WHP Cruise Summary Information

WOCE section designation	A24
Expedition designation (EXPOCODE)	316N151_2
Chief Scientist(s) and their affiliation	Lynne Talley, SIO
Dates	1997.05.30 – 1997.07.05
Ship	KNORR
Ports of call	Ponta Delgada, Azores to Halifax, Nova Scotia
Number of stations	153

Geographic boundaries of the stations

$$97˚64.8''N$$
$$98˚42.9''W \qquad 49˚9.3''W$$
$$01˚38.8''N$$

Floats and drifters deployed	12 PALACE floats and 17 RAFOS floats
Moorings deployed or recovered	1 RAFOS source (also 2 RAFOS sources on initial transit)
Contributing Authors (in order of appearance)	F. Delahoyde
	K. Sanborn
	E. Firing
	M. Vollmer
	L. Arlen
	S. Khatiwala

WHP Cruise and Data Information

Instructions: Click on items below to locate primary reference(s) or use navigation tools above.

Cruise Summary Information	Hydrographic Measurements
Description of scientific program	CTD - general
	CTD - pressure
Geographic boundaries of the survey	CTD - temperature
Cruise track (figure)	CTD - conductivity/salinity
Description of stations	CTD - dissolved oxygen
Description of parameters sampled	
	Salinity
Floats and drifters deployed	Oxygen
Moorings deployed or recovered	Nutrients
	CFCs
Principal Investigators for all measurements	Helium
Cruise Participants	Tritium
	CO2 system parameters
	Other parameters
Navigation	
Bathymetry	
Acoustic Doppler Current Profiler (ADCP)	

Cruise report for WOCE A24
Knorr 151, leg 2:   Ponta Delgada, Azores to Halifax, NS, Canada

A.   Cruise Narrative

Ship: R/V KNORR operated by Woods Hole Oceanographic Institution
Ports: Ponta Delgada, Azores to Halifax, NS, Canada
Dates: 30 May 1997 depart Ponta Delgada, 5 July 1997 arrive Halifax
WOCE Designator: 316N151_2
Chief Scientist: Lynne D. Talley
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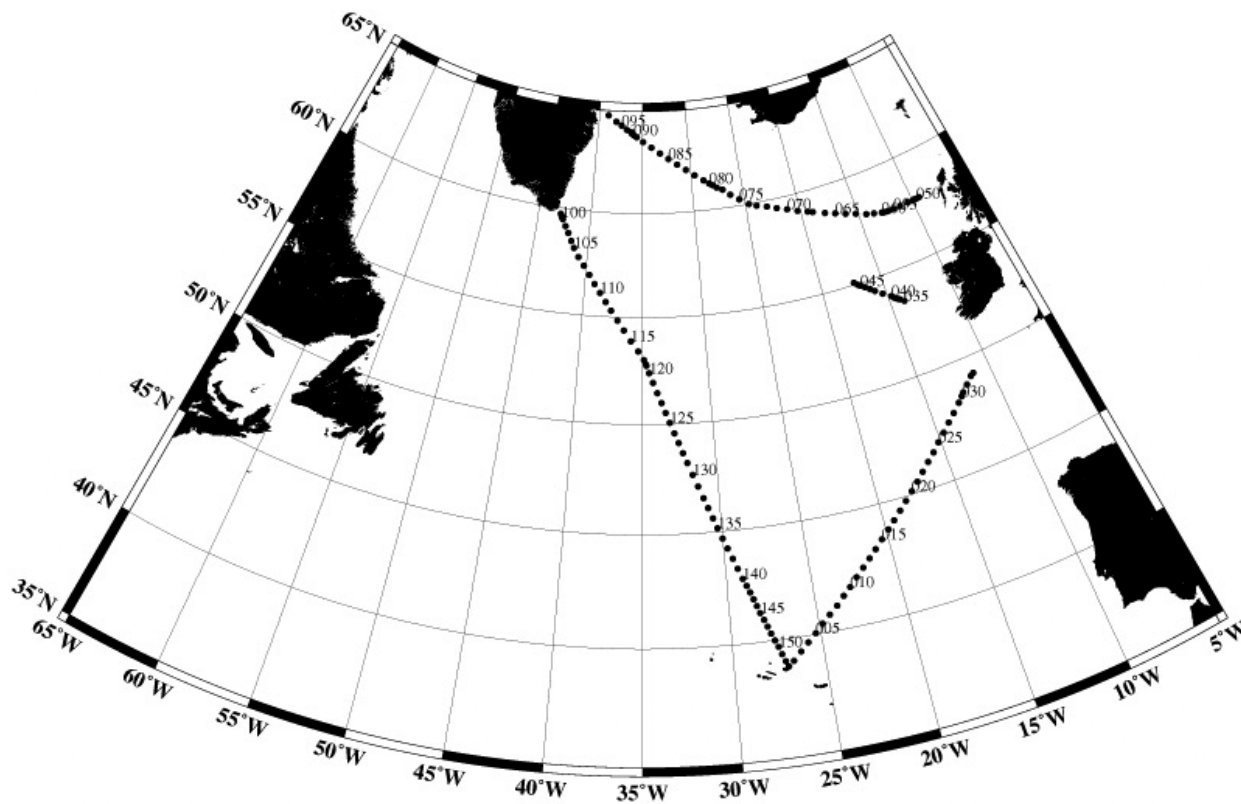
WOCE A24 Cruise Track

A hydrographic survey consisting of CTD/rosette sections between the Azores and Greenland was carried out May to July, 1997. The R/V Knorr departed Ponta Delgada, Azores on 30 May 1997. 153 CTD/Rosette stations were occupied from 30 May through 28 June. Water samples (up to 31) and CTD data were collected in most cases to within 10 meters of the bottom, for a total of 3450 bottles. Salinity, dissolved oxygen and nutrient samples were

analyzed from every level sampled by the rosette. The cruise ended in Halifax, Nova Scotia on 5 July 1997. 1 URI RAFOS Mooring, 12 ALACE floats, 17 Rafos floats, and 45 XBT's were deployed during the cruise. Two RAFOS moorings were also deployed on the transit from Woods Hole to Ponta Delgada.

These sections are part of the WOCE Atlantic Climate Change Experiment, and their purpose is to assist in measuring the upper water transports in the eastern subpolar gyre, including those which feed the Norwegian Sea and the Labrador Sea, and to observe the overflows from the Greenland-Iceland-Norwegian Seas in the Denmark Strait, Iceland Basin and Rockall Trough. Primary measurement programs included hydrography (CTDO, salinity, oxygen, nutrients, CFC's, carbon dioxide, helium, tritium), and velocity (shipmounted ADCP, lowered ADCP, neutrally buoyant floats ALACE and RAFOS). A RAFOS sound source mooring was placed during the Greenland-Azores leg of the cruise.

A transit leg to the Azores left from Woods Hole, MA on May 15, 1997, with chief scientist Tom Rossby. Underway to Ponta Delgada, two RAFOS sound source moorings were deployed, at 47°N, 39°W and 47°N, 31°W.

Four sections were completed as part of the main cruise. After departing Ponta Delgada, we sailed to Terceira, Azores and began the first section there, proceeding northeastward towards the Goban Spur. Upon completion of the first section, we diverted into the harbor in Cork, Ireland, for an emergency exchange of crewmembers. The time associated with this was approximately 22 hours beyond that which was expected for a direct transit to the next section.

The first section crossed the Mediterranean Water/Labrador Sea Water mixing zone obliquely, with large variations between groups of station dominated by Mediterranean Water and those dominated by Labrador Sea Water.

The second (short) section crossed the southern Rockall Trough, from Porcupine Bank to the southern end of Rockall Bank. Due to time limitations imposed by the emergency trip to Cork, the full set of short sections occupied near Porcupine Bank in November 1996 were not repeated. The northernmost section was angled more northwest-southeast than in fall, 1996, in order to reach a portion of Rockall Bank which would still allow a boundary for the Wyville Thomson overflow, which was found below 1200 meters in the northern part of Rockall Trough. This strategy was successful, and overflow water was found on our short section, hugging Rockall Bank.

The third section crossed the northern part of the subpolar gyre, from the Hebrides to Rockall Bank, to Hatton Bank, to the Reykjanes Ridge and to Greenland near Angmassalik. The eastern end of this section was moved north from that in November 1996 because the Meteor (chief scientist Walter Zenk) completed a section identical to the November section in May, 1997, just weeks before our arrival in the area. Therefore we chose to cross Rockall Trough farther north, just north of Anton Dohrn Seamount. The relocated section joined the original section in the middle of the Iceland Basin and then exactly duplicated the November, 1996 section to Greenland. Ice conditions at Greenland were favorable, and stations were

completed well up onto the deep shelf (average depth 500 meters), although not as far west as in November, 1996. This section as a whole clearly delineated the overflow waters in each of the three troughs Irminger Basin, Iceland Basin and Rockally Trough.

After a transit southward to Cape Farewell, Greenland, the fourth section was completed from Cape Farewell southeastward to the Charlie Gibbs Fracture Zone (CGFZ), and thence to Terceira. Time permitted an additional station in the CGFZ, allowing the cross-channel velocity (LADCP) and temperature/salinity structure to be delineated and a geostrophic velocity profile to be computed. Full water column bottle sampling was not included on the northern station. Time permitted additional stations on the southern end of the section. The last station was a double cast, with the first cast being a test of LADCP bottom tracking, and the second cast being the complete cast with bottle sampling.

Measurement Programs

The principal programs of A24 are shown in Table A.1. The SIO ODF hydrographic measurements program is described in section 1 following. Section 2 describes the ADCP/LADCP program, section 3 the CFC program, section 4 the alkalinity program, section 5 the CO_2 program (no information included), and section 6 the helium/tritium/^{18}O program.

Analysis	Institution	Principal Investigator
Basic Hydrography (Salinity, O_2, Nutrients, CTD)	SIO	Lynne Talley
CFC	SIO	Ray Weiss
He/Tr/^{18}O	LDEO	Peter Schlosser
TCO_2	BNL	Doug Wallace
TCO_2 (reference samples)	SIO	Charles Keeling
Alkalinity	UH/RSMAS	Frank Millero
Transmissometer	TAMU	Wilf Gardner
ADCP and LADCP	UH	Eric Firing, Peter Hacker
PALACE/SOLO Floats	SIO	Russ Davis
RAFOS Floats	WHOI	Amy Bower, Phil Richardson
RAFOS Floats/Moorings	URI	Tom Rossby, Mary Elena Carr & Mike Prater
pCO_2	LDEO	Taro Takahashi, Dave Chipman
UW pH, TCO_2 (Transit only)	WHOI	Catherine Goyet
UW pH, TCO_2	BNL	Doug Wallace
UW Meteorology/XBTs	WHOI	Barry Walden
UW Thermosalinograph	SIO	Lynne Talley
UW Sea surface & air gas analysis, pCO_2, pN_2O, pCH_4, CH_4, CO_2, N_2O	SIO	Ray Weiss

Table A.1 Principal Programs of WOCE A24

Scientific Personnel		
Name	**Affiliation**	**Duties**
Talley, Lynne	SIO/PORD	Chief Scientist
Arlen, Linda	LDEO	TCO_2
Becker, Susan	SIO/STS/ODF	Nutrients
Boaz, John	SIO/STS/ODF	Watch Leader/O_2/Rosette/Bottle data
Chen, Shuiming	UH	ADCP/LADCP
Costello, Lawrence	WHOI	Mooring, RAFOS Floats, Rosette
Delahoyde, Frank	SIO/STS/ODF	CTD data Processing
Firing, Eric	UH	ADCP/LADCP
Galanter, Meredith	UM/RSMAS	Alkalinity
Goen, Jamie	UM/RSMAS	Alkalinity
Ha Min, Dong	SIO/GRD	CFC
Johnson, Kenneth	BNLT	CO_2
Khatiwala, Samar	LDEO	Helium, Tritium, O-18
Lavender, Kara	SIO/PORD	CTD Console/Sample Cop/Salinities/Rosette
Mask, Andrea	FSU	CTD Console/Sample Cop/Salinities
Masten, Douglas	SIO/STS/ODF	Nutrients
Mattson, Carl	SIO/STS/ODF	TIC/Watch Leader/ET/Rosette
Newton, David	SIO/MLRG	CTD Console/Rosette/Sample Cop
Packard, Greg	WHOI	SSSG Technician
Rusk, Steven	SIO/STS/ODF	O_2/Rosette
Sanborn, Kristin	SIO/STS/ODF	Bottle data/Salinities/Rosette/O_2
Smith, Daniel	LDEO	Helium, Tritium, O-18
Van Woy, Frederick	SIO/GRD	CFC
Vollmer, Martin	SIO/GRD	CFC
Wilson, Angela	LDEO	pCO_2

Table A.2 Scientific Personnel WOCE A24

1.   Hydrographic Measurements Program

The hydrographic measurements program consisted of salinity, dissolved oxygen and nutrient (nitrite, nitrate, phosphate and silicate) measurements made from bottles taken on CTD/rosette casts plus pressure temperature, salinity and dissolved oxygen from CTD profiles. Rosette casts were made to within 10 meters of the bottom. No major problems were encountered during the operation. The resulting data set met and in many cases exceeded WHP specifications. The distribution of samples is illustrated in figures 1.0-1.3.
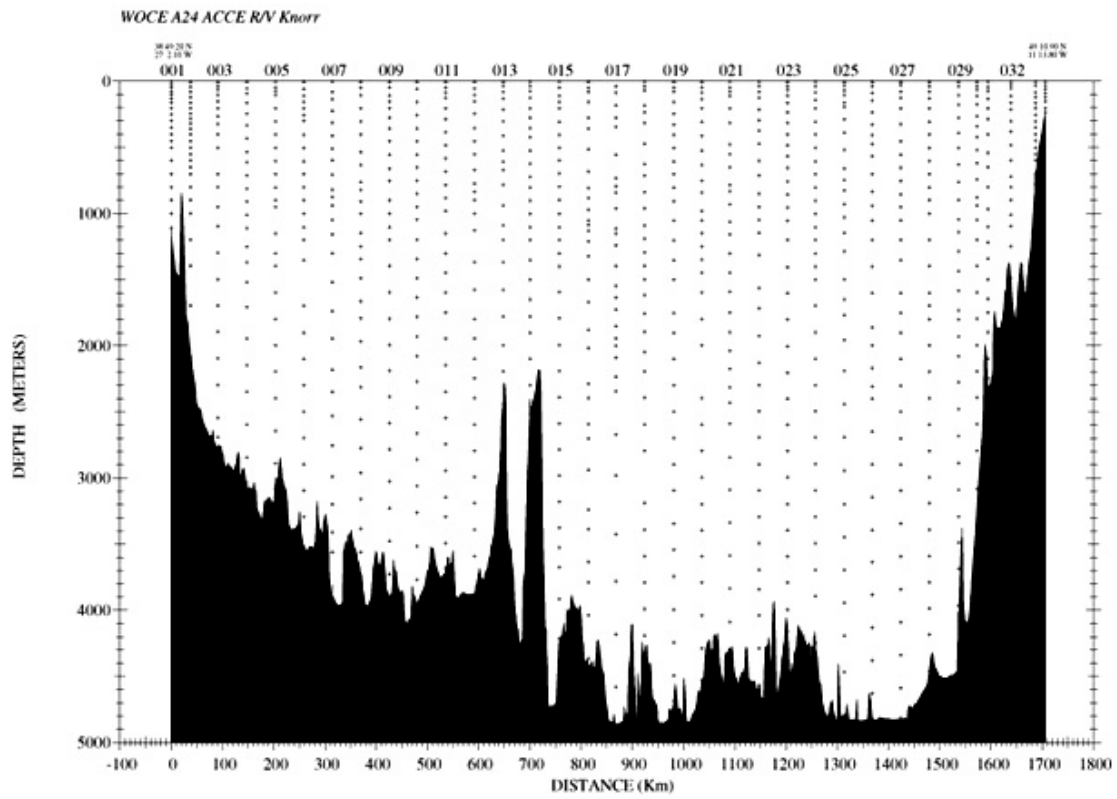
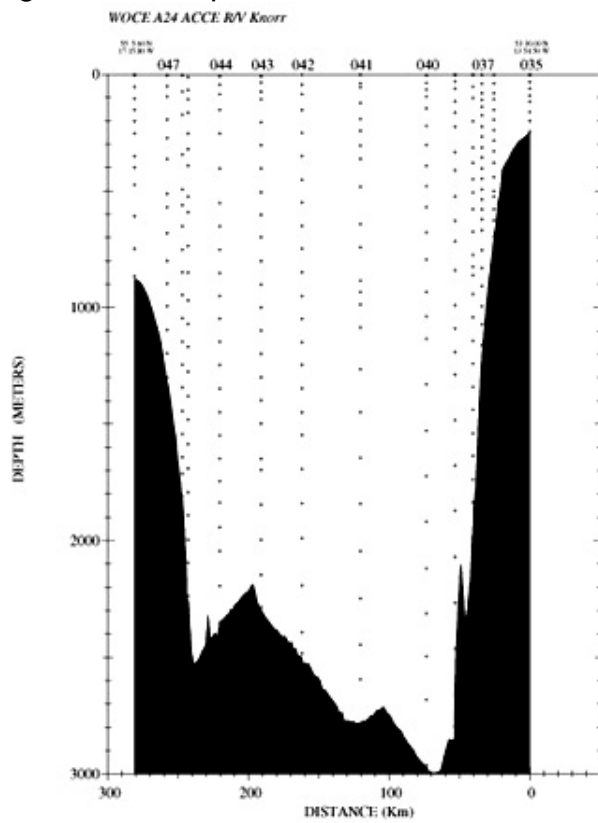Figure 1.0 Sample distribution, stations 1-34.

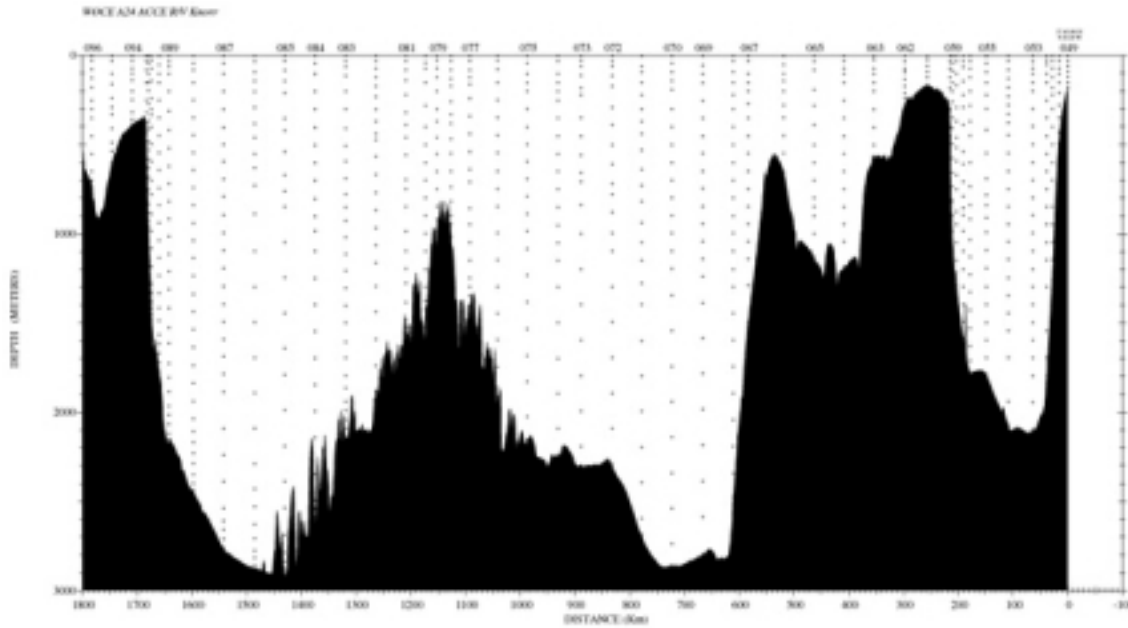Figure 1.1 Sample distribution, stations 35-48.

