enable command - no reply
14:36		at range of 7 cables sent enable command - no reply
14:37		at range of 6.5 cables sent enable command - no reply
14:38		at range of 6 cables sent enable command - no reply
14:40		at range of 5.4 cables sent enable command - no reply
14:44		at range of 4 cables sent enable command - no reply
14:45		at range of 3.5 cables sent enable command - release replied, 1266 m slant range, 3.3 cables from mooring position
14:47		1218 m slant range, 501 metres from mooring position
14:51		1140 m slant range, 300 m from mooring position
14:52		1120 m slant range, 213 m from mooring position, vessel stopped
14:53		release command sent - release confirmed - 220 m from mooring position
14:55		slant range 1029 m
15:09		mooring sighted off port beam - coming alongside
15:15		hooked on mooring line between buoyancy packages
	ACM 9328	ACM 9328 out of water - rotor spinning
15:17		hooked onto ring at top of release, CM and associated line fell back into the water as release and double bb brought on board
15:20		hooked onto top float
15:24		all gear on board

Recovery

Mooring No. **M1275**
Ship: Hudson Cruise No: 99 022 Date: 10 July 1999
Mooring Technician: Scotney/Hartling
Type of Nav: GPS - dif
Sea State: 1 metre sea Weather Conditions: 15 knots NE
Cancel Notship: Yes _____ No _____

Recovery Log

Time (Z)	Instrument	Remarks
08:58	EGG 107602	release enable sent / reply 1/2 sec for 1 min, 8 cables from position
09:03		release command sent / reply 1/sec for 1 min
09:09		float at surface
09:21		BUB on surface
09:41		have pick up line
09:42		tag line to happy hooker
09:45		surface buoy out of water, unhooked (there was a SBE39 #32 attached)
09:54	SeaCat 1628	on board
09:56	ACM 6509	on board, rotor freely spinning
10:02	SBE 39 #9, 2 str BUB	on board, instrument imploded
10:07	SeaCat 16 - 1624	on board
10:10	SBE 39 # 10	on board - instrument imploded
10:15	SeaCat 16 - 1829	on board
10:22	ACM 6410	on board, rotor freely spinning
10:28	str BUB	on board
10:31	SeaCat 16 - 1625	on board
10:39	ACM 3299	on board, rotor freely spinning
10:44	2 BUB	on board
10:47	SeaCat 16 - 1623	on board
10:53	ACM 3584	on board, rotor freely spinning
10:58	2BUB	on board
11:02	SeaCat 16 - 1626	on board
11:10	SeaCat 16 - 1627	on board
11:13	ACM 8695	on board, rotor spinning
11:21	BUB	on board
11:28	Benthos 809, ACM 8696	on board all in a tangle, rotor spinning free
11:41	BUB with broken ball	on grapple hook, on board
11:44	BUB & EGG 107602	Hooked with grapple, on board all gear on board

Placement

Mooring No. 1325

Geographic Area: Labrador Sea Intended Duration: 12 months

Ship: Hudson Cruise No: 99 022 Date: 10 July 1999

Sea State: 1 metre sea Weather Conditions: 15/20 knots N

Mooring Technician: Scotney/Hartling Navigation Inst: GPS - diff

Notship # _____ (Maritimes 902-426-6030, Nfld 709-772-2083, Laurentian 418-648-5410)

Latitude: 56° 41.36 N Longitude: 52° 29.73 W Time of Fix: 1720 Z

Depth: Raw: 1880 fths Corrected: 3444 m

Main Float: Type: syntatic foam Markings: 002

Radio Beacon: Type: Argos/ Seimac Freq. S/N 12402

Light: Type: none Colour/Rate: / per second

Mooring Line: Type: ¼ inch jacketed Colour: yellow

Release: Type: Benthos S/N: 888 Release Code: A enable, C release, Rx 11.5, Trns 10.0