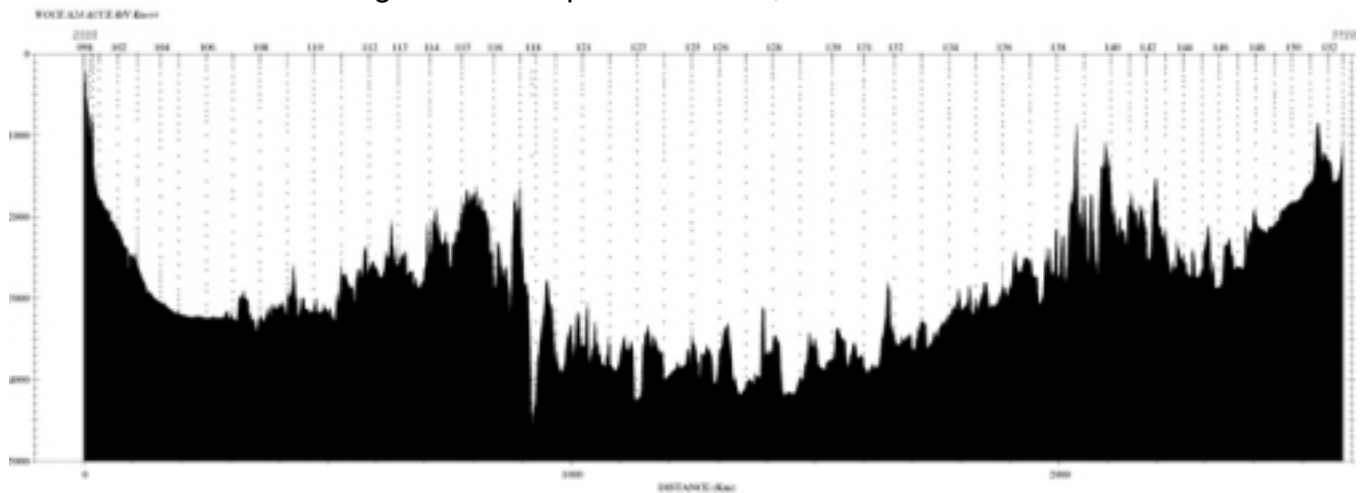Figure 1.2 Sample distribution, stations 49-97.

Figure 1.3 Sample distribution, stations 98-153.

Description of Measurement Techniques

1.1. Water Sampling Package

Hydrographic (rosette) casts were performed with a 36-place 10-liter rosette system consisting of a 36-bottle rosette frame (ODF), a 36-place pylon (General Oceanics 1016, SBE 32) and 31 10-liter PVC bottles (ODF). Underwater electronic components consisted of an ODF-modified NBIS Mark III CTD with dual conductivity and temperature sensors, SeaTech transmissometer, RDI LADCP, Simrad altimeter and Benthos pinger. The CTD was mounted horizontally along the bottom of the rosette frame, with the transmissometer, dissolved oxygen and SBE 35 PRT sensors deployed alongside. The LADCP was mounted vertically, inside the rosette frame bottle rings. The Simrad altimeter provided distance-above-bottom in

the CTD data stream. The Benthos pinger was monitored during a cast with a precision depth recorder (PDR) in the ship's laboratory. The rosette system was suspended from a new three-conductor 0.322" electromechanical (EM) cable which was installed prior to the ship's departure from Woods Hole. Power to the CTD and pylon was provided through the cable from the ship. Separate conductors were used for the CTD and pylon signals with the General Oceanics 1016 pylon (casts 001/01-010/01). A single conductor was used with the SBE 32 pylon and SBE 33 deck unit (casts 011/01-153/02).

The rosette system was deployed from the starboard side hangar, using an air-powered cart to move the rosette into the sampling area. The portside Markey CTD winch was used throughout the leg.

The deck watch prepared the rosette 45 minutes prior to a cast. All valves, vents and lanyards were checked for proper orientation. The bottles were cocked and all hardware and connections rechecked. Upon arrival on station, time, position and bottom depth were logged and the deployment begun. The rosette was moved into position under a projecting boom from the rosette room using an air-powered cart on tracks. Two stabilizing tag lines were threaded through rings on the frame. CTD sensor covers were removed and the pinger turned on. Once the CTD acquisition and control system in the ship's laboratory had been initiated by the console operator and the CTD and pylon had passed their diagnostics, the watch leader would verify with the bridge that deployment could begin. The winch operator would raise the package and extend the boom over the side of the ship. The package was then quickly lowered into the water, the tag lines removed and the console and winch operators notified by radio of the target depth (wire-out).

During each cast, the rosette was lowered to 5-10 meters above the bottom. Bottles on the rosette were identified with unique serial numbers. These numbers corresponded initially to the pylon tripping sequence 1-31, the first trip closing bottle #1. No bottles were changed during the leg.

Averages of CTD data corresponding to the time of bottle closure were associated with the bottle data during a cast. Pressure, depth, temperature, salinity and density were immediately available to facilitate examination and quality control of the bottle data as the sampling and laboratory analyses progressed.

At the end of the cast, two tugger lines terminating in large snap hooks were mounted on poles and used by the deck watch to snag recovery rings on the rosette frame. The package was then lifted out of the water, the boom retracted, and the rosette lowered onto the cart. Sensor covers were replaced, the pinger turned off and the cart and rosette moved into the rosette room for sampling. A detailed examination of the bottles and rosette would occur before samples were taken, and any extraordinary situations or circumstances noted on the sample log for the cast.

Rosette maintenance was performed on a regular basis. O-rings were changed as necessary and bottle maintenance performed each day to insure proper closure and sealing. Valves were inspected for leaks and repaired or replaced.

1.2. Underwater Electronics Packages

CTD data were collected with modified NBIS Mark III CTDs (ODF CTD #3, #5). CTD #3 was used on a single cast (001/01). An unstable PRT temperature channel was traced to a small leak in the PRT turret and was repaired. CTD #3 was subsequently maintained as the backup CTD. CTD #5 was deployed on all other casts (002/01-153/02). This instrument provided pressure, temperature, conductivity and dissolved O_2 channels, and additionally provided redundant PRT temperature and conductivity channels. Other data channels included elapsed-time, an altimeter, several power supply voltages, a second dissolved O_2 channel and a transmissometer. The instrument supplied a standard 17-byte NBIS-format data stream at a data rate of 20 fps. Modifications to the instrument included revised pressure and dissolved O_2 sensor mountings; ODF-designed sensor interfaces for O_2 and the SeaTech transmissometer; implementation of 8-bit and 16-bit multi-plexer channels; an elapsed-time channel; instrument id in the polarity byte and power supply voltages channels. The instrument sensor configuration is provided in Table 1.2.0.

Sensor	Manufacturer	Serial	Notes
Pressure	Paine 211-35-440-05	77017	Primary
Temperature	Rosemount 171BJ	15407	Primary
Conductivity	GO 09035-00151	E197	Primary
Temperature	Rosemount 171BJ	15046	Secondary
Conductivity	GO 09035-00151	E184	Secondary
Dissolved O_2	SensorMedics	6-02-07	Primary
Dissolved O_2	Royce		Secondary, experimental

Table 1.2.0 CTD #5 sensor configuration data.

The CTD pressure sensor mounting had been modified to reduce the dynamic thermal effects on pressure. The sensor was attached to a length of coiled, oil-filled stainless-steel tubing threaded into the end-cap pressure port. The transducer was also insulated. The NBIS temperature compensation circuit on the pressure interface was disabled; all thermal response characteristics were modeled and corrected in software.

The SensorMedics O_2 sensor was deployed in a pressure-compensated holder assembly mounted separately on the rosette frame and connected to the CTD by an underwater cable. The O_2 sensor interface was designed and built by ODF. A second, experimental O_2 sensor (Royce) was also deployed to collect some comparison data.

A SBE 35 Laboratory-grade reference PRT was employed as an additional temperature calibration check. This device is internally-recording and triggered by the SBE 32 pylon confirmation signal, providing a calibration point for each bottle trip.

Standard CTD maintenance procedures included soaking the conductivity and O_2 sensors in distilled water between casts to maintain sensor stability, and protecting the CTD from exposure to direct sunlight or wind to maintain an equilibrated internal temperature.

A General Oceanics 1016 36-place pylon was employed for the first 10 casts, then was replaced by a SBE 32 36-place pylon and SBE 33 deck unit for the rest of the cruise. The SBE 32 has the advantage of requiring a single sea cable conductor for power and signals, in contrast to the 2 required for the General Oceanics 1016. It also provides for the use of the SBE 35 reference PRT. Both pylons provided generally reliable operation and positive confirmation of all bottle trip attempts. A software configuration problem that caused some erroneously reported trip failures was corrected by station 27.

1.3. Navigation and Bathymetry Data Acquisition

Navigation data were acquired from the ship's Trimbal Pcode GPS receiver via RS-232. It was logged automatically at one minute intervals by one of the Sun Sparcstations. Underway bathymetry was acquired from the ship's SeaBeam system (center beam depth) at five-minute intervals, then merged with the navigation data to provide a time-series of underway position, course, speed and bathymetry data. These data were used for all station positions, PDR depths, and for bathymetry on vertical sections [Cart80].

1.4. CTD Laboratory Calibration Procedures

Laboratory calibrations of the CTD pressure and temperature sensors were used to generate tables of corrections applied by the CTD data acquisition and processing software at sea.

Pressure and temperature calibrations were last performed on CTD #5 at the ODF Calibration Facility (La Jolla) in April, 1997, prior to WOCE A24.

The CTD pressure transducer (Paine 211-35-440-05 8850 psi, Serial #77017) was calibrated in a temperature-controlled water bath to a Ruska Model 2400 Piston Gauge pressure reference. Calibration curves were measured at -0.39 and 11.57°C to two maximum loading pressures (1191 and 6081 db). Figure 1.4.0 summarizes the laboratory pressure calibration performed in April, 1997.

CTD PRT temperatures were calibrated to a NBIS ATB-1250 resistance bridge and Rosemount standard PRT. The primary (Rosemount 171BJ, Serial #15407) and secondary (Rosemount 171BJ, Serial #15046) CTD temperatures were offset by 1.5C to avoid the 0-point discontinuity inherent in the internal digitizing circuitry. Figure 1.4.1 summarizes the laboratory temperature calibration performed on the primary PRT April, 1997.
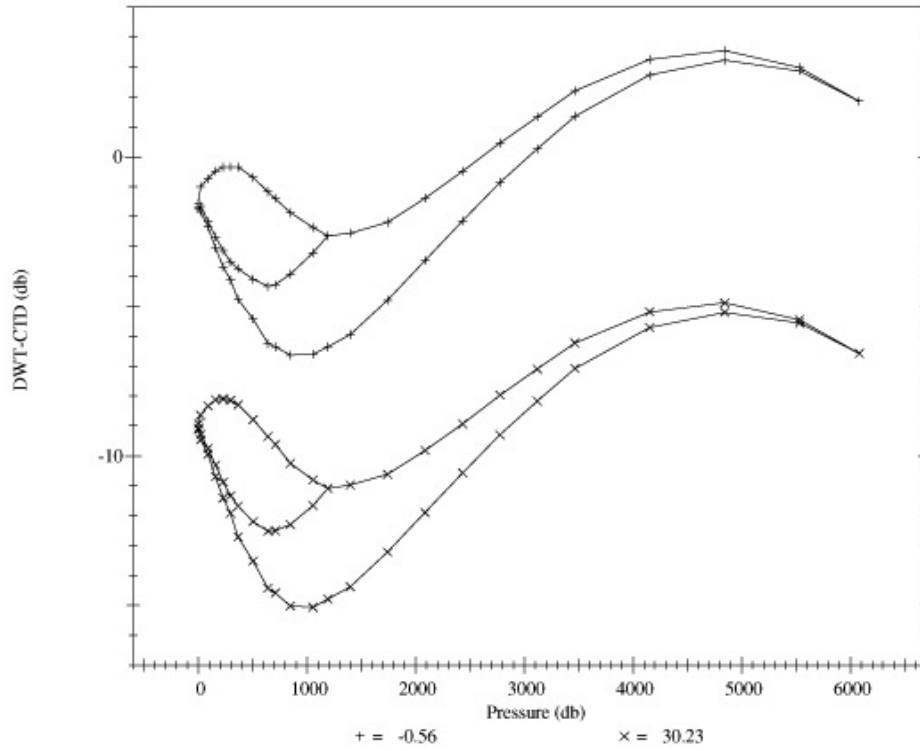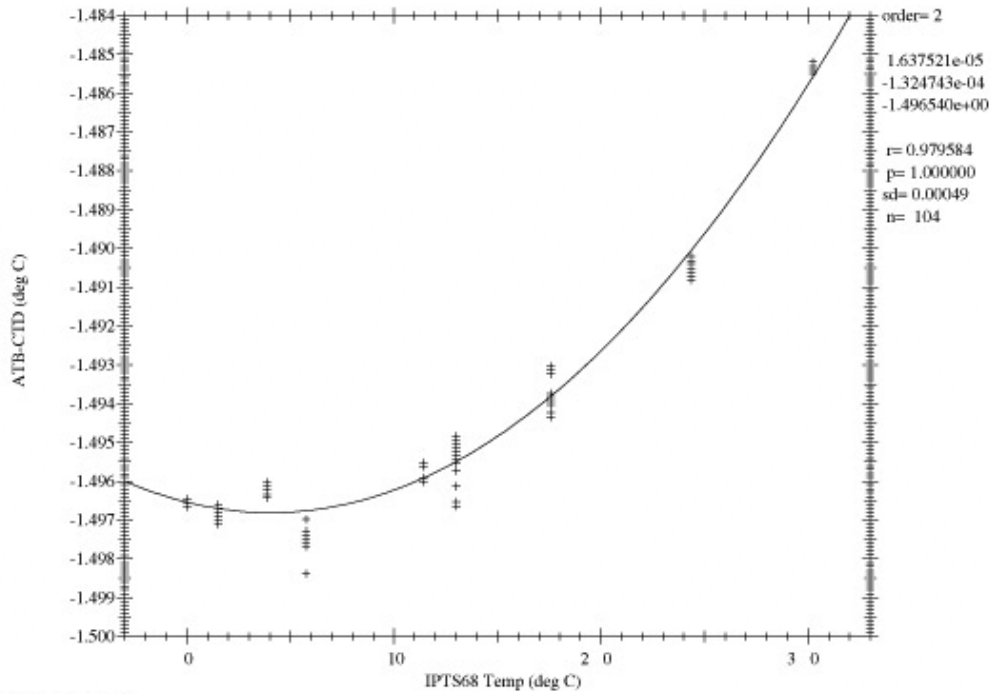
+ = -0.56   × = 30.23

Figure 1.4.0 Pressure calibration for ODF CTD #5, April 1997.

ODF CTD #5 04/97

Figure 1.4.1 Temperature calibration for ODF CTD #5, April 1997.

These calibration procedures will be repeated when the instrument is returned to ODF.

1.5.   CTD Data Acquisition, Processing and Control System

The CTD data acquisition, processing and control system consisted of a Sun SPARCstation 5 computer workstation, ODF built CTD deck unit, SBE 33 pylon deck unit and power supply and a VCR recorder for real-time analog backup recording of the sea cable signal. The Sun system consisted of a color display with trackball and keyboard (the CTD console), 18 RS-232 ports, 4.5 GB disk and 8-mm cartridge tape. Two other Sun systems (one Sparc 5, one Sparc LX) were networked to the data acquisition system, as well as to the rest of the networked computers aboard the Knorr. These systems were available for real-time CTD data display as well as providing hydrographic data management and backup. An HP 1200C color inkjet printer provided hardcopy from any of the workstations.

The CTD FSK signal from the sea cable was demodulated and converted to a 9600 baud RS-232˚C binary data stream by the CTD deck unit. This data stream was fed to the Sun SPARCstation. The pylon deck unit was also connected to the Sun through a bi-directional 300 baud serial line, allowing rosette trips to be initiated and confirmed through the data acquisition software. A bitmapped color display provided interactive graphical display and control of the CTD rosette sampling system, including real-time raw and processed data displays, navigation, winch and rosette trip displays.

The CTD data acquisition, processing and control system was prepared by the console watch a few minutes before a deployment. A console operations log was maintained for each deployment, containing a record of every attempt to trip a bottle as well as any pertinent comments. Most CTD console control functions, including starting the data acquisition, were performed by pointing and clicking a trackball cursor on the display at pictures representing functions to perform. The system would then present the operator with a short dialog prompting with automatically-generated choices that could either be accepted as default or overridden. The operator was instructed to turn on the CTD and pylon power, then to examine a real-time CTD data display on the screen for stable voltages from the underwater unit. Once this was accomplished, the data acquisition and processing was begun and a time and position automatically associated with the beginning of the cast. The backup analog recording of the CTD signal on a VCR tape was started. A rosette trip display and pylon control window popped up, giving visual confirmation that the pylon was initializing properly. Various plots and displays were initiated. When all was ready, the console operator informed the deck watch by radio.

Once the deck watch had deployed the rosette, the deck watch leader provided the winch operator with a target depth (wire-out) and lowering rate (normally 60 meters/minute or less for this package).

The console operator would examine the processed CTD data during descent via interactive plot windows on the display, which could also be initiated from other workstations on the network. Additionally, the operator would decide where to trip bottles on the up cast, noting this on the console log. The PDR was monitored to insure the bottom depth was known at all times.

The rosette distance above the bottom was monitored by the deck watch leader using the distance between the rosette pinger signal and its bottom reflection displayed on the PDR. The winch, altimeter and PDR displays allowed the watch leader to refine the target depth relayed to the winch operator and safely approach to within 10 meters of the bottom.

Bottles would be closed on the up cast by pointing the console trackball cursor at a graphic firing control and clicking a button. The data acquisition system would respond with the CTD rosette trip data and a pylon confirmation message in a window. All tripping attempts were noted on the console log. The console operator would then direct the winch operator to the next bottle stop. The console operator was also responsible for generating the sample log for the cast.

After the last bottle was tripped, the console operator would inform the deck watch and the rosette would be brought on deck. Once on deck, the console operator would terminate the data acquisition and turn-off the CTD, pylon and VCR recording. The VCR tape was filed. Frequently the console operator would also bring the sample log to the rosette room and serve as the sample cop.

1.6. CTD Data Processing

ODF CTD processing software consists of some 35-odd programs running under the Unix operating system. The initial CTD processing program (ctdba) is used either in real-time or with existing raw data sets to:

- Convert raw CTD scans into scaled engineering units, and assign the data to logical channels;
- Filter data channels according to specified filtering criteria;
- Apply sensor or instrument-specific response correction models;
- Provide periodic averages of the channels corresponding to the output time-series interval; and
- Store the output time-series in a CTD-independent format.

Once the CTD data are reduced to a standard-format time series, they can be manipulated in a number of various ways. Channels can be additionally filtered. The time-series can be split up into shorter time-series or pasted together to form longer time-series. A time-series can be transformed into a pressure-series, or a different interval time-series. Calibration corrections to the series are maintained in separate files and are applied whenever the data are accessed.

ODF data acquisition software acquired and processed the CTD data in real-time, providing calibrated, processed data for interactive plotting and reporting during a cast. The 20 fps data from the CTD were filtered, response-corrected and averaged to a 2 hz time-series. Sensor correction and calibration models were applied to pressure, temperature, conductivity and O_2. Rosette trip data were extracted from this time-series in response to trip initiation and confirmation signals. The calibrated 2 hz time-series data were stored on disk (as were the 20

hz raw data) and were available in real-time for reporting and graphical display. At the end of the cast, various consistency and calibration checks were performed, and a 2.0 db pressure-series of the down-cast was generated and subsequently used for reports and plots.

CTD plots generated automatically at the completion of deployment were checked daily for potential problems. The two PRT temperature sensors were inter-calibrated and checked for sensor drift. The CTD conductivity sensor was monitored by comparing CTD values to check-sample conductivities and by deep TS comparisons with adjacent stations. The CTD dissolved O_2 sensor was calibrated to check-sample data. A few casts exhibited conductivity offsets due to biological or particulate artifacts. On some casts, noise in the O_2 channel was evident. In these cases additional filtering was applied to the 2 hz time-series, using a spike-removal filter that replaced points exceeding (by a specified multiple of the standard deviation) the least-squares polynomial fit of specified order of segments of the data. The filtered points were replaced by the filtering polynomial value. Table 1.6.0 provides a list of all CTD casts requiring special attention.

Cast	Problems	Solutions
001/01	CTD #3 temp offsets (water in turret).	Switch to CTD #5.
001/01	Temperature drift on down cast.	Use up cast.
004/01	Winch stopped for maintenance @ 2370M d/c, o_2 affected.	Filtered.
005/01	raw serial in crash on up cast, restarted.	Time offset.
007/01	Surf cond spike.	Filtered.
011/01	Cond drop-out@8.2deg theta d/c.	Filtered.
011/01	Switched to SBE 32 pylon.	
019/01	Deck unit blew fuse @1700M d/c, not noticed until 2100M. Power restored, returned to 1700M, then continued.	Yo removed, filtered.
025/01	O_2 sensor cover left on.	No O_2.
027/01	SBE pylon no-confirms-really time glitches in CTD#5.	Software change for timing source.
028/01	O_2 spike@3100db d/c.	Filtered.
029/01	Bottom cond spike.	Filtered.
032/01	Surf cond spike.	Filtered.
037/01	Surf cond spike.	Filtered.
038/01	Surf cond spike.	Filtered.
039/01	Surf cond spike.	Filtered.
040/01	Probably touched bottom.	Filtered.
040/01	Cond spike@100M d/c.	Filtered.
053/01	Surf cond spike (rain).	No action.
055/01	Cond spike @ 5M d/c.	Filtered.
058/01	Surf cond spike (rain).	No action.
068/01	Surf O_2 attenuated.	Filtered.
069/01	Surf O_2 exaggerated.	Filtered.
070/01	Surf O_2 exaggerated.	Filtered.
071/01	Cond dropout @30M d/c.	Filtered.
072/01	Surf O2 exaggerated.	Filtered.

Cast	Problems	Solutions
073/01	Surf O2 attenuated.	Filtered.
074/01	Surf O2 attenuated.	Filtered.
076/01	Surf O2 spike.	Filtered.
082/01	Cond spike @1000M d/c.	Filtered.
086/01	Surf O2 attenuated.	Filtered.
089/01	Discovered W. Gardner's transmissometer log.	Switched to instrument #266AD (from #265AD).
090/01	Salinity spiking on u/c @ rosette trips.	Filtered.
113/01	Surf cond spike.	Filtered.
132/01	Cond spike @ 6.8°C theta d/c.	Filtered.
142/01- 146/01	Cond offsets on upcast.	Calibration shift.
147/01	O2 drop-out on entry.	Filtered.
147/01	Cond spike @ 9.7°C theta d/c.	Filtered.
150/01	Cond spike @ 8.1°C theta u/c.	No action.
151/01	Cond spikes @ 700-630M u/c.	No action.

Table 1.6.0 Tabulation of problem CTD casts.

1.7. CTD Shipboard Calibration Procedures

ODF CTD #3 was used for a single cast (001/01) and developed a turret leak, which was repaired. ODF CTD #5 was used for all subsequent casts.

A SBE 35 Laboratory-grade reference PRT was deployed on the rosette as a cross calibration for the primary and secondary PRT temperatures.

CTD conductivity and dissolved O_2 were calibrated to in-situ check samples collected during each rosette cast.

CTD Pressure and Temperature

The final pressure and temperature calibrations will be determined when CTD #5 is returned to ODF. Based on the secondary PRT comparisons and the conductivity calibration, there were no significant shifts in the CTD pressure or temperature.

The primary PRT (serial #15407) appeared to hold its calibration relative to the SBE 35 to within 0.0005°C. The secondary PRT (serial #15046) appeared to drift by 0.003°C over the cruise and had drifted by 0.005°C since calibration in April. Figures 1.7.0 and 1.7.1 summarize the comparisons between the SBE 35 reference PRT and the primary and secondary PRT temperatures.
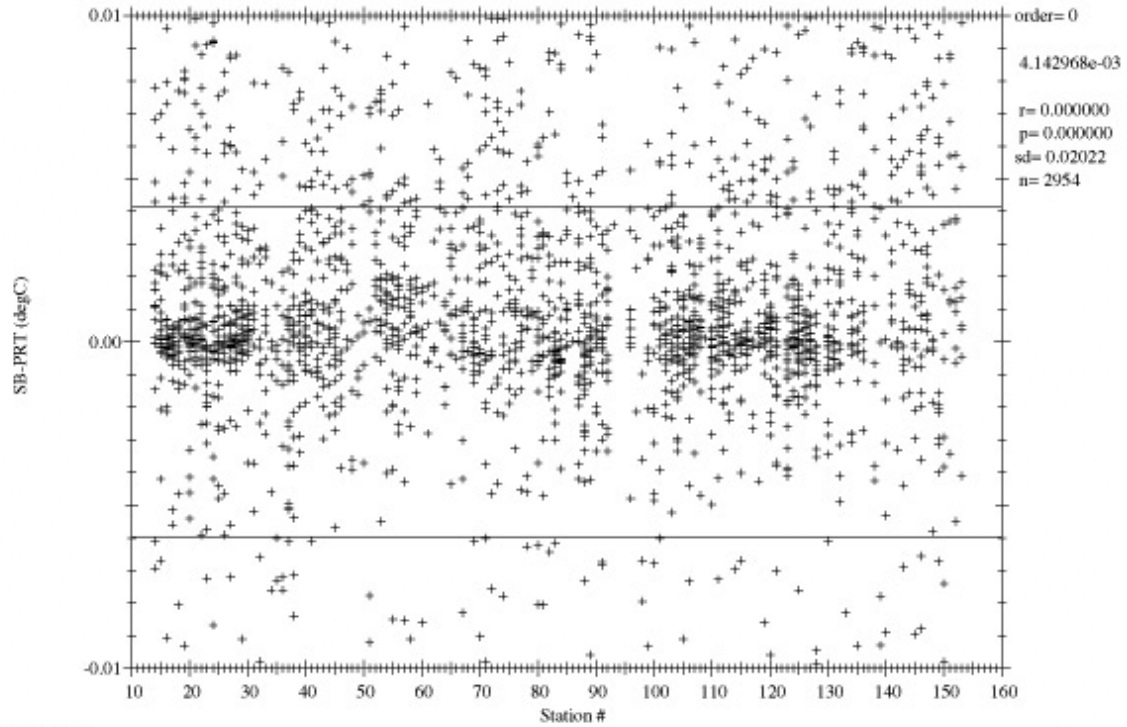
CTD#5, PRT1

Figure 1.7.0 Comparison between SBE 35 reference and primary PRT temperatures.

CTD#5, PRT2
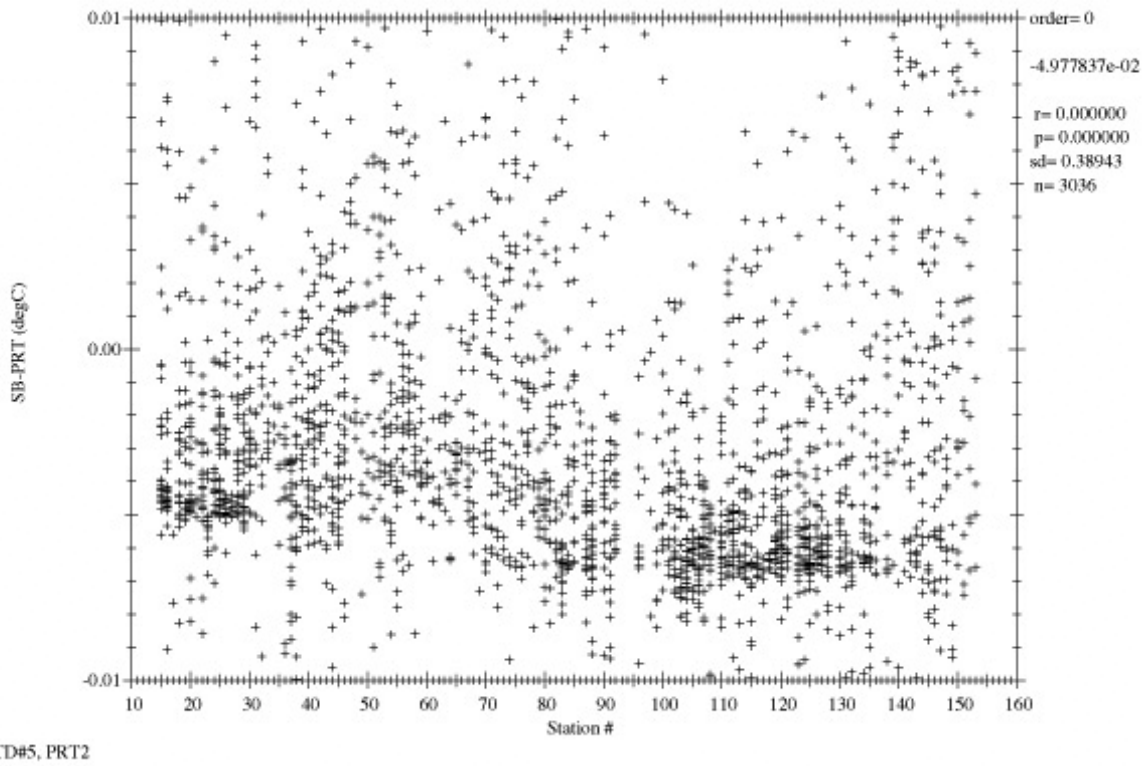
Figure 1.7.1 Comparison between SBE 35 reference and secondary PRT temperatures.

Conductivity

The CTD rosette trip pressure and temperature and the bottle salinity were used to calculate a bottle conductivity. Differences between the bottle and CTD conductivities were then used to derive a conductivity correction. This correction is normally linear for the 3cm conductivity cell employed in the Mark III.

Figure 1.7.2 Conductivity correction slopes, per station.

Figure 1.7.3 Mean conductivity correction slope, all stations.

Conductivity differences were fit to CTD conductivity for each cast, and the mean of the conductivity correction slopes examined:

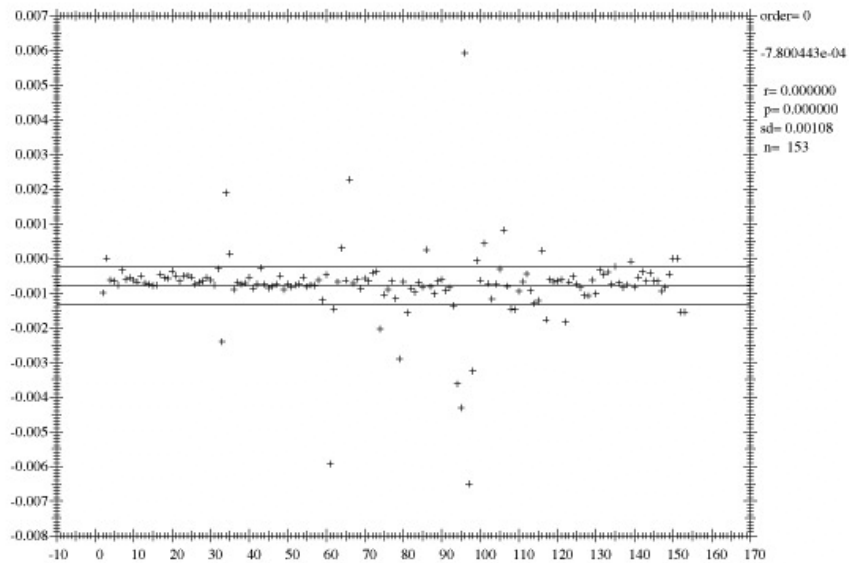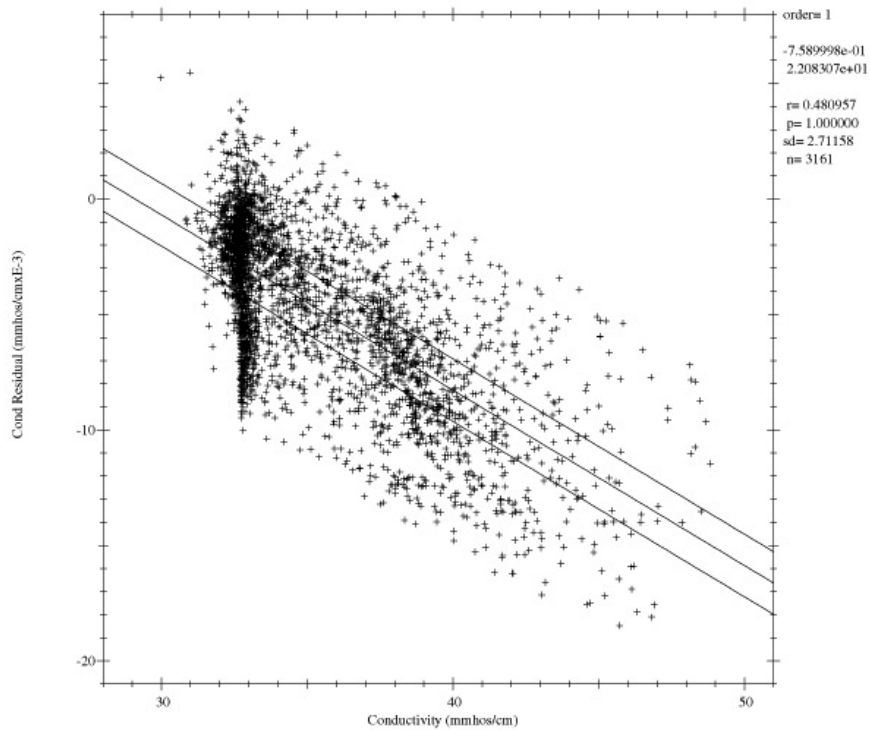No significant change in the conductivity correction slope occurred over the cruise. Conductivity differences were then fit to CTD conductivity for all bottles to determine a mean conductivity correction slope:

Since the mean correction slope did not significantly differ from the mean of individual slopes, the mean correction slope was applied and individual correction offsets fit for each cast. The resulting correction was adjusted for minor non-linearities in conductivity and pressure. Figure 1.7.4 illustrates the correction offsets by station after applying the correction slope:
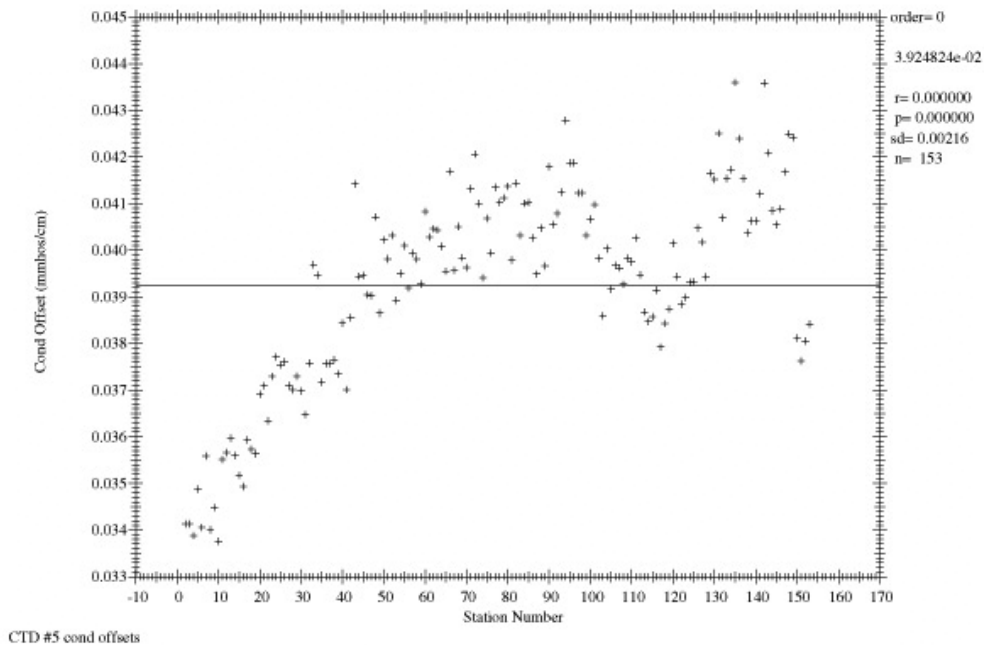
Figure 1.7.4 Conductivity correction offsets, all stations.

The final form of the applied conductivity correction was:

$$G_{corr}=G_{raw}-9.13543\text{e-}11P^2+1.80848\text{e-}07P+0.0000147071G^2_{raw}\ 0.00176569G_{raw}+C_{offset} \quad (1.7.0)$$

where:

G_{corr} = Corrected conductivity (mmhos/cm);
G_{raw} = Raw sensor conductivity;
P   = Corrected CTD pressure (db); and
C_{offset} = Coefficient derived from the fit to bottle conductivity.

Deep potential temperature-salinity overlays of successive CTD casts were then examined for consistency and the corrections fine-tuned.

Figures 1.7.5, 1.7.6 and 1.7.7 summarize the residual differences between bottle and CTD salinities after applying the conductivity correction.

CTD #5 all residual salt diffs >800 db after correction

Figure 1.7.5 Salinity residual differences after correction, by pressure.