Type: Benthos S/N: 883 Release Code: A enable, C release, Rx 11.0, Trns 10.0

Placement Log

Time (Z)	Instrument	Remarks
9 July 14:10	releases 883 & 888	begin release test - lower to 700 m
	Benthos 883	enabled & transponding, disabled
	Benthos 888	enabled & transponding to 733 m, release command sent, confirmation received, disabled
	Benthos 883	enabled, release command sent, confirmation received
10 July 13:30	anchor	swung over the rail and secured
13:55	top float, μCat 0861	over side / in water / float pulling to starboard,, cannot get wire junction back into chute
14:01	ACM 2663	in water / rotor OK, 148 m wire
14:06	μCat 0862	in water, 246 m wire
14:12	μCat 0863	in water, 248 m wire
14:18	ACM 3300	in water, rotor OK, 121 m wire
14:22	2 str BUB	in water, 124 m wire
14:26	μCat 0864	in water, 247 m wire
14:31	ACM 4406	in water, rotor OK, 121 m wire
14:35	2 str BUB	in water, 124 m wire
14:39	SeaCat 2393	in water, 247 m wire
14:45	ACM 4600	in water, rotor OK, 120 m wire
14:48	2 BUB	in water, 124 m wire, jacket nicked through to wire 1 metre from termination, taped.
14:51	SeaCat 2395	in water, 486 m wire
15:02	SeaCat 2398	in water, 9 m wire
15:02	ACM 4998	in water, rotor OK, 435 m wire
15:08	2BUB	in water, 256 m wire
15:13	Benthos 888	in water, 125 m wire
15:16	2 BUB	in water, 134 m wire
15:20	ACM 7134	in water, rotor OK, 20 m wire
15:24		on slip line to chain
15:25	3 BUB, Benthos 883	in chute, hooked to mooring line and anchor chain, slip lined into water
15:39		anchor away depth 1880 Fathoms, 3444 metres

		56 41.4258 52 29.7478
15:40	Benthos 883	enabled and tracking descent on sounder
16:40	Benthos 883	on bottom
16:39		closest approach 56 41.39 N 52 29.66 W
17:20		closest approach 56 41.33 N 52 29.80 W
		best position **56 41.36 N 52 29.73 W**
17:28	Benthos 883	Disable command sent / disabled

Placement

Mooring No. 1326

Geographic Area: Labrador Sea Intended Duration: 12 months

Ship: Hudson Cruise No: 99 022 Date: 2 / July/ 99

Sea State: light sea / 1 m swell Weather Conditions: light wind

Mooring Technician: Scotney/Hartling Navigation Inst: GPS

Notship # _____ (Maritimes 902-426-6030, Nfld 709-772-2083, Laurentian 418-648-5410)

Latitude: 55° 7.337 N Longitude: 54° 5.617 W Time of Fix: 16:56 Z / 17:11 Z

Depth: Raw: 606 fths Corrected: 1116 m

Main Float: Type: Hibernia Markings: none

Radio Beacon: Type: none Freq. _____

Light: Type: Novatech Colour/Rate: white / 1 per 2 second

Mooring Line: Type: ¼ inch jacketed Colour: yellow

Release: Type: Benthos S/N: 890 Release Code: C Receive 10.5, Transmit 10.0

Placement Log

Time (Z)	Instrument	Remarks
15:55	release 890	at 200 m on hydrowire / passed all its tests, enable, transpond, release
16:14		mooring all hooked together on foredeck / at position, swinging anchor outboard
16:22	release 890	anchor / release / 2bb secured out over the rail
16:26	ACM 4208	top float & CM 4208 in water, rotor spinning
16:28		anchor away
16:29		position 55 7.369 N 54 5.701 W, sounding (corrected) 1070m from winch room sounder (Hull transducer)
16:42		anchor on bottom
16:56		closest range was 1098 m at position of 55 7.3487 N 54 5.6105 W
17:11		closest range was 1098 m at position of 55 7.3257 N 54 5.6234 W, 606 fathoms, 1098 m from forward lab sounder on the ram best mooring position 55 7.337 N 54 5.617 W depth of 606 fathoms
17:38		ranged on release out to 1.5 n miles departing mooring site at 4 knots

E. ACKNOWLEDGEMENTS

F. APPENDICES

Appendix 1: Along Track CTD Calibration Information

BSB SEABIRD Model 25-03 Serial Number 258917-0116

Temperature Sensor 031548

$$T = 1/\{a + b[\ln(f_o/f)] + c[\ln^2[f_o/f] + d[\ln^3(f_o/f)]\} - 273.15$$

where ln indicates a natural logarithm, f is the frequency

a = 3.68120903 E-03
b = 6.05726873 E-04
c = 1.57453931 E-05
d = 2.37605653 E-06
f_o = 6145.410
slope = 1, offset = 0(Seabird calibration dated November 2, 1993)