CTD #5 all residual salt diffs > 800db after correction

Figure 1.7.6 Salinity residual differences after correction, by station.
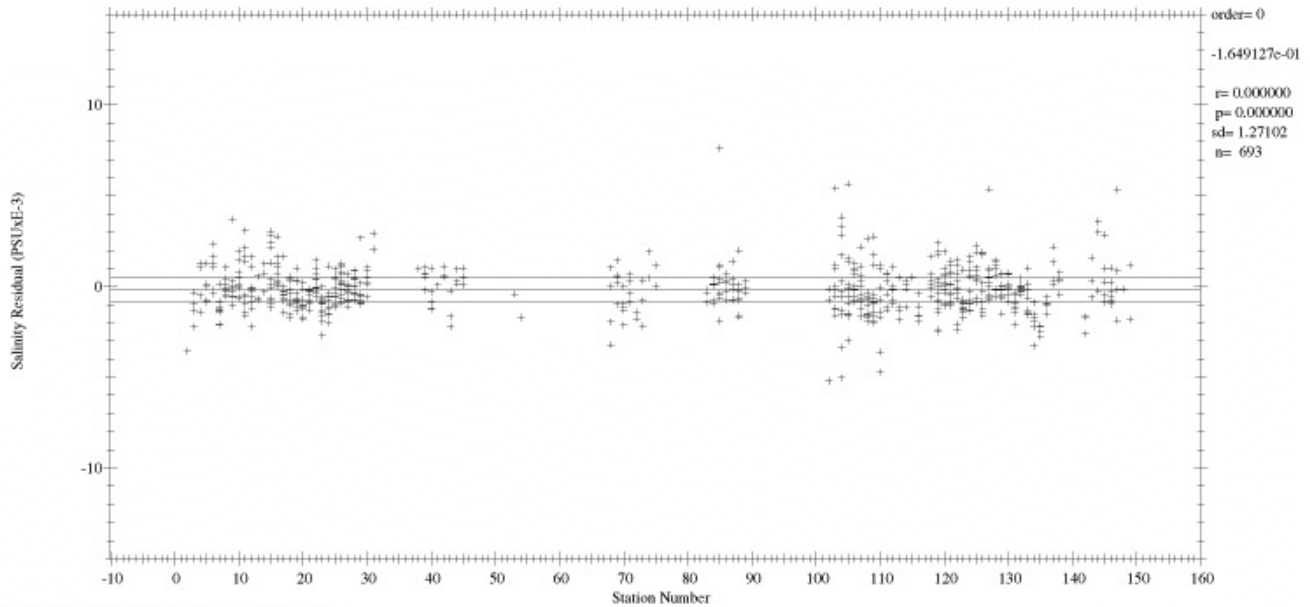
Figure 1.7.7 Deep salinity residual differences after correction, by station.

Note that some pressure-related nonlinearity exists after correction. This could have been further reduced by increasing the complexity of the correction.

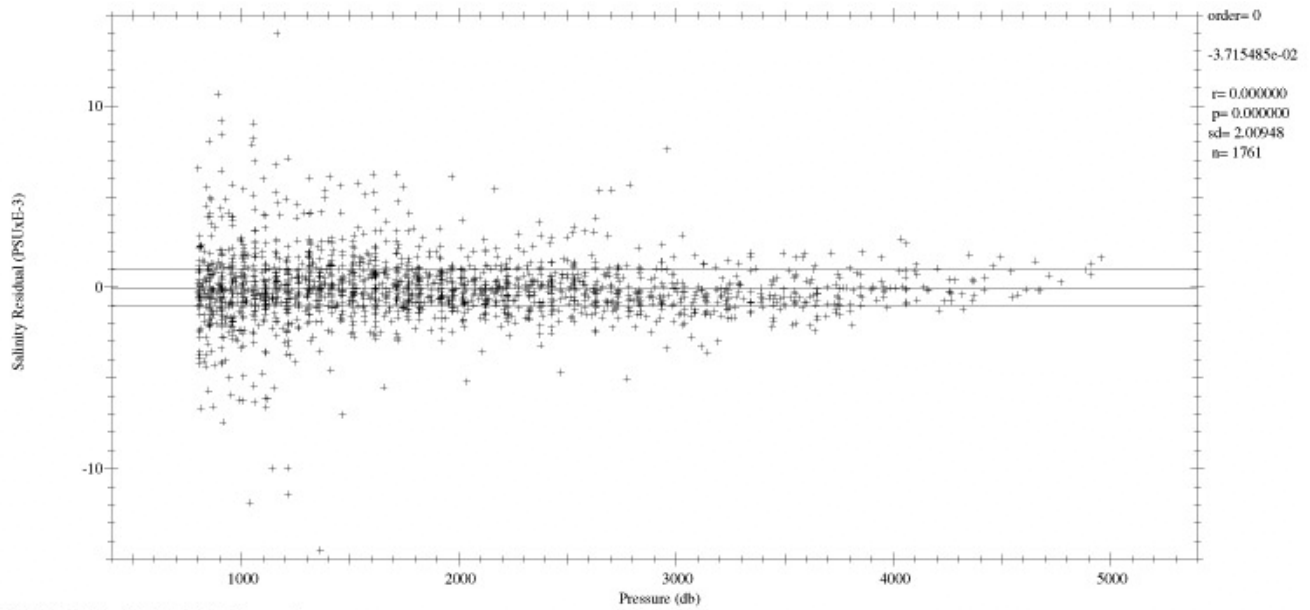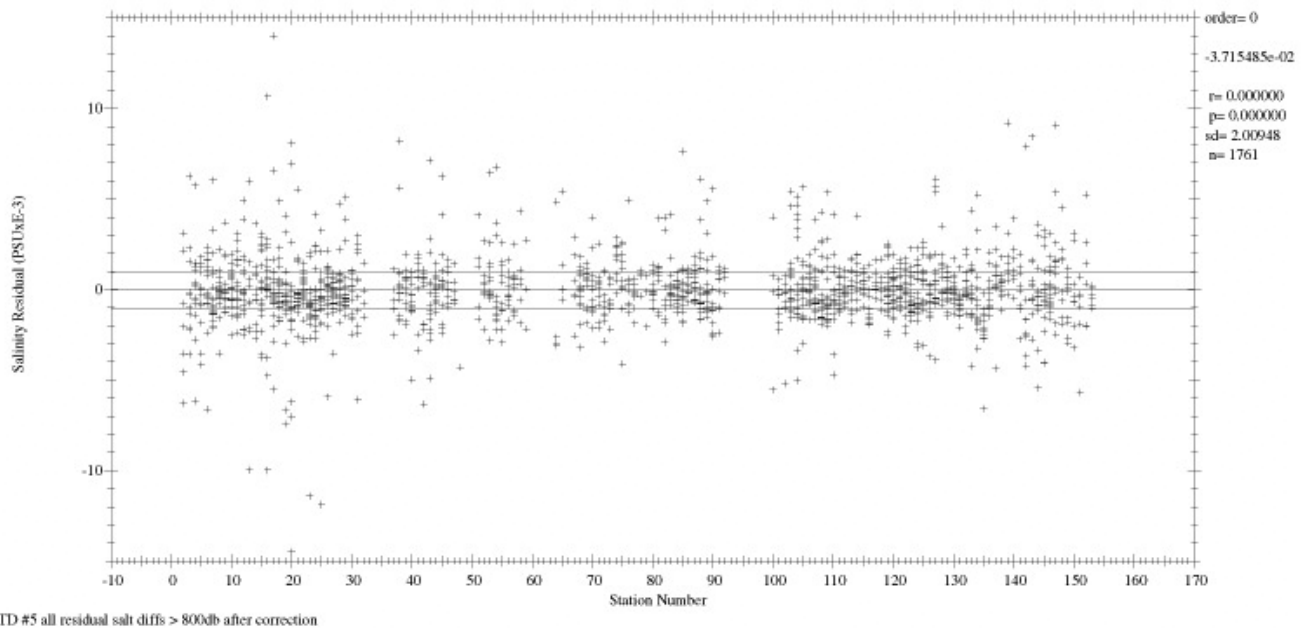3 from the mean residual in Figures 1.7.6 and 1.7.7, or ±0.003 PSU for all salinities and ±0.0019 PSU for deep salinities represents the limit of repeatability of the bottle salinities with all sources of variation (e.g., Autosal, rosette, operators and samplers) included. This limit agrees with station overlays of deep TS. Within a cast (a single salinometer run), the precision of bottle salinities appears to exceed 0.001 PSU. The precision of the CTD salinities appears to exceed 0.0005 PSU.

CTD Dissolved Oxygen

The CTD dissolved O_2 sensor (serial #6-02-07) worked without major problems the entire cruise. A series of consecutive casts (072/01-076/01, 086/01) exhibited some minor surface response problems.

There are a number of problems with the response characteristics of the Sensormedics O_2 sensor used in the NBIS Mark III CTD, the major ones being a secondary thermal response and a sensitivity to profiling velocity. Because of these problems, CTD rosette trip data cannot be directly calibrated to O_2 check samples. Instead, down-cast CTD O2 data are derived by matching the up-cast rosette trips along isopycnal surfaces. The differences between CTD O_2 modeled from these derived values and check samples are then minimized using a non-linear least-squares fitting procedure. Figures 1.7.8 and 1.7.9 show the residual differences between the corrected CTD O_2 and the bottle O_2 (ml/l) for each station.

order= 0

8.518178e-03

r= 0.000000
p= 0.000000
sd= 0.07115
n= 2529
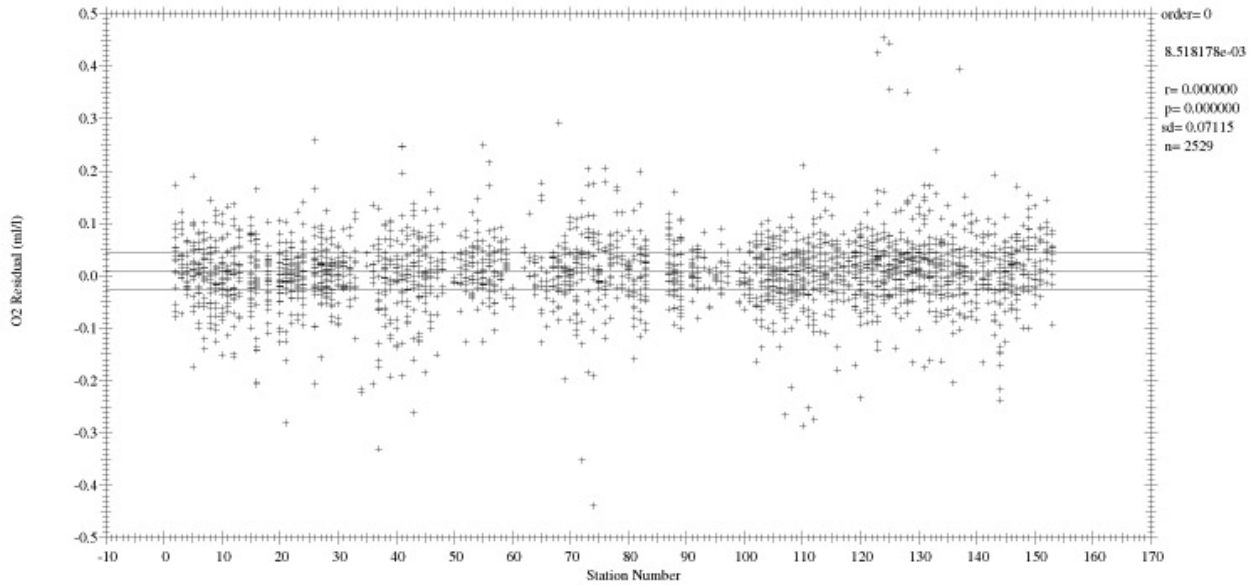
CTD #5 all residual o2 diffs after correction

Figure 1.7.8 O_2 residual differences after correction, by station.

order= 0

6.127151e-03

r= 0.000000
p= 0.000000
sd= 0.03716
n= 648
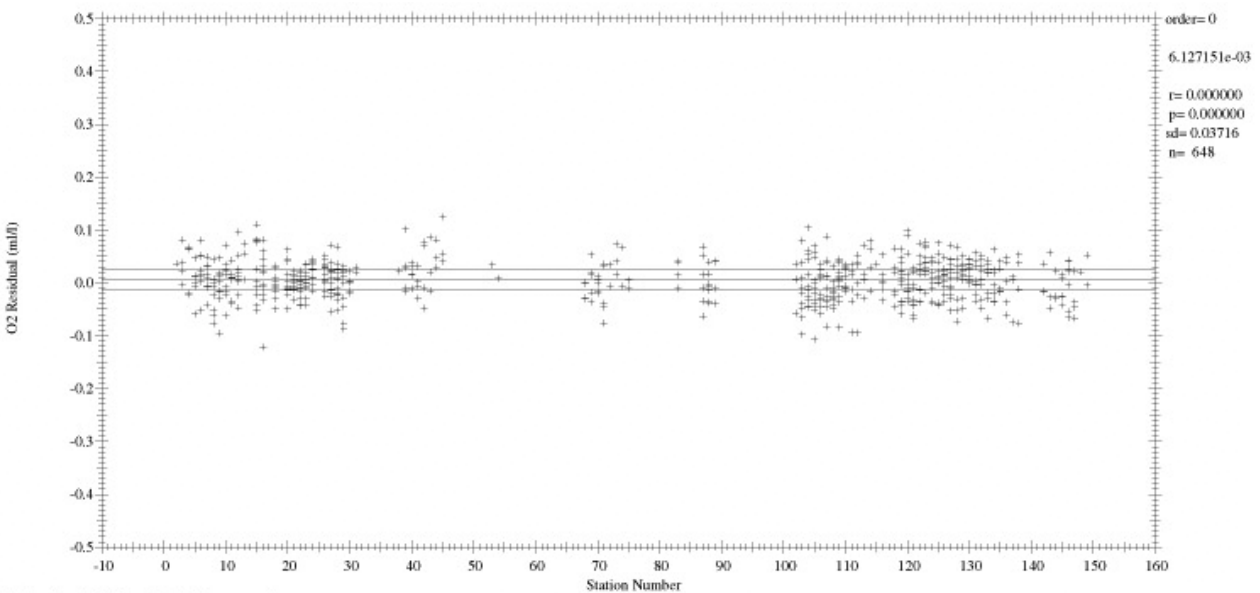
CTD #5 residual o2 diffs > 2000db after correction

Figure 1.7.9 O_2 residual differences (>2000db).

Note that the mean of the differences is not zero, because the O_2 values are weighted by pressure before fitting. The standard deviations of 0.071 ml/l for all oxygens and 0.037 ml/l for deep oxygens are only intended as metrics of the goodness of the fits. ODF makes no claims regarding the precision or accuracy of CTD dissolved O_2 data.

The general form of the ODF O_2 conversion equation follows Brown and Morrison [Brow78] and Millard [Mill82], [Owen85]. ODF does not use a digitized O_2 sensor temperature to model the secondary thermal response but instead models membrane and sensor temperatures by

low-pass filtering the PRT temperature. *In-situ* pressure and temperature are filtered to match the sensor response. Time-constants for the pressure response τ_p, and two temperature responses τ_{Ts} and τ_{Tf} are fitting parameters. The sensor current, or O_c, gradient is approximated by low-pass filtering $1°$ O_c differences. This term attempts to correct for reduction of species other than O_2 at the cathode. The time-constant for this filter, τ_{og}, is a fitting parameter. Oxygen partial-pressure is then calculated:

$$O_{pp}=[c_1 O_c+c_2]\cdot f_{sat}(S,T,P)e^{(c3Pl+c4Tf+c5Ts+c6\cdot(dOc/dt))} \quad (1.7.1)$$

where:

O_{pp}	= Dissolved O_2 partial-pressure in atmospheres (atm);
O_c	= Sensor current (amps);
$f_{sat}(S,T,P)$	= O_2 saturation partial-pressure at S,T,P (atm);
S	= Salinity at O_2 response-time (PSUs);
T	= Temperature at O_2 response-time (C);
P	= Pressure at O_2 response-time (decibars);
P_l	= Low-pass filtered pressure (decibars);
T_f	= Fast low-pass filtered temperature (C);
T_s	= Slow low-pass filtered temperature (C);
dO_c/dt	= Sensor current gradient (amps/secs).

1.8. Bottle Sampling

At the end of each rosette deployment water samples were drawn from the bottles in the following order:

- CFCs;
- ^{3}He;
- O_2;
- pCO_2;
- Total CO_2;
- Alkalinity;
- Tritium;
- Nutrients;
- Salinity;
- $^{18}O/^{16}O$.

Note that some properties were sub-sampled by cast or by station, so the actual sequence of samples drawn was modified accordingly.

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

the sampling team was designated the sample cop, whose sole responsibility was to maintain this log and insure that sampling progressed in proper drawing order.

Normal sampling practice included opening the drain valve before opening the air vent on the bottle, indicating an air leak if water escaped. This observation together with other diagnostic comments (e.g., "lanyard caught in lid", "valve left open") that might later prove useful in determining sample integrity were routinely noted on the sample log.

Drawing oxygen samples also involved taking the sample draw temperature from the bottle. The temperature was noted on the sample log and was sometimes useful in determining leaking or mis-tripped bottles.

Once individual samples had been drawn and properly prepared, they were distributed to their laboratory for analysis. Oxygen, nutrients and salinity analyses were performed on computer-assisted (PC) analytical equipment networked to Sun SPARC Stations for centralized data analysis. The analyst for a specific property was responsible for insuring that their results updated the cruise database.

1.9.   Bottle Data Processing

The first stage of bottle data processing consisted of verifying and validating individual samples, and checking the sample log (the sample inventory) for consistency. Oxygen flask numbers were verified, as each flask is individually calibrated and significantly affects the calculated O_2 concentration. At this stage, bottle tripping problems were usually resolved, sometimes resulting in changes to the pressure, temperature and other CTD data associated with the bottle. The rosette bottle number was the primary identification for all samples taken from the bottle, as well as for the CTD data associated with the bottle. All CTD trips were retained whether confirmed or not so that they could be used to help resolve bottle tripping problems.

Diagnostic comments from the sample log were then translated into preliminary WOCE quality codes, together with appropriate comments. Each code indicating a potential problem would be investigated.

The next stage of processing would begin after all the samples for a cast had been accounted for. All samples for bottles suspected of leaking were checked to see if the properties were consistent with the profile for the cast, with adjacent stations and where applicable, with the CTD data. All comments from the analysts were examined and turned into appropriate water sample codes.

The third stage of processing would continue throughout the cruise and until the data set is judged "final". Various property-property plots and vertical sections were examined for both consistency within a cast and consistency with adjacent stations. In conjunction with this process the analysts would review (and sometimes revise) their data as additional calibration or diagnostic results became available. Assignment of a WHP water sample quality code to an anomalous sample value was typically achieved through consensus.

WHP water bottle quality flags were assigned with the following additional interpretations:

3 |An air leak large enough to produce an observable effect on a sample is identified by a |code of 3 on the bottle and a code of 4 on the oxygen. (Small air leaks may have no |observable effect, or may only affect gas samples.)
4 |Bottles tripped at other than the intended depth were assigned a code of 4. There may be |no problems with the associated water sample data.
5 |No water sample data reported. This is a representative level derived from the CTD data |for reporting purposes. The sample number should be in the range of 80-99.

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

1 |The sample for this measurement was drawn from a bottle, but the results of the analysis |were not (yet) received.
2 |Acceptable measurement.
3 |Questionable measurement. The data did not fit the station profile or adjacent station |comparisons (or possibly CTD data comparisons). No notes from the analyst indicated a |problem. The data could be correct, but are open to interpretation.
4 |Bad measurement. Does not fit the station profile, adjacent stations or CTD data. There |were analytical notes indicating a problem, but data values were reported. Sampling and |analytical errors were also coded as 4.
5 |Not reported. There should always be a reason associated with a code of 5, usually that |the sample was lost, contaminated or rendered unusable.
9 |The sample for this measurement was not drawn.

WHP water sample quality flags were assigned to the CTDSAL (CTD salinity) parameter as follows:

2 |Acceptable measurement.
3 |Questionable measurement. The data did not fit the bottle data, or there was a CTD |conductivity calibration shift during the cast.
4 |Bad measurement. The CTD data were determined to be unusable for calculating a salinity.
8 |The CTD salinity was derived from the CTD down cast, matched on an isopycnal surface.

WHP water sample quality flags were assigned to the CTDOXY (CTD oxygen) parameter as follows:

2 |Acceptable measurement.
4 |Bad measurement. The CTD data were determined to be unusable for calculating a |dissolved oxygen concentration.
5 |Not reported. The CTD data could not be reported.
9 |Not sampled. No operational dissolved oxygen sensor was present on this cast.

Note that all CTDOXY values were derived from the down cast data, matched to the upcast along isopycnal surfaces.

Table 1.9.0 shows the number of samples drawn and the number of times each WHP sample quality flag was assigned for each basic hydrographic property:

Rosette Samples Stations 1-153								
	Reported	WHP Quality Codes						
	Levels	1	2	3	4	5	8	9
Bottle	3451	0	3387	4	56	1	0	3
CTD Salt	3451	0	3441	10	0	0	0	0
CTD Oxy	3260	0	3260	0	0	157	0	34
Salinity	3438	0	3406	12	20	3	0	10
Oxygen	3434	0	3419	3	12	9	0	8
Silicate	3439	0	3431	5	3	3	0	9
Nitrate	3439	0	3436	0	3	3	0	9
Nitrite	3439	0	3436	0	3	3	0	9
Phosphate	3439	0	3435	0	4	3	0	9

Table 1.9.0 Frequency of WHP quality flag assignments.

Additionally, all WHP quality code comments are presented in Appendix A.

1.10. Salinity Analysis

Salinity samples were drawn into 200 ml Kimax high alumina borosilicate bottles after 3 rinses, and were sealed with custom-made plastic insert thimbles and Nalgene screw caps. This assembly provides very low container dissolution and sample evaporation. When loose inserts were found, they were replaced to ensure an airtight seal. Salinity was determined after a box of samples had equilibrated to laboratory temperature, usually within 8-12 hours of collection. The draw time and equilibration time, as well as per-sample analysis time and temperature were logged.

Two Guildline Autosal Model 8400A salinometers (55-654 and 48-263) located in a temperature-controlled laboratory were used to measure salinities. The salinometers were modified by ODF and contained interfaces for computer-aided measurement. A computer (PC) prompted the analyst for control functions (changing sample, flushing) while it made continuous measurements and logged results. The salinometer cell was flushed until successive readings met software criteria for consistency, then two successive measurements were made and averaged for a final result.

The salinometer was standardized for each cast with IAPSO Standard Seawater (SSW) Batch P-127, using at least one fresh vial per cast. The estimated accuracy of bottle salinities run at sea is usually better than 0.002 PSU relative to the particular Standard Seawater batch used. PSS-78 salinity [UNES81] was then calculated for each sample from the measured conductivity ratios, and the results merged with the cruise database.

3438 salinity measurements were made and 279 vials of standard water were used. Six of the vials were found to be bad. Salinometer 55-654 was used throughout this leg. Salinometer 48-263 was the backup salinometer and was not used. Various statistics pertaining to each run are summarized in Table 1.10.0. The temperature stability of the laboratory used to make the measurements was very good, ranging from 21.4 to 24.6°C. The salinometer bath temperature was maintained at 24°C. The salinities were used to calibrate the CTD conductivity sensor.

Autosal log starting 26/05/1997
Expedition: WOCE ACCE A24
Ship: R/V KNORR
Salinometer serial number 55-654

St	Cs	Box Nbr	Nbr Smp	Equ Hrs	Date Time	Start Time	End Air	Start Air	End Temp	Bath Batch	Worm Sby	Start Sby	End Dial	Std	Drift	OPR	
1 1		R	19	11.8	3105	1024	1147	23.2	23.3	24	P127	6494	6494	549	+0.00001	ACM	
2 1		88	23	11.3	3105	1435	1643	23.2	23.4	24	P127	6494	6495	549	-0.00003	KLL	
1 1		R	18	19.9	3105	1844	2024	22.9	23.0	24	P127	6516	6495	549	-0.00003	KLL	Rerun of sta
3 1		5	23	15.1	3105	2342	0123	22.9	23.2	24	P127	6496	6494	549	+0.00000	KLL	7,12,14,15-loose thimble, 1st end SSW bad opened new vial
4 1		3	24	13.4	0106	0207	0332	23.2	22.7	24	P127	6495	6496	549	+0.00000	ACM	4 & 23-loose thimble, first end worm bad opened a new vial
5 1		J	24	10.4	0106	0447	0604	22.5	22.5	24	P127	6496	6496	550	-0.00001	ACM	Bad 1st vial of SSW used 3 bottles initially
2 2		4	24	27.2	0106	0623	0748	22.3	22.4	24	P127	6496	6496	550	-0.00003	ACM	
6 1		R	26	11.6	0106	1018	1202	22.8	23.1	24	P127	6496	6496	550	+0.00000	ACM	
7 1		E	27	8.3	0106	1216	1453	23.1	22.9	24	P127	6496	6497	550	-0.00002	KLL	
8 1		J	28	8.4	0106	1815	2025	22.5	22.6	24	P127	6496	6496	550	-0.00004	KLL	
9 1		R	28	9.5	0206	0021	0207	22.3	22.6	24	P127	6496	6496	550	-0.00002	ACM	
10 1		E	27	12.2	0206	0824	1007	22.4	22.6	24	P127	6496	6496	550	-0.00002	ACM	
11 1		J	29	8.8	0206	1056	1300	22.6	22.9	24	P127	6498	6497	552	-0.00002	ACM	
12 1		R	28	8.6	0206	1615	1857	22.9	22.9	24	P127	6498	6497	552	-0.00001	KLL	
13 1		MT	20	11.3	0206	2236	0018	22.7	22.8	24	P127	6497	6497	552	-0.00002	KLL	
14 1		4	24	8.4	0306	0037	0259	22.7	22.6	24	P127	6497	6497	552	-0.00001	ACM	
15 1		J	30	11.9	0306	0813	1046	22.3	23.0	24	P127	6497	6497	552	-0.00002	ACM	
16 1		E	31	11.5	0306	1544	1719	22.8	23.0	24	P127	6497	6497	552	-0.00001	KLL	Maintenance done on the machine
17 1		R	30	11.7	0306	2156	2320	22.5	22.9	24	P127	6497	6497	552	-0.00002	KLL	
18 1		J	31	12.6	0406	0331	0515	22.3	22.7	24	P127	6498	6497	552	-0.00002	ACM	
19 1		E	32	11.3	0406	0832	1015	22.5	23.0	24	P127	6497	6497	552	-0.00001	ACM	
20 1		R	31	10.5	0406	1409	1553	22.8	23.4	24	P127	6497	6497	552	+0.00000	KLL	
21 1		J	31	10.9	0406	1923	2101	23.5	23.3	24	P127	6497	6497	552	-0.00001	KLL	
22 1		E	31	11.5	0506	0145	0325	22.9	23.0	24	P127	6497	6498	551	+0.00001	ACM	
23 1		R	31	11.2	0506	0557	0737	22.7	22.6	24	P127	6498	6497	551	-0.00002	ACM	
24 1		J	31	10.9	0506	1118	1248	22.8	22.9	24	P127	6498	6497	551	-0.00000	ACM	
25 1		E	31	8.8	0506	1429	1612	22.7	23.0	24	P127	6498	6498	551	-0.00001	KLL	

St	Cs	Box Nbr	Nbr Smp	Equ Hrs	Date Time	Start Time	End Air	Start Air	End Temp	Bath Batch	Worm Sby	Start Sby	End Dial	Std	Drift	OPR	
26	1	R	31	8.8	0506	2030	2203	22.6	22.9	24	P127	6497	6497	551	-0.00002	KLL	
27	1	J	31	11.0	0606	0354	0525	22.2	22.7	24	P127	6498	6498	551	-0.00002	ACM	At start, SBY jumping by 3-5 units; stopped run started later
28	1	E	31	11.0	0606	0952	1125	22.6	22.9	24	P127	6499	6497	551	-0.00001	ACM	
29	1	R	28	10.4	0606	1349	1506	22.5	22.7	24	P127	6498	6498	551	-0.00001	KLL	
30	1	4	24	9.0	0606	1604	1711	22.7	22.8	24	P127	6498	6497	551	-0.00002	KLL	
31	1	A	20	10.1	0606	1928	2028	22.6	22.9	24	P127	6498	6498	551	-0.00002	KLL	
32	1	M	17	14.9	0706	0343	0437	22.5	22.7	24	P127	6498	6498	551	-0.00002	ACM	
33	1	88	16	14.1	0706	0559	0653	22.5	22.7	24	P127	6497	6499	552	-0.00001	ACM	
34	1	5	8	18.9	0706	1158	1222	22.4	22.7	24	P127	6499	6498	552	+0.00000	KLL	
934	1	5	7	41.9	0806	1104	1149	22.3	22.4	24	P127	6499	6498	553	-0.00002	DN	Test used 3 vials of worm at start
35	1	A	24	8.5	0906	0254	0415	21.9	21.8	24	P127	6501	6501	556	-0.00001	KMS	Replaced btls 4,6,8
36	1	3	24	8.5	0906	0254	0415	21.9	21.8	24	P127	6501	6501	556	-0.00001	KMS	Ran with Sta 35
37	1	83	24	11.0	0906	1009	1203	21.8	22.4	24	P127	6500	6501	557	-0.00000	ACM	
38	1	4	24	11.7	0906	1340	1548	22.2	22.4	24	P127	6503	6501	557	+0.00001	KLL	
39	1	A	24	12.4	0906	1817	2058	22.0	22.3	24	P127	6501	6500	557	-0.00004	KLL	Replace pump washers, flushed cell tube; replace fill tube
40	1	3	24	12.9	0906	2223	2316	22.4	22.2	24	P127	6500	6499	552	-0.00001	KLL	STD dial 557; mistyped as 552
41	1	88	23	13.3	1006	0249	0354	21.9	22.2	24	P127	6499	6499	557	+0.00006	ACM	
42	1	4	24	15.5	1006	0910	1016	22.1	22.7	24	P127	6499	6500	557	+0.00002	ACM	Used 2 vials of worm at start
43	1	R	24	17.7	1006	1405	1534	23.4	23.7	24	P127	6498	6498	556	+0.00003	SR	more multiple attempts than noted
44	1	A	25	27.8	1006	1547	1648	23.7	23.4	24	P127	6498	6498	555	+0.00004	KLL	
45	1	3	23	15.3	1006	1804	1936	23.1	23.4	24	P127	6499	6498	556	+0.00003	SR	
46	1	88	19	15.1	1006	1952	2042	23.1	23.2	24	P127	6499	6499	556	+0.00002	KLL	
47	1	B	15	19.4	1106	0201	0246	22.4	22.8	24	P127	6498	6499	556	+0.00001	DN	1st worm bad, used 2nd, total of 5
48	1	J	12	17.8	1106	0249	0320	22.8	22.7	24	P127	6498	6498	556	+0.00002	DN	
49	1	A	7	8.9	1106	2107	2126	22.0	21.9	24	P127	6500	6499	556	+0.00000	KLL	
50	1	3	10	8.1	1106	2126	2154	21.9	21.9	24	P127	6500	6499	556	+0.00000	KLL	Ran with Sta 049
51	1	88	16	12.2	1206	0324	0403	21.9	22.0	24	P127	6498	6499	556	+0.00000	ACM	
52	1	4	19	11.1	1206	0403	0449	22.0	21.9	24	P127	6498	6499	556	+0.00001	ACM	Ran with Sta 051
53	1	B	24	10.6	1206	0700	0759	21.6	22.0	24	P127	6499	6509	556	-0.00001	ACM	
54	1	A	24	8.6	1206	0829	0924	21.8	22.0	24	P127	6499	6499	556	+0.00004	ACM	

St	Cs	Box	Nbr Smp	Equ Hrs	Date Time	Start Time	End Time	Start Air	End Air	Bath Temp	Worm Batch	Start Sby	End Sby	Std Dial	Drift	OPR
55	1	3	21	9.9	1206	1310	1356	22.1	22.0	24	P127	6501	6490	556	+0.00000	KLL
56	1	88	21	8.1	1206	1356	1446	22.0	22.2	24	P127	6501	6499	556	+0.00000	KLL Ran with Sta 055
57	1	4	20	10.0	1206	1813	1856	21.6	21.7	24	P127	6489	6499	556	+0.00000	KLL
58	1	B	17	9.0	1206	1856	1936	21.7	21.9	24	P127	6489	6500	556	-0.00001	KLL Ran with Sta 057
59	1	A	15	10.4	1206	2203	2237	21.6	21.7	24	P127	6500	6501	557	+0.00000	KLL
60	1	J	8	10.0	1206	2237	2257	21.7	21.6	24	P127	6500	6500	557	-0.00000	KLL Ran with Sta 059
61	1	88	6	13.3	1306	0431	0445	21.7	21.7	24	P127	6500	6500	557	+0.00000	ACM
62	1	3	9	10.0	1306	0445	0512	21.7	21.8	24	P127	6500	6500	557	+0.00003	ACM Ran with Sta 061
63	1	R	10	11.9	1306	0905	0929	21.8	22.0	24	P127	6500	6499	557	+0.00000	ACM
64	1	A	14	8.3	1306	0930	1011	22.0	22.1	24	P127	6500	6500	557	+0.00000	ACM Ran with Sta 063
65	1	B	14	11.1	1306	1536	1607	22.2	22.5	24	P127	6500	6499	557	+0.00000	KLL
66	1	4	10	8.6	1306	1607	1636	22.5	22.5	24	P127	6500	6499	557	+0.00004	KLL Ran with Sta 065
67	1	A	17	12.3	1406	0030	0109	21.9	22.4	24	P127	6497	6498	555	+0.00000	ACM
68	1	3	24	10.2	1406	0110	0209	22.4	22.6	24	P127	6497	6498	555	+0.00000	ACM Ran with Sta 067
69	1	4	22	8.9	1406	0456	0548	22.2	22.5	24	P127	6498	6498	555	+0.00001	ACM
70	1	B	24	8.7	1406	0900	0955	22.4	22.7	24	P127	6497	6499	555	+0.00002	ACM
71	1	88	24	11.8	1406	1621	1711	22.7	23.1	24	P127	6499	6498	555	-0.00000	KLL
72	1	A	20	9.8	1406	1826	1908	22.9	22.9	24	P127	6498	6497	555	+0.00002	KLL
73	1	3	20	15.4	1506	0353	0439	22.1	22.6	24	P127	6498	6498	555	+0.00000	ACM
74	1	B	21	12.7	1506	0440	0528	22.6	22.6	24	P127	6498	6498	555	+0.00001	ACM Ran with Sta 073
75	1	88	21	12.8	1506	0941	1035	22.3	22.8	24	P127	6498	6497	555	+0.00000	KMS
76	1	A	18	10.8	1506	1036	1117	22.8	22.7	24	P127	6498	6498	555	+0.00000	KMS Ran with Sta 075
77	1	4	20	10.4	1506	1355	1435	22.2	22.6	24	P127	6498	6498	555	+0.00000	KLL
78	1	R	16	8.9	1506	1435	1510	22.6	22.7	24	P127	6498	6498	555	-0.00001	KLL Ran with Sta 077
79	1	B	14	10.5	1506	1841	1912	22.1	22.5	24	P127	6499	6499	555	+0.00000	KLL
80	1	3	20	9.1	1506	1912	1956	22.5	22.7	24	P127	6499	6498	555	+0.00001	KLL Ran with Sta 079
81	1	A	21	13.6	1606	0240	0327	22.0	22.3	24	P127	6499	6498	555	+0.00000	ACM
82	1	4	22	10.6	1606	0327	0420	22.3	22.2	24	P127	6499	6499	555	+0.00001	ACM Checked/changed Boxes A & B; Ran with Sta 081
83	1	R	28	10.5	1606	0757	0859	22.0	22.4	24	P127	6498	6498	555	+0.00002	ACM
84	1	J	25	13.9	1606	1601	1653	22.3	22.8	24	P127	6498	6499	555	+0.00000	KLL
85	1	E	25	10.9	1606	1754	1846	22.5	22.8	24	P127	6498	6499	555	+0.00001	KLL
86	1	R	27	9.9	1606	2056	2151	22.4	22.8	24	P127	6499	6499	555	-0.00001	KLL
87	1	A	29	9.9	1706	0148	0253	22.1	22.5	24	P127	6498	6498	555	+0.00001	ACM
88	1	J	30	11.0	1706	0640	0742	21.7	22.0	24	P127	6498	6498	555	-0.00003	ACM
89	1	R	27	10.1	1706	0934	1031	21.5	21.9	24	P127	6498	6498	555	+0.00001	ACM
90	1	88	23	12.8	1706	1430	1530	21.5	22.0	24	P127	6500	6499	556	+0.00000	KLL

St	Cs	Box	Nbr Smp	Equ Hrs	Date Time	Start Time	End Air	Start Air	End Temp	Bath Batch	Worm Sby	Start Sby	End Dial	Std	Drift	OPR	
91	1	B	21	11.4	1706	1531	1620	22.0	22.0	24	P127	6500	6498	556	-0.00002	KLL	Ran with Sta 090
92	1	A	18	12.0	1706	1807	1843	21.4	22.0	24	P127	6500	6499	556	+0.00000	KLL	
93	1	4	10	11.1	1706	1843	1908	22.0	22.2	24	P127	6500	6499	556	-0.00002	KLL	Ran with Sta 092
94	1	J	10	10.9	1706	2037	2107	21.4	22.0	24	P127	6503	6503	561	+0.00000	SR	
95	1	E	11	9.4	1706	2108	2148	22.0	22.2	24	P127	6503	6502	561	+0.00000	SR	Ran with Sta 094
96	1	3	14	12.0	1806	0230	0319	21.8	22.1	24	P127	6497	6498	550	+0.00000	KMS	
97	1	R	10	9.8	1806	0319	0349	22.1	22.4	24	P127	6497	6498	550	-0.00004	KMS	Cleaned cell, replaced internal tubing, soaked cell in RBS; Ran with Sta 096
98	1	3	8	10.5	1906	1119	1136	23.0	23.1	24	P127	6494	6494	547	ACM		Used 4 vials to initialize
99	1	A	10	8.9	1906	1137	1159	23.1	23.1	24	P127	6494	6493	547	+0.00001	ACM	Ran with Sta 098
100	1	4	16	11.8	1906	1621	1656	23.1	23.6	24	P127	6493	6494	547	+0.00002	KLL	
101	1	B	17	16.4	2006	0007	0042	22.8	23.3	24	P127	6493	6493	547	+0.00000	KLL	
102	1	88	21	13.0	2006	0042	0123	23.3	23.1	24	P127	6493	6493	547	+0.00002	KLL	Ran with Sta 101
103	1	R	27	9.6	2006	0143	0239	23.0	23.3	24	P127	6493	6493	547	+0.00002	ACM	
104	1	J	29	10.0	2006	0605	0703	22.8	23.3	24	P127	6493	6493	547	+0.00002	ACM	
105	1	E	29	9.6	2006	0936	1035	22.9	23.6	24	P127	6491	6491	545	+0.00002	ACM	
106	1	R	28	10.7	2006	1610	1704	22.4	22.6	24	P127	6492	6492	546	-0.00001	KLL	
107	1	J	28	11.2	2006	2044	2143	22.2	22.5	24	P127	6493	6492	546	-0.00003	KLL	
108	1	E	29	12.1	2106	0208	0309	22.1	22.7	24	P127	6493	6493	546	+0.00001	ACM	
109	1	R	30	10.2	2106	0551	0652	22.4	23.0	24	P127	6493	6493	546	+0.00001	ACM	
110	1	J	30	9.5	2106	0944	1052	22.8	23.2	24	P127	6492	6492	545	-0.00000	KMS	
111	1	E	27	9.9	2106	1443	1557	23.5	23.9	24	P127	6490	6489	541	+0.00000	SWR	
112	1	R	27	8.2	2106	1807	1903	23.5	23.7	24	P127	6489	6490	542	-0.00002	KLL	
113	1	J	26	9.3	2206	0613	0710	22.7	23.0	24	P127	6491	6490	542	+0.00002	ACM	
114	1	R	24	9.0	2206	1044	1131	23.5	23.6	24	P127	6490	6490	542	+0.00003	ACM	
115	1	3	22	9.7	2206	1532	1617	22.7	22.9	24	P127	6490	6491	542	-0.00002	KLL	
116	1	A	23	8.0	2206	1843	1932	22.3	22.5	24	P127	6491	6492	543	-0.00002	KLL	
117	1	B	19	12.5	2306	0258	0334	22.7	22.8	24	P127	6492	6492	543	+0.00000	ACM	
118	1	88	12	10.1	2306	0334	0401	22.8	23.0	24	P127	6492	6492	543	+0.00003	ACM	Ran with Sta 117
119	1	E	31	11.5	2306	0952	1058	22.6	23.0	24	P127	6492	6491	543	-0.00000	KMS	
120	1	J	31	11.9	2306	1411	1505	22.4	22.8	24	P127	6493	6492	543	+0.00002	KLL	
121	1	R	29	11.2	2306	1840	1936	22.6	23.0	24	P127	6491	6492	542	+0.00002	KLL	
122	1	E	29	11.5	2406	0013	0110	22.4	22.9	24	P127	6493	6491	542	+0.00001	ACM	
123	1	J	31	10.6	2406	0438	0540	22.6	22.9	24	P127	6491	6491	542	+0.00001	ACM	
124	1	R	31	9.7	2406	0912	1014	22.6	23.1	24	P127	6493	6492	542	+0.00002	ACM	
125	1	E	29	9.8	2406	1413	1506	23.0	23.2	24	P127	6490	6491	541	+0.00004	KLL	