Conductivity Sensor 041124

$$\text{Conductivity} = (af^m + bf^2 + c + dt)/[10(1-9.57(10^{-8})p)]$$

where f is the frequency, p is pressure in dbars, t is the temperature

m = 4.4
a = 7.91164000 E-06
b = 4.91698742 E-01
c = -4.03526125 E+00
d = 6.64743265 E-05
Slope = 1.00000000
Offset = 0.000

Irradiance Sensor 1567

where

m = -0.7558000
b = -3.4702000
Calibration Constant = 3.34000
Multiplier = 1.000

Fluorometer Sensor 304

where

Scale Factor = 10.000
Offset = 0.000

NT Servers

This was the first deep ocean cruise to use the recently acquired HP NT NetServers (Model LH3 PII 400). These servers have replaced the MicroVAX systems first used in 1986. The HP servers provide Science staff with 12 G bytes of disk space are mirrored internally and operate in parallel. Science backups on the servers were easy and rapid using the HP DAT tapes. Printing to both the HP LaserJet 4000 and the HP Draftmaster was much easier than in previous years.

Most science computers were connected to the network using dynamic IP allocation. However, UNIX workstations and PCs connecting to these workstations used a bank of 20 static IPs. The transition from the land to ship based networks continues to provide frustration from inconsistent network connections, and lack of shore-ship application access commonality. More integration of the land and shore based systems would improve the portability of computers and thus benefit science staff.

Areas for potential improvement for the future include email and network connections to the laboratories in containers. The email access would provide improved communication with shore based resources. Network connections available in the containers would provide science staff with added flexibility and information regarding past, current and planned science operations.

Seasave for Windows NT/95

At the beginning of the 1999 field season, the CTD logging PCs were upgraded to PII 300 MHz computers with Windows 95. This provided the necessary platform for use of the Seabird Seasave for Windows software. Initial cruises in the season used Seasave version 1.08. On this cruise, Seasave Ver. 1.10 was the logging software. The processing software continued to be Seasoft for DOS, Ver. 4.232.

The Windows Seasave provided much more flexible for display of the logged CTD trace. The multiple document interface allowed operators to customise the environment for their particular interests. This is a welcomed functional addition. Problems of an unchanging temperature trace were encountered on two casts. Opening another plot window appeared to reactivate the temperature trace. However, this does reduce our confidence in the software's ability.

A colour printer has also become part of the standard shipboard CTD logging equipment. A HP 882C colour printer connected directed to the logging PC was used on initial casts. However, during printer data loss occurred as a result of the deck unit buffer going from the standard 20500 bytes to 0. On some casts, up to 5 seconds of data loss occurred. To correct this problem, we moved the HP 882C from the logging PC to the NT server, and printed via the network. The printer was connected directly to the parallel port of the server, since no network connection exists on the printer. After this change, print jobs did not case any data loss. In terms of the deck unit buffer, the print jobs caused a decrease from 20500 to about 18000 bytes.

ODIN

The Ocean Data and Information system (ODIN) is a shipboard database application for tracking and collecting the metadata and water sample data associated with an oceanographic cruise. ODIN was beta tested last year, during 98023 in the Labrador Sea. The system was implemented on 99022 as an operational system. Our standard paper based system was maintained in parallel to ODIN.

As with most software/hardware implementations, operational use uncovers technical issues not accounted for. In the case of ODIN, the majority of these issues were trivial dealing with output formatting, mouse related resource activity indicators, etc. However, three issues involved detailed thought, these being:

- the ability to spontaneously increase the number of rosette bottles to close on a particular cast
- the ability to have other groups use a block of sample ID numbers above or below the block being used by the CTD operations, and to include sample data from this block in ODIN
- the ability to ensure maintenance of planned sampling strategy from past operations

Only the last point required a modification to the ODIN data model. The modification represents a change of about 2% to the initial model as specified in 1996.

ODIN has the capacity to provide staff with improved information related to the science activities and data on a research cruise. It provides a “complete cruise” representation of activities, rather than a group or program perspective. ODIN is close, but not yet at a stage permitting operational release. The largest issue to be dealt with is improved planned sampling. This cruise, which included the collection of 22 different water sample parameters, provided ODIN with an operational extreme, that if addressed properly, will strengthen the system for not only the large sampling cruises but also the smaller sampling cruises.

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