St	Cs	Box	Nbr Smp	Equ Hrs	Date Time	Start Time	End Time	Start Air	End Air	End Temp	Bath Batch	Worm Sby	Start Sby	End Dial	Std	Drift	OPR
126	1	J	30	9.5	2406	1823	1918	23.1	23.6	24	P127	6490	6490	541	+0.00002	KLL	
127	1	R	30	10.3	2506	0013	0111	23.1	23.5	24	P127	6492	6491	541	+0.00001	ACM	
128	1	E	27	10.7	2506	0451	0541	23.2	23.6	24	P127	6490	6491	541	+0.00003	ACM	
129	1	J	30	9.4	2506	0910	1008	23.1	23.6	24	P127	6489	6489	539	+0.00002	ACM	
130	1	R	29	10.4	2506	1510	1603	23.5	23.9	24	P127	6490	6490	540	+0.00002	KLL	
131	1	E	29	10.5	2506	2051	2145	23.9	24.3	24	P127	6489	6490	539	+0.00004	KLL	
132	1	J	27	10.6	2606	0129	0222	23.8	24.1	24	P127	6488	6487	537	+0.00000	ACM	
133	1	R	28	9.1	2606	0502	0554	23.8	24.1	24	P127	6490	6489	539	+0.00002	ACM	
134	1	E	27	8.8	2606	0929	1020	23.9	24.3	24	P127	6489	6490	539	+0.00002	ACM	
135	1	B	24	8.8	2606	1343	1430	24.1	24.6	24	P127	6489	6489	539	+0.00003	KLL	
136	1	3	24	8.8	2606	1804	1849	24.6	25.0	24	P127	6490	6489	539	+0.00002	KLL	
137	1	J	25	8.4	2606	2144	2232	24.7	25.1	24	P127	6488	6488	538	+0.00004	KLL	
138	1	A	22	8.4	2706	0144	0228	24.3	24.7	24	P127	6489	6489	538	+0.00003	ACM	
139	1	B	18	10.6	2706	0807	0839	24.2	24.4	24	P127	6488	6489	538	+0.00000	ACM	
140	1	3	18	8.1	2706	0840	0913	24.4	24.5	24	P127	6488	6488	538	+0.00002	ACM Ran with Sta 139	
141	1	A	20	8.4	2706	1237	1320	24.3	24.6	24	P127	6489	6489	539	+0.00002	KLL	
142	1	88	23	8.8	2706	1552	1633	24.5	24.9	24	P127	6488	6488	538	+0.00002	KLL	
143	1	3	21	8.4	2706	1849	1929	24.8	24.6	24	P127	6488	6488	538	+0.00003	KLL	
144	1	B	24	8.6	2706	2229	2315	24.1	24.4	24	P127	6488	6488	538	+0.00002	KLL	
145	1	E	26	10.4	2806	0410	0500	23.8	24.1	24	P127	6489	6488	538	+0.00002	ACM	
146	1	R	27	10.2	2806	0756	0848	23.7	24.1	24	P127	6488	6488	538	+0.00001	ACM	
147	1	A	24	9.8	2806	1029	1113	23.7	24.1	24	P127	6490	6490	540	+0.00003	ACM Ran DI through the system, standardization came out the same	
148	1	88	20	9.3	2806	1334	1412	23.7	24.0	24	P127	6491	6490	540	+0.00003	KLL	
149	1	B	22	8.9	2806	1614	1655	23.7	24.0	24	P127	6489	6490	540	+0.00002	KLL	
150	1	3	19	10.4	2806	2040	2116	23.6	24.0	24	P127	6490	6490	540	+0.00002	KLL	
151	1	A	17	15.4	2906	0446	0518	23.4	23.8	24	P127	6490	6489	540	+0.00000	ACM	
152	1	88	17	13.3	2906	0518	0553	23.8	23.7	24	P127	6490	6490	540	+0.00002	ACM Ran with Sta 151	
153	1	J	3	12.1	2906	0555	0601	23.7	23.8	24	P127	6489	6489	540	+0.00000	ACM	
153	2	B	15	10.4	2906	0602	0632	23.8	23.9	24	P127	6489	6489	540	+0.00001	ACM Ran with Sta 153 Cast 1	

Table 1.10.0 WOCE A24 per-box salinometer log.

1.11. Oxygen Analysis

Samples were collected for dissolved oxygen analyses soon after the rosette sampler was brought on board and after CFC and helium were drawn. Nominal 125 ml volume-calibrated iodine flasks were rinsed twice with minimal agitation, then filled via a drawing tube and allowed to overflow for at least 3 flask volumes. The sample temperature was measured with a small platinum resistance thermometer embedded in the drawing tube. Draw temperatures are useful in detecting possible bad trips even as samples were being drawn. Reagents were added to fix the oxygen before stoppering. The flasks were shaken twice; immediately after drawing, and then again after 20 minutes, to assure thorough dispersion of the $MnO(OH)_2$ precipitate. The samples were analyzed within 4 hours of collection.

Dissolved oxygen analyses were performed with an SIO designed automated oxygen titrator using photometric endpoint detection based on the absorption of 365 nm wavelength ultra-violet light. Thiosulfate was dispensed by a Dosimat 665 buret driver fitted with a 1.0 ml buret. ODF uses a whole-bottle modified-Winkler titration following the technique of Carpenter [Carp65] with modifications by Culberson et. al [Culb91], but with higher concentrations of potassium iodate standard (approximately 0.012N) and thiosulfate solution (50 gm/l). Standard solutions prepared from pre-weighed potassium iodate crystals were run at the beginning of each session of analyses, which typically included from 1 to 3 stations. Several standards were made up during the cruise and compared to assure that the results were reproducible, and to preclude the possibility of a weighing error. Reagent/distilled water blanks were determined to account for oxidizing or reducing materials in the reagents. No preservative was added to the thiosulfate. The auto-titrator generally performed very well.

The samples were titrated and the data logged by the PC control software. The data were then used to update the cruise database on the Sun SPARCstations.

Blanks, and thiosulfate normalities corrected to 20˚C, calculated from each standardization, were plotted versus time, and were reviewed for possible problems. New thiosulfate normalities were recalculated after the blanks had been smoothed. These normalities were then smoothed, and the oxygen data were recalculated.

Oxygens were converted from milliliters per liter to micromoles per kilogram using the in-situ temperature. Ideally, for whole-bottle titrations, the conversion temperature should be the temperature of the water issuing from the bottle spigot. The sample temperatures were measured at the time the samples were drawn from the bottle, but were not used in the conversion from milliliters per liter to micromoles per kilogram because the software was not available. Aberrant drawing temperatures provided an additional flag indicating that a bottle may not have tripped properly.

Oxygen flasks were calibrated gravimetrically with degassed deionized water (DIW) to determine flask volumes at ODF's chemistry laboratory. This is done once before using flasks for the first time and periodically thereafter when a suspect bottle volume is detected. All

volumetric glassware used in preparing standards is calibrated as well as the 10 ml Dosimat buret used to dispense standard Iodate solution.

Iodate standards are pre-weighed in ODF's chemistry laboratory to a nominal weight of 0.44xx grams and the exact normality is calculated at sea. Potassium Iodate (KIO_3) is obtained from Johnson Matthey Chemical Co. and is reported by the suppliers to be > 99.4% pure. All other reagents are "reagent grade" and are tested for levels of oxidizing and reducing impurities prior to use.

3434 oxygen measurements were made. There were a few times when the data acquisition computer (PC) hung up and a sample was lost. The temperature stability of the laboratory used for the analyses was fair. No major problems were encountered with the analyses. Fifty-seven pair of replicate (ie. from the same rosette bottle) oxygen samples drawn. The standard deviation of the replicates was 0.004 ml/l. The oxygen data were used to calibrate the CTD dissolved O_2 sensor.

1.12. Nutrient Analysis

Nutrient samples were drawn into 45 ml high density polypropylene, narrow mouth, screw-capped centrifuge tubes which were rinsed three times before filling. The tubes were rinsed with 1.2N HCL before each filling. Standardizations were performed at the beginning and end of each group of analyses (one cast, usually 24 samples) with a set of an intermediate concentration standard prepared in low-nutrient seawater for each run from secondary standards. The secondary standards were prepared aboard ship by dilution from dry, pre-weighed primary standards. Sets of 6-7 different concentrations of shipboard standards were analyzed periodically to determine the deviation from linearity as a function of concentration for each nutrient.

Nutrient analyses (phosphate, silicate, nitrate and nitrite) were performed on an ODF-modified 4 channel Technicon AutoAnalyzer II, generally within one hour of the cast. Occasionally some samples were refrigerated at 4C for a maximum of 4 hours. The methods used are described by Gordon et al. [Atla71], [Hage72], [Gord92]. The colorimeter output from each of the four channels were digitized and logged automatically by computer (PC), then split into absorbence peaks. Each run was manually verified.

Silicate is analyzed using the technique of Armstrong et al. [Arms67]. Ammonium molybdate is added to a seawater sample to produce silicomolybdic acid which is then reduced to silicomolybdous acid (a blue compound) following the addition of stannous chloride. Tartaric acid is added to impede PO_4 color (interference). The sample is passed through a 15 mm flowcell and the absorbence measured at 660nm. ODF's methodology is known to be non-linear at high silicate concentrations (>120 M); a correction for this non-linearity is applied in ODF's software. All silicates during this expedition were in the linear range (<100 M).

Modifications of the Armstrong et al. [Arms67] techniques for nitrate and nitrite analysis are also used. The seawater sample for nitrate analysis is passed through a cadmium column where the nitrate is reduced to nitrite. Sulfanilamide is introduced, reacting with the nitrite,

then N-(1-naphthyl)ethylenediamine dihydrochloride which couples to form a red azo dye. The reaction product is then passed through a 15 mm flow-cell and the absorbence measured at 540 nm. The same technique is employed for nitrite analysis, except the cadmium column is not present, and a 50 mm flow-cell is used.

Phosphate is analyzed using a modification of the Bernhardt and Wilhelms [Bern67] technique. An acidic solution of ammonium molybdate is added to the sample to produce phosphomolybdic acid, then reduced to phosphomolybdous acid (a blue compound) following the addition of dihydrazine sulfate. The reaction product is heated to 58°C to enhance color development, then passed through a 50 mm flow-cell and the absorbence measured at 820 nm.

Nutrients, reported in micromoles per kilogram, were converted from micromoles per liter by dividing by sample density calculated at zero pressure, in-situ salinity, and an assumed laboratory temperature of 25°C.

Na_2SiF_6, the silicate primary standard, is obtained from Aesar, a division of Johnson Matthey Chemical Co., and is reported by the supplier to be >98% pure. Primary standards for nitrate (KNO_3), nitrite ($NaNO_2$), and phosphate (KH_2PO_4) are also obtained from Johnson Matthey Chemical Co. and the supplier reports purities of 99.999%, 97%, and 99.999%, respectively.

3439 nutrient analyses were performed. No major problems were encountered with the measurements. The pump tubing was changed 3 times, and deep seawater was run as a substandard on each run. The efficiency of the cadmium column used for nitrate was monitored throughout the cruise and ranged from 99.0-100.0%. The temperature stability of the laboratory used for the analyses ranged from 21 to 28°C, but was relatively constant during any one station ($\pm$1.5°C).

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2. Shipboard ADCP and LADCP

Shipboard ADCP

Upper ocean current measurements were made throughout the cruise using the hull-mounted acoustic Doppler current profiler (ADCP) system that is permanently installed on the R/V Knorr. The system includes five components:

1) an incoherent (narrow bandwidth, un-coded pulse) 4-beam Doppler sonar operating at 153 kHz (model VM-150 made by RD Instruments), mounted with beams pointing 30 degrees from the vertical and 45 degrees azimuth from the keel;

2) the ship's main gyro compass, continuously providing ship's heading measurements to the ADCP via a 1:1 synchro;

3) a Global Positioning System (GPS) attitude sensor (Ashtech model 3DF), which uses a 4-antenna array to provide interferometric measurements of ship's pitch, roll, and heading;

4) a GPS navigation receiver (Trimble Tasman) providing position fixes using both GPS frequency bands (L1 and L2) and the P and Y codes (military "Precision Positioning Service", or PPS);

5) an IBM-compatible personal computer running the Data Acquisition Software (DAS) version 2.48 from RD Instruments, augmented by Firing's software interrupt handler ("user exit") program "ue4", C. Flagg's user exit "agcave", and Flagg's TSR watchdog timer program.

The ADCP was configured for 16-m pulse length, 8-m processing bin, and a 4-m blanking interval (all distances being projections on the vertical and based on a nominal sound speed of 1470 m/s). The transducer depth was 5 m; 60 velocity measurements were made at 8-m intervals starting 21 m below the surface. About 240 pings were sent in each 5-minute averaging interval. For each ping, velocities relative to the transducer were rotated to a geographical coordinate system using the gyro compass heading, but assuming pitch and roll to be zero. The single-ping velocities were then vector-averaged over the 5-minute ensemble. The ensemble-averaging was done separately for the vertical average from bins 2 through 10 and for the deviation of each bin from this vertical subset; the two parts were then added back together and stored. The conversion from Doppler shift to velocity was done using sound-speed calculated from the temperature measured by a sensor in the transducer, assuming a constant salinity of 35 psu. When a velocity estimate in one of the four beams was missing, velocity was calculated from the remaining three beams.

In regions of shallow water, the ADCP was configured to track the bottom with one bottom-tracking ping for each water-tracking ping. This was effective to depths of 600 m or more. From the time the ship left Woods Hole to the last station of the present cruise, approximately 100 hours of underway bottom tracking data were collected. This is significant for the calibration calculations discussed below.

The user exit program integrated the GPS position and attitude information into the ADCP data stream. Position fixes were recorded at the start and end of each ADCP averaging interval (5-minute ensemble). Attitude from the 3DF was sampled at each ping and edited within each ensemble. The mean, standard deviation, minimum, and maximum values of pitch, roll, and compass heading error were calculated and recorded. The compass error is the quantity of primary interest: for each ping, the compass reading used by the ADCP was subtracted from the most recent 3DF heading (updated once per second), and this difference was taken as the time-variable compass error plus some constant misalignment of the 3DF antenna array. The 3DF attitude information was not used for the real-time vector-averaging of velocity because it is not quite reliable enough; dropouts and outliers do occur.

Velocity, position, and attitude measurements were post-processed using the University of Hawaii CODAS software package, generally as described by Firing in WHP Office Report WHPO 91-1, WOCE report 68/91. The essential modification since then is the rotation of the velocity measurements relative to the ship to correct for the gyro compass error as measured by the 3DF. After this correction, and a small but varying sound speed correction (not yet made at the time of this writing), standard water and bottom tracking calibration methods (Joyce, 1989; Pollard and Read, 1989) should yield two constants: a velocity scale factor, and a horizontal angular offset between the transducer and the 3DF antenna array. The angular offset is particularly important; an error of 0.1 degree leads to a cross-track bias of 1 cm/s for a ship speed of 11 kts. For the onboard data processing, these calibration factors were calculated based on bottom tracking from the transit from Woods Hole prior to the cruise and the transits to and from Cork. Water track calibration calculations based on the entire cruise (all stations--water track calibration requires ship accelerations, such as stops for stations) indicate an overall error of only 0.05 degree relative to the preliminary calibration. At present this small correction has not been applied. Closer inspection of all available calibration

information indicates that the "constant" factors are measurably not constant. The angle offset factor may vary within a range of up to plus or minus 0.2 degrees. A possible cause is under investigation; it is not clear whether it will be possible to reduce this uncertainty in the present or future data sets.

The quality of the shipboard ADCP data set from this cruise is exceptionally good. No instrument problems were detected; weather was mostly good and never very bad; there was an abundance of acoustic targets on the entire cruise track. The depth range was typically 400 m or more, sometimes a full 500 m, and only occasionally less than 300 m. There were no known compass failures and no long dropouts of 3DF data.

The upper ocean velocity field during the cruise is summarized in a map of shipboard ADCP velocity vectors averaged from 100 to 300 m (Figure 2.0); vertical shear was weak on most of the cruise track, so this layer average is representative. The overall impression is of weak currents--usually under 50 cm/s, and mostly in the form of ubiquitous small-scale squirts and eddies. The contribution from tides and near-inertial motions has not yet been estimated quantitatively, but I believe it is a small part of what we see in Figure 2.0. The East Greenland Current stands out as a narrow jet flowing southwestward along the Greenland coast, particularly off Cape Farewell. On the northern crossing, however, it appears to have been highly convergent in the cross-track direction. The eddy field was relatively strong in the Rockall Trough and in the Iceland and Irminger basins on the section from Scotland to Greenland. Currents were mostly weak on the section from the Azores to Ireland on leg 1, and between the sub-polar front (about 50°N) and the East Greenland Current on leg 4. At and south of the sub-polar front the currents are stronger, but much of the pattern is not easy to interpret. There seem to be four main zones of eastward flow north of 40°N, some of them very narrow. There is a major southward component in the sub-polar front and at other spots between there and the Azores.

Lowered ADCP

To measure velocity throughout the water column at each station, a self-contained ADCP was mounted on the rosette; this is referred to as the lowered ADCP (LADCP). The LADCP includes a magnetic compass and a tilt sensor, so the velocity profiles can be rotated into the local east-north-up coordinate system. Because the motion of the rosette over the ground is not measured, the LADCP measurements of current relative to the instrument cannot be used directly to infer the current over the ground. Instead, the single-ping velocity profiles are differentiated vertically to remove the package motion (which changes only slightly between the time a ping is transmitted and the time the back-scattered return is received). The vertical shear estimates from all pings are then interpolated and averaged on a single uniform depth grid covering the whole water column. This full-depth shear profile is integrated vertically to yield a velocity profile with an unknown constant of integration; and the constant is calculated from the known displacement of the instrument between beginning and end of the cast, together with the shape of the relative velocity profile and the measured current past the instrument as a function of time during the cast. The method is explained in detail by Fischer and Visbeck (1993).

A24 ACCE-2   SHIPBOARD-ADCP

May 31 to June 28, 1997 CTD stations 1-153
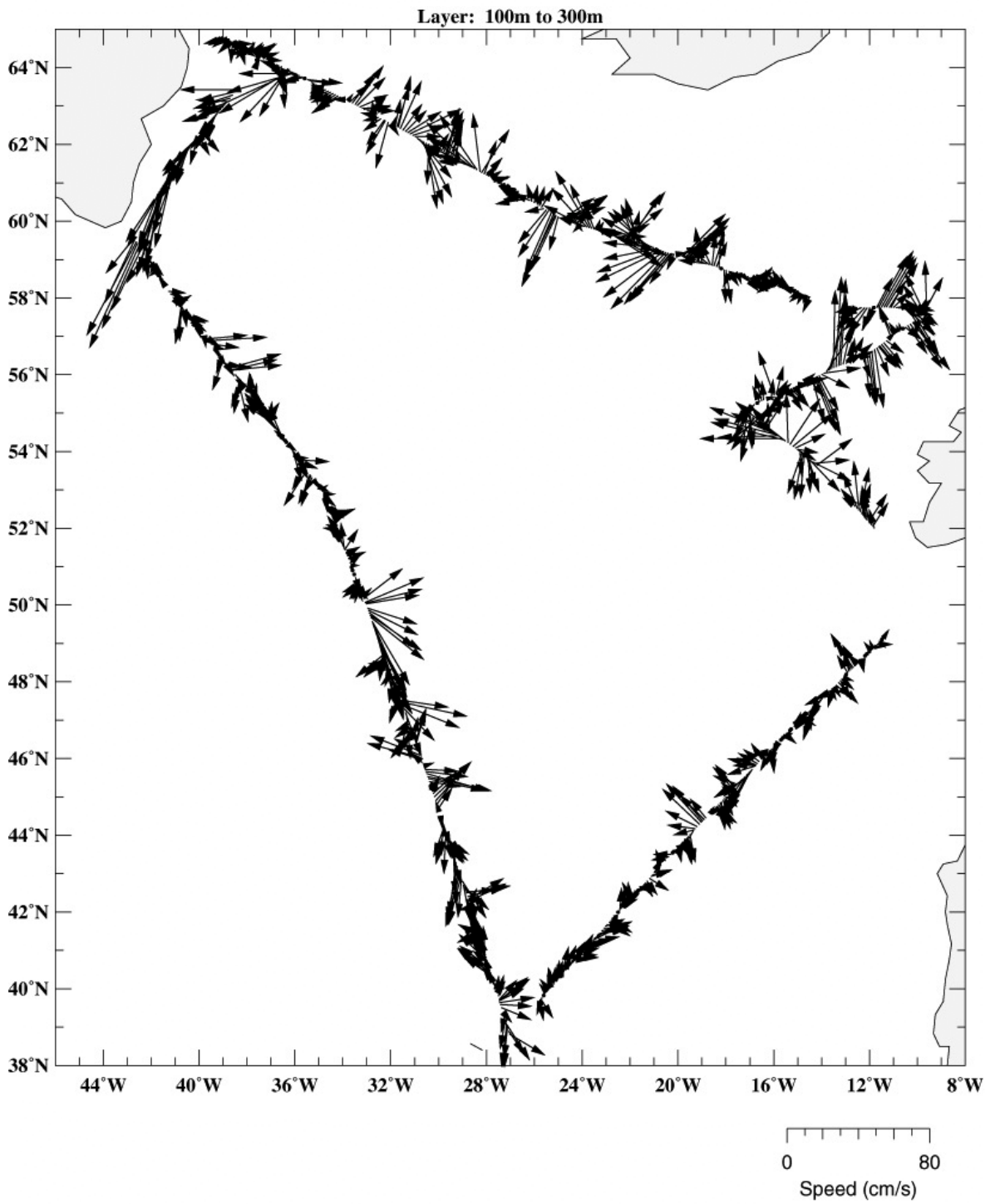
Layer: 100m to 300m

Figure 2.0 A24 Shipboard ADCP velocity vectors.

The instrument used on this cruise was a new 150-kHz coded pulse ("Broadband") profiler made by RD Instruments (a specially modified Phase-III DR-BBADCP), with four beams angled 30 degrees from the vertical. All but four of the 154 profiles were made with the following instrument parameters: blanking interval, pulse length, and processing bin length were all set to 16 m (projected on the vertical). Sixteen depth bins were recorded. Pings were transmitted alternately at 1 and 1.5 or 1.6 second intervals. Data from each ping was recorded individually, with no averaging. Ambiguity resolution mode 1 (no automatic resolution) was used, with an ambiguity interval of either 3 m/s or 3.6 m/s--the smaller value was used when weather was exceptionally calm. Medium bandwidth was selected. Three-beam velocity solutions were not used, and solutions with an error velocity exceeding 15 cm/s were rejected. Bin-mapping based on tilt was selected.

Immediately after each station the data were dumped from the LADCP to a PC via a serial line (RS-422), and transferred to a Sun workstation for archiving and processing. The profile was processed using the University of Hawaii system, a mixture of C, Matlab, and Perl programs. Velocity and shear data are automatically edited based on several criteria including correlation magnitude (typically 70-count minimum), error velocity (10 cm/s maximum), deviation of vertical velocity in a given bin from its vertical average (5 cm/s maximum), and deviation of individual shear estimates from a mean shear profile (3.5 standard deviations). These parameters are subject to change in later processing, but the values quoted seemed reasonable and adequate for the present data set. Additional editing is done on the upcast: the top two depth bins are rejected if the current, profiler vertical velocity, and profiler orientation are such that one beam may be intersecting the profiler's wake. Depth bins subject to contamination from the side-lobe return from the bottom, or from the return of the previous ping from the bottom, are also automatically rejected. Critical to this part of the editing is accurate knowledge of the depth of the bottom and the depth of the profiler. Therefore we have an automated routine for matching the time series of vertical velocity measured by the LADCP with the time series of vertical velocity calculated from the CTD pressure record, and then assigning the corresponding CTD-derived depths to the LADCP. With these instrument depths in the LADCP database, another program scans the LADCP back-scatter amplitude profiles in the near-bottom region; the LADCP depth plus the vertical range to the amplitude maximum is the bottom depth. With a high quality and continuous CTD time series available from ODF immediately after each cast, we were able to complete the LADCP processing about 20 minutes after the end of the data transfer.

Accurate position fixes at the start and end of the LADCP profile are essential to the calculation of absolute velocities. We log the PPS GPS fixes at the full 1 Hz sampling rate. The processing software accesses these files and extracts the subsets needed for each profile. Magnetic variation is needed to calculate true direction from the compass readings; we calculate the variation from a standard model of the earth's magnetic field. To date we have not, however, performed any calibration of the compass in the instrument, but have taken the compass headings at face value.

As with the shipboard ADCP, and for the same reasons, the LADCP quality on this cruise is excellent. Package motion was moderate and scattering levels were good, particularly at the higher latitudes. The only instrument problem was a bizarre incident early in the cruise: at

stations 2 and 3 the program usually used to communicate with the LADCP (BBSC) gradually ceased working with it. (It turns out that a similar problem was encountered by Doug Wilson at about the same time. As of this writing, no one understands what happened, given that both failures occurred with profiler/PC/program combinations that had been working normally.) A simpler alternative program (BBTALK) was completely unaffected, and was used for the remainder of the cruise. In the scramble to switch to BBTALK for station 4, the setup commands were entered by hand and something seems not to have been right-the profiler returned garbage during about the first third of the cast, then inexplicably started recording normal-looking profiles. The result is that profile 4 is incomplete at best, and probably will be neglected henceforth.

A map of LADCP current vectors averaged over the full depth range of the profile (Figure 2.1) shows some characteristics of the currents as observed on this cruise. As in the shipboard ADCP data, the East Greenland Current stands out as a prominent feature amid the welter of eddies. The barotropic component of the eddy field is weakest on the Azores-Ireland section and strongest on the Scotland-Greenland section, where vertically averaged velocities of 10 cm/s or more are common. The eddy field is not well resolved by the station spacing; the velocity profiles typically change radically from one station to the next. The tidal fraction of the velocity field measured by the LADCP has not yet been estimated, but is not expected to dominate the observations in any of the more energetic regions.

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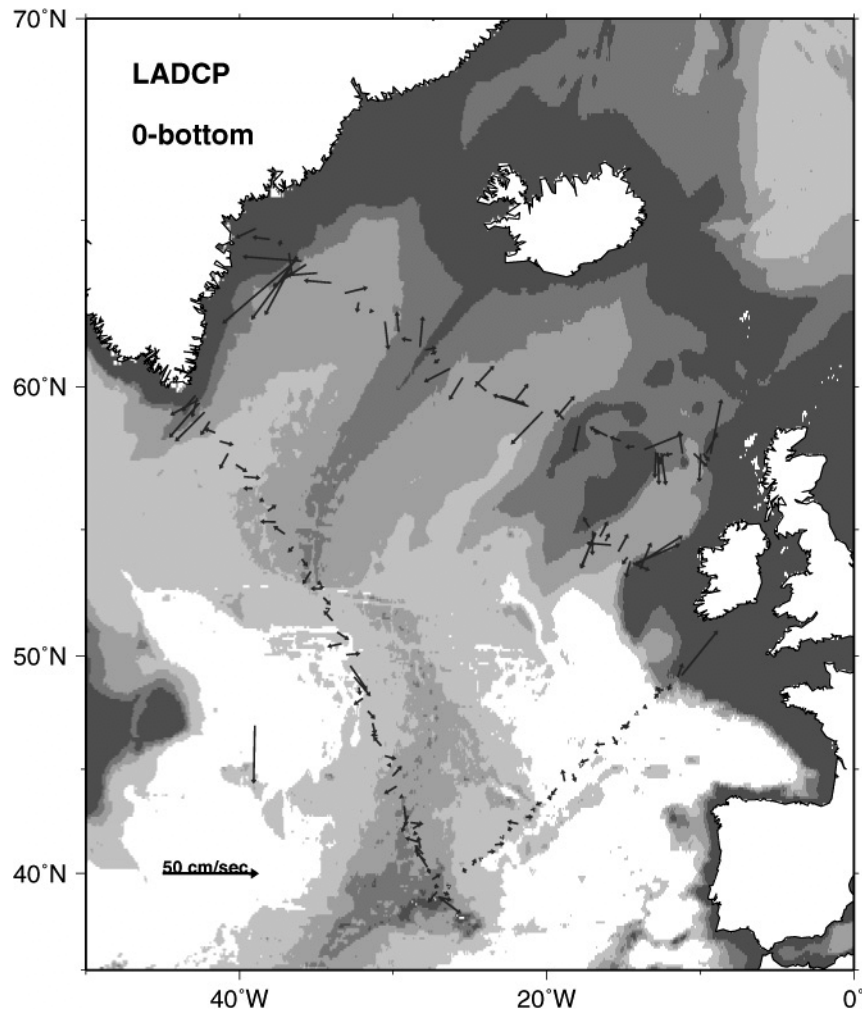
Figure 2.1 A24 Map of LADCP current vectors.

3.   CFC-11 and CFC-12

Sample Collection

Water samples were collected using 10 liter Niskin bottles which were cleaned for CFC analysis. All O-rings of the Niskin bottles (end cap O-rings and spigot O-rings) were baked in a vacuum oven to remove CFCs. CFC samples were drawn from 10 to 31 Niskin bottles per station, depending on bottom depth or station spacing. 100 ml precision groundglass syringes with Luer-lock fittings were used to draw water samples from the Niskin bottles. Vacuum-baked syringe valves were used, and were replaced whenever there was a suspicion of contamination or leakage. In general, sampling for CFC analysis was done at every station alternating fulldepth sampling and partial-depth sampling depending on the measurement progress of the previous station's samples. The partial depth sampling was planned according to the CFCs results readily available from previous stations as well as from the CTD profiles. A total of 2085 water samples from 132 CTD stations were measured, including approx. 70 duplicate pairs used to estimate measurement precisions. The shipboard CFC values will be

finalized after a few minor blank corrections and a stripper efficiency correction for CFC-11 in the lab. Typical stripping efficiency of CFC-11 in various water temperature during this cruise is approx. 99.3%.

Air samples were collected by Air Cadet pump through intake lines of 3/8" OD Decabon tubing from inlets at the bow and stern of the vessel. The bow side air intake was mostly used during this cruise. 107 air samples were measured to estimate current atmospheric CFC concentrations and to calculate the surface water CFC saturation conditions. Three or four replicate air samples were measured at each location to obtain reliable numbers.

Equipment and Technique

The chlorofluorocarbons CFC-11 and CFC-12 were measured by an ECD-GC (electron capture detector equipped gas chromatograph system), as described by Bullister and Weiss (1988), with slight modifications. Gas samples, dry air or standard gas, were injected onto a cold trap (-30°C) for concentration. Approximately 30 cc of seawater from collected samples was introduced into a glass stripping chamber where the dissolved gases were purged with purified gas, and the evolved CFCs were concentrated using the same cold trap. The trap was subsequently isolated and heated (100°C), so that the evolved CFCs could be transferred into a pre-column (15 cm of Porasil-C) and then a chromatographic separating column (3 m of Porasil C) held at 70°C in the GC oven. The ECD was operated at 250°C. The analysis of all water samples was completed within 3 to 7 hours of the water coming on board. Typical standard gas and water sample chromatograms are shown in Figures* 1a and 1b. The data acquisition, peak integration and calculation were carried out by a Sun Microsystems computer with an HP35900 chromatographic interface.

Calibration

The CFC-11 and CFC-12 analyses were calibrated over the concentration range of the samples, using calibration curves made by injections of fixed volumes of standard gas filled to various pressures as measured by a precision quartz pressure transducer (Paro-scientific 740). Using polynomial curves fitted to the calibration points, the corrected peak areas were converted into molar concentrations. The standard gas was prepared at the Scripps Institution of Oceanography (SIO) and was calibrated on the SIO 1993 scale.

Preliminary Results

CFC-11 and CFC-12 were near saturation in surface waters, and deep and bottom waters of the North Atlantic Ocean basins are in general well ventilated unlike the Indian or Pacific Ocean where deep basins are mostly filled with low CFC or CFC-free waters. The lowest CFC content water was observed in the North-Eastern Atlantic Basin in the LEG-1 (Azores to Ireland) toward the north below 3000-4000 m (CFC-11: less than 0.04 pmol/kg). Typical CFCs profiles from different basins are shown in Figures* 2a, 2b and 2c to show dynamic and spatially heterogeneous features of the North Atlantic Ocean. Well known bottom and deep water features such as overflow waters and the Labrador Sea Water were clearly resolved by CFCs distributions. High CFC-content Denmark Strait Overflow Water (DSOW) was observed

in the Irminger Basin (LEG-3) and on the Eirik Ridge south of Greenland (LEG-4). The other high CFC-content overflow water, Iceland-Scotland Overflow Water (ISOW), was observed on the eastern flank of the Reykjanes Ridge in the Iceland Basin and on the western side of the ridge in the Irminger Basin (LEG-3). The low salinity, high CFC and high oxygen content Labrador Sea Water (LSW) was observed at about 1500-2000 m depth range in nearly every survey section. The CFC concentration of the LSW core layer was highest (CFC-11: ~4 pmol/kg) on the Eirik Ridge, Greenland (LEG-4) and in the Irminger Basin, and progressively became lower toward the west and south. The CFC-11 concentration of the LSW core layer observed in the North-Eastern Atlantic Basin (LEG-1) was as low as 1.5-2.0 pmol/kg. The mid-depth low CFCs, low oxygen and high salinity water originated from the Mediterranean Sea was observed in the Azores-Ireland (LEG-1) section, in the southern Rockall Trough (LEG-2) section, and the southern part of the Greenland-Azores (LEG-4) section at approx. 1000 m depth. Thick and relatively homogeneous Subpolar Mode Water with high CFC concentration was well developed in the upper few hundred meters in the northern part of the survey area. The highest CFC concentration surface water was generally found in the Eastern Greenland Current area. Near 0°C cold surface water near the Angmassalik, Greenland (LEG-3) showed the highest CFC concentration (CFC-11: as high as 6.83 pmol/kg). The CFC-11 contour sections from the four legs of this expedition in the subpolar North Atlantic Ocean are shown in Figures* 3a-d.

Reference

Bullister, J. L., and R. F. Weiss. 1988. Determination of CCl_3F and CCl_2F_2 in seawater and air. Deep-Sea Research, 35: 839-853.

4.   Alkalinity

Dr. Frank J. Millero's University of Miami group measured Total Alkalinity (TA) using a potentiometric titration system for the WOCE/ACCE North Atlantic A24 research cruise aboard the R/V Knorr. Two systems were operated, each consisting of a Metrohm 665 Dosimat titrator, an Orion pH meter, a fixed volume closed plexiglass cell, and a PC. During the transit from Woods Hole, MA to Ponta Delgada, Azores, 300 underway samples were collected from the flowing seawater line. The samples were taken every half an hour, with additional salt samples collected from the flowing line once daily for comparison with the TSG data. The transit from west to east showed a decline in TA normalized to salinity (NTA), with values ranging from approximately 2400 to 2280 mmol/kg. Some interesting features were observed in the rapid change intervals of mixing water between roughly 63°W to 53°W, as well as, a peak in the NTA at 44°W.

The next leg of the cruise departing from the Azores was a repeat of a previous cruise track from the Fall of 1996. 153 CTD stations were carried out to depth to give a hydrographic profile of the cruise transects. Alkalinity followed the TCO_2 group's sampling strategy, where at every other station, a full CTD cast was sampled. Surface duplicates were sampled on the stations in between. This sampling strategy was chosen due to the time involved in analyzing the samples versus station spacing. Comparisons between the Fall 96 cruise and this Summer 97 cruise show some slight seasonal shifts in salinity, temperature, and TA.

Upon finishing the rectangular cruise track in the North Atlantic offshore of the Azores, underway samples were again collected during the transit to Halifax, Nova Scotia. 114 TA samples were collected every hour during the last transit, while salts were collected every 6 hours for comparison to the TSG data. The transit from east to west showed an increase in NTA, with values ranging from approximately 2280 to 2360 mmol/kg. The sea surface temperature reported almost 10˚C higher than the data collected at the latitudes further south. Interesting features were again observed in that the mixing waters beginning around 47˚W, with the peak in NTA previously observed at 44˚W, drastically decreased at the higher latitude.

5. CO_2

6.   Helium, Tritium and ^{18}O

Sample Collection

Water samples for later analysis of helium, tritium and ^{18}O were collected from 10 litre Niskin bottles. The strategy was to sample the entire water column with emphasis on Labrador Sea Water and the Overflow waters. In particular, we extensively sampled the east Greenland Shelf and Slope.

607 Helium samples, 596 Tritium samples, and 367 ^{18}O samples were collected at 43, 42 and 37 stations respectively. Since samples for ^{18}O measurement will also be drawn from the tritium samples, the total number of samples available for ^{18}O analysis is 963. Water samples for Helium analysis were collected in stainless steel cylinders with rotating plug valves on both ends. The cylinder was attached to the spigot on the Niskin by tygon tubing. When not in use, the tubing was kept soaked in a bucket of seawater to keep it conditioned. Tritium samples were collected in 1 litre glass bottles. The bottle caps were then secured using insulation tape.

^{18}O samples were collected in 30 ml glass bottles. Bottle caps were secured similarly.

Equipment

Samples collected in the cylinders were processed on board for Helium. This was done using the "at sea extraction system" provided by W.J. Jenkins of the WHOI Helium Isotope Lab (Jenkins, 1992). The extracted Helium was collected in 30 ml glass bulbs, which were subsequently flame-sealed. All samples will be analysed mass-spectrometrically at the Lamont-Doherty Earth Observatory. Helium and Tritium samples will be analyzed in the Noble Gas Lab using techniques described in Bayer (1989). ^{18}O samples will be analyzed in the Stable Isotope Lab.

References

Bayer, R., Schlosser, P., Bonisch, G., Rupp, H., Zaucker, F., and Zimmek, G., 1989. Performance and blank components of a mass spectrometric system for routine measurement of helium isotope and tritium by the ^{3}He ingrowth method. Sitzungsberichte der heidelberger Akademie der Wissenschaften, Mathematisch-naturwissenschaftliche Klasse.

Jenkins, W. J., 1992. ASEX User's Manual: Documentation on procedures, software and hardware for the At Sea Extraction System, version 2.0. Woods Hole Oceanographic Institution.

Appendix A Bottle Quality Comments

All data comments per PI's request from WOCE A24 ACCE. Investigation of data may include comparison of bottle salinity and oxygen data with CTD data, review of data plots of the station profile and adjoining stations, and rereading of charts (i.e., nutrients). Comments from the Sample Logs and the results of ODF's investigations are included in this report. Units stated in these comments are degrees Celsius for temperature, Practical Salinity Units for salinity, and unless otherwise noted, milliliters per liter for oxygen and micromoles per liter for Silicate, Nitrate, and Phosphate. The first number before the comment is the cast number (CASTNO) times 100 plus the bottle number (BTLNBR).

Station 001

Cast 1   Salinity samples are all from rerunning the samples. An error was made in transferring the data. No printouts were made of the data before the transfer. NO_3 appeared low, shallow, when plotted vs. pressure. Bottom NO_3 appeared high, O_2 high compared with adjoining stations. No analytical problem found. N:P ratio acceptable.

107   Salinity is low compared to CTD. No analytical problem found. Salinity is acceptable.

106   Sample Log: "Leak from bottom end cap." Oxygen as well as other samples are acceptable. Salinity was lost, see Cast 1 salinity comment.

104   Salinity was lost, see Cast 1 salinity comment. Pressure is 808db.

103   Sample Log: "Bottom end-cap leak when vent cracked." Oxygen is high. Other samples appear to be acceptable. Footnote O_2 bad. Pressure is 908db.

102   Salinity is high compared to CTD. No analytical problem found. Salinity is acceptable.

101   Salinity is high compared to CTD. No analytical problem found. Salinity is acceptable.

101-120   CTD upcast had to be used. Therefore, CTDO lost.

Station 002

Cast 1   Console Ops: "Changed to CTD 5, because of prim temp offset on sta 001." Salinity file was lost during computer transfer. Fortunately, a duplicate set of salinity samples were drawn and eventually run. The data that is reported is the second drawn samples.

124   Oxygen: "Flask 1453 may have a calibration problem." Oxygen data is acceptable.

114	Salinity is high, nutrients are low, oxygen appears to be okay. Footnote bottle leaking, samples bad.
107	Oxygen: "Flask 1408 may have a calibration problem." Oxygen is acceptable.
103	Sample Log: "Bottom cap leaking." Oxygen is low. Other data are acceptable. Footnote bottle leaking and oxygen bad.

Station 003

124-125	Sample Log: "Not closed, pylon is advanced 2 places as it should be." So the first attempt at tripping bottle 14 did not work. These bottles were not suppose to be closed. Comments on Sample Log confirm suspicion of proper bottle closure.
Cast 1	Sample Log: "Tripping problem." Console Ops: "No confirm, 1 push on 14, 2 No confirms." One level was missed (600 desired depth), but that was because of an operator error. Console operator did not realize the No confirm message and had the winch operator come up to next tripping depth. Data are correct as pressure assigned.
123	Sample Log: "Vent not closed." Oxygen as well as other samples are acceptable.
116	PO_4 appears 0.04 high. Nutrient analyst could not find any analytical problems. PO_4 is acceptable.
114-123	Bottles did not trip as scheduled. Data appear acceptable as trip levels reassigned. See Cast 1 comments.
112	Salinity indicates a large delta-S with CTD. Gradient area, salinity appears to be okay.
108	Sample Log: "Vent not closed." O_2 is high. Other samples are acceptable. Footnote bottle leaking, oxygen bad.
105	Oxygen is low compared to adjoining stations and CTDO. No analytical problems noted. Feature is not seen in other parameters. Footnote oxygen questionable.
103	Sample Log: "Bottom seal leaks." Salinity is ~0.020 low. Footnote salinity bad. Oxygen as well as other samples are acceptable.
101-102	Sample Log: "May have bubbled nitrogen through the valve." Oxygen as well as other samples are acceptable.

Station 004

123	Sample Log: "Vent was open." Oxygen as well as other samples are acceptable.
120	O_2 is high, nutrients are low. Salinity agrees with the CTD. Data are acceptable. O_2 does not agree with adjoining stations. Footnote o2 bad.
114	Oxygen minimum, but nutrients are also low. Nutrient Analyst: "No analytical problems found."
111	Delta-S at 1122db is -0.0062. No analytical problems noted. Salinity is acceptable.
108	Sample Log: "Leaker." O_2 appears to be acceptable. Delta-S at 1536db is 0.006. Salinity is high. No analytical problems noted. Footnote salinity bad.
105	Salinity is ~0.006 high. No analytical problems found. Footnote salinity bad per PI review notes.
103	Sample Log: "New bottle." O_2 as well as other samples are acceptable.

Station 005

111 Salinity large delta with CTD. Gradient area. Other samples are acceptable. Density inversion with this salinity, therefore salinity probably not real. Footnote salinity bad.

106 Salinity high compared with CTD. Autosal diagnostics indicate 4 tries to get a good reading. Gradient area, salinity minimum. Variation in CTD trace. Salinity is acceptable.

103 Sample Log: "Vent left open." O_2 as well as other data are acceptable.

Station 006

128 Sample Log: "Not closed." Okay, not suppose to be.

Cast 1 Console Ops: "Duplicate No Confirm on 11, No confirm, retrip on 22." One level was missed (1500 desired depth). Data are correct as pressure assigned.

124 Oxygen is high and nutrients low, salinity is acceptable when compared to adjoining stations. N:P ratio is good. Data are acceptable.

113 Salinity is low, oxygen and nutrients high. N:P ratio is good. Data are acceptable.

111-127 See Cast 1 comments. Footnote bottle did not trip as scheduled. Data are acceptable as pressure for trip levels assigned.

109 Sample Log: "Salt bottle thimbles don't fit." Salinity is acceptable.

104 Oxygen: "Late start." Oxygen is acceptable.

103 Salinity bottle had a loose thimble. Salinity is a little low. Footnote salinity questionable, out of WOCE spec.

101 Sample Log: "Vent not closed." Oxygen as well as other data are acceptable. Autosal diagnostics indicate 4 tries before getting readings to agree. The first readings gave better results and are used in this salinity calculation. Salinity is acceptable.

Station 007

Cast 1 Console Ops: "2 No confirms, 1 push on 2, 2 No confirm 1 confirm on 12, 2 No confirm 1 confirm on 19, 2 No confirm 1 confirm on 20. One level was missed (3800 desired depth). Data appear acceptable as trip levels reassigned.

119 Sample Log: "Vent open." Oxygen as well as other data are acceptable.

117 PO_4 ~0.06 high, so is SiO_3 high. Nutrient analyst: "No analytical problem found, peaks, calcs look okay, normal n:p."

111 SiO_3 a little high. Nutrient analyst: "No analytical problem found, peaks, calcs look okay."

110 SiO_3 ~1.0 high. Nutrient analyst: "No analytical problem found, peaks, calcs look okay."

102-127 See Cast 1 comment. Footnote bottle did not trip as scheduled.

Station 008

Cast 1 No comments on the Sample Log. Console ops: "2 No confirm, 1 confirm on 12, 2 No confirm, 1 confirm on 17. No levels were missed and bottles tripped on the confirm signal.

125 Nutrients low, O_2 high, salinity agrees with adjoining stations. Nutrient analyst: "N:P normal, no analytical problem found."

109-110   Oxygen appears low compared to adjoining stations, agrees with CTDO. Oxygen is acceptable.

Station 009

Cast 1   No comments on the Sample Log. Console Ops: "Retripped 5." No levels were missed and bottles tripped on the confirm signal.

116   O_2 looks high, but is okay, agrees with CTDO. Salinity gradient area acceptable. NO_3 maybe 0.4 high, PO_4 0.04 high. Nutrient Analyst: "Peaks okay, calculation okay. No problem noted. This peak is higher than adjacent peaks. Could be real." 106 Autosal diagnostics had the sample run 6 times. This bottle gave analyst trouble last time it was used. This time it caused a problem with the data. Footnote salinity bad. Salinity bottle removed from box and replaced with a new bottle.

105   Oxygen is ~0.04 low. No analytical problems noted. Footnote oxygen questionable.

102-105 PO_4 slightly low. Nutrient analyst: "No analytical problems found, N:P same as Sta 008."

101   SiO_3 high. Nutrient analyst: "No analytical problems found."

Station 010

Cast 1   No comments on the Sample Log.

128   Sample Log indicates that no salinity was drawn, but there is a sample and it appears to be acceptable.

129   No salinity sample drawn, only TCO2.

126   Sample Log indicates that no salinity was drawn, but there is a sample and it appears to be acceptable.

125   Had trouble getting two reading to agree, but agrees fairly well for shallow value with the CTD.

124   Oxygen appears high, flask 1308. Data are acceptable.

116   Salinity low compared with CTD. No analytical problem found. Gradient area. Agrees fairly well with adjoining stations.

101   Salinity about 0.003 high. No analytical problem found. Footnote salinity bad.

Station 011

Cast 1   Console Ops: "SBE pylon changed into rosette trip 1: 3 false confirms, manually fired after resetting." No levels were missed and bottles tripped on the confirm signal. Bottles were tripped as console operator had expected.

126   Nutrients high, oxygen low. Data are acceptable. Salinity agrees with adjoining stations.

121   Nutrients were not drawn. This was an error in sampling, they should have been drawn. Footnote nutrients lost.

116   Nutrients were not drawn. This was an error in sampling, they should have been drawn. Footnote nutrients lost.

105   Sample Log: "Anomalous O_2 draw temp." Salt way high. Suspect bottle tripped on the way down between 300 and 400 db. Footnote bottle did not trip as scheduled, samples bad.

104	Bottle tripped at deepest level by request of console operator through the pylon trip box.
101	O_2 is a little low. SiO_3 high. Nutrient analyst: "No analytical problem found."

Station 012

120	Salinity is high compared with CTD. PI: "Okay."
116	Oxygen: "During titration, PC froze up, sample lost."
115-120	PO_4 low, NO_3 low in this range. Nutrient analyst: "Could be low, N:P a little high, but hard to tell. No analytical problem noted."
114	Salinity has a large difference with the CTD agrees with adjoining stations. Salinity is acceptable.
111	O_2 high, nutrients low. Data is acceptable.
108	Sample Log: "Leaky vent." Oxygen as well as other data are acceptable.

Station 013

119	Sample log: "Vent not closed." Oxygen as well as other data are acceptable.
110	PO_4 appears high. Nutrient analyst: "NO_3 higher here, too. N:P looks about right.
107	Salinity does not agree with CTD. No analytical problem found. Oxygen appears slightly low. Gradient area. Other samples appear to be acceptable.
101	SiO_3 low. Nutrient analyst: "No analytical problem found."

Station 014

Cast 1	Tripping problem. CTD tripping diagnostics indicated that bottle 5 did not trip, console operator then tried to fire the bottle but instead bottle 6 closed. Data are correct as pressure is assigned.
108	Sample log: "Leaking from vent." Oxygen as well as other samples are acceptable.
105	Console Ops: "Retripped, confirmed." Sample log: "Didn't close." Bottle did not close, but CTD data the same as bottle 6 is included to give users an additional flag that there was a slight problem, but it has been properly resolved.
102	Salinity ran 4 times, loose thimble. The first readings gave better results and are used in this salinity calculation. Salinity is acceptable.

Station 015

Cast 1	Sample Log: "No surface sample."
132	Surface CTD data included for data users convenience.
130-131	Bottles did not trip as scheduled. They tripped one level shallower than planned.
128	Console Ops: "One no confirm, then confirm." Bottle tripped as scheduled.
129	Sample Log: "Didn't close." Only the CTD data is included.
110	Salinity is a little high compared with CTD. No analytical problems found. Different water from adjoining stations.
109	Salinity is a little high compared with CTD. No analytical problems found. Different water from adjoining stations. Oxygen high and nutrients low (NO_3, SiO_3, PO_4)

108   Salinity is a little high compared with CTD. No analytical problems found. Different water from adjoining stations. Oxygen is low; could be Labrador Sea Waters.

102-108 The oxygen appears lower than adjoining stations. However SiO_3 seems to follow that same pattern.

Station 016

Cast 1   No comments on the Sample Log. Nutrient analyst double checked entire SiO_3 profile.

126   Autosal diagnostics indicate 4 tries to get a good reading. Salinity is high compared with CTD. Variation is CTD trace, difference between the down and up. PI: "Salinity is acceptable."

123   Salinity is high compared with CTD. No analytical problem noted. Salinity is acceptable.

118   Salinity is low compared with CTD. No analytical problem noted. Salinity is acceptable. PI: "High gradient region."

114   Salinity is high compared with CTD. Autosal diagnostics indicate 4 tries to get a good reading, indicating a problem with the samples. Footnote salinity bad.

112   Oxygen may be low as compared to CTDO. No analytical reason noted for low oxygen. Feature does not show in other properties or adjoining stations. PI: "This is okay, just the most extreme Labrador Sea water in the section."

111   Oxygen appears high. No analytical reason noted. Feature does not show in other properties or adjoining stations. Oxygen agrees with CTDO. Oxygen is acceptable. See 112 PI comment.

110   Salinity is high compared with CTD. No analytical problem noted. Gradient area. Salinity is acceptable.

101   Salinity is high compared with CTD. Autosal diagnostics indicate 4 tries to get a good reading, indicating a problem with the samples. Footnote salinity bad.

Station 017

120   Sample Log: "Lanyard hung, leaking." Salinity is high compared with CTD. No analytical problems found. Oxygen as well as other parameters appear to be acceptable. There is a large change in salinity between the down up, salinity may also be acceptable.

119   Sample Log: "O_2 flask 1403 broke, replaced by 1515."

112   Sample Log: "Lanyard hung, leaking." Salinity is high compared with CTD. No analytical problems found. Nutrients and oxygen are a little low. Footnote bottle leaking, samples bad.

109   Console Ops: "10th light on."

107   Console ops: "No FF08, 7 light on."

108   Sample Log: "Was open, didn't close." Console Ops: "FF10 9th light on." Bottle did not close, but CTD data the same as bottle 7 is included to give users an additional flag that there was a slight problem, but it has been properly resolved.

106-111 NO_3 appears low, SiO_3 low and O_2 high. Nutrient Analyst: "No analytical problem noted, different water perhaps."

Station 018

124	Oxygen high and nutrients (NO_3, SiO_3, PO_4) low
119	Salinity is higher than CTD. No analytical problem found. Feature in CTD which gives a large Delta-S. Salinity is acceptable. Other data also okay.
109	Console Ops: "Off by 1." Bottle tripped after 10, footnote bottle did not trip as scheduled. Data are acceptable. Bottle tripped before 09, the pylon was manually positioned and the bottle tripped as planned.
110	Console Ops: "Manual position." Sample Log: "Leaking from end cap." Oxygen as well as other data are acceptable. Bottle tripped before 09, the pylon was manually positioned and the bottle tripped as planned.
108	Console Ops: "No confirm, then confirm."

Station 019

Cast 1	No comments on the Sample Log.
127	Oxygen: "PC locked up, lost sample."
120	NO_3 and PO_4 appear high. Nutrient Analyst: "Gradient here, probably real."
119	Salinity is high compared with CTD. No analytical problem found. Oxygen is high. NO_3 and PO_4 also appear high. Nutrient Analyst: "Gradient here, probably real."
107	Salinity analyst switched to 8 before finishing 7. All conductivity ratios were remembered and written down.
101	SiO_3 low. Nutrient analyst: "No analytical problem found. Agrees with 102 and 103 which it should." Data are acceptable.
101-131	Power failure on down cast--not recoverable. CTDO lost. Noticed that there was a power failure on the deck unit at 2400db, brought CTD up to 1500 then back down.

Station 020

124	Salinity is high compared with the CTD. Autosal diagnostics indicate 4 tries to get a good reading, indicating a problem with the samples. Salinity agrees with adjoining stations. Offset as much as station profile 100-700 db.
121	Salinity is high compared with the CTD. Autosal diagnostics indicate 4 tries to get a good reading, indicating a problem with the samples. Salinity agrees with adjoining stations.
119	Salinity is high compared with the CTD. Autosal diagnostics indicate 4 tries to get a good reading, indicating a problem with the samples. PI: "Could be okay, high variability region." CTD profile indicates changing area. Down/up differences. Salinity is acceptable.
116	Salinity is low compared with the CTD Autosal diagnostics indicate 4 tries to get a good reading, indicating a problem with the samples. Agrees with Station 019. Salinity is acceptable.
108	Sample Log: "Vent not fully closed." Oxygen as well as other samples appear to be acceptable.

| 104 | Salinity is high compared with the CTD. Autosal diagnostics indicate 3 tries to get a good reading, indicating a problem with the samples. Also high compared with adjoining stations. Footnote salinity bad. |
| 101 | Oxygen high. No analytical problem noted. Footnote oxygen bad. |

Station 021

Cast 1	SiO$_3$ ~0.6 high. Nutrient analyst: "No analytical problem noted." SiO$_3$ is acceptable.
104	Console Ops: "Manually positioned with software to 4, no affect. Dialed up 4 on deck unit and pushed button, bottle closed. This occurred with the rosette at the surface." Sample Log: "Surface bottle."
112	Salinity is high compared with the CTD. Autosal diagnostics indicate 3 tries to get a good reading. Variation in CTD trace. PI: "Salinity is acceptable."
107	Salinity is high compared with the CTD. Autosal diagnostics indicate 3 tries to get a good reading, indicating a problem with the samples. Footnote salinity bad.

Station 022

Cast 1	No comments on the Sample Log.
130	PO$_4$ ~0.4 high. Nutrient analyst:" High surface gradient here." Data are acceptable.
124	Oxygen ~0.2 high. No analytical problems noted. Footnote oxygen bad.
123	Oxygen ~0.3 high on station profile. No analytical problems noted. Oxygen agrees with CTDO. Oxygen is acceptable.
122-124	Nutrients appear low, oxygen appears high. Salinity agrees with CTD. Suspect this is real feature. Data are acceptable.
105-108	Nutrients appear low, oxygen appears high. Salinity agrees with CTD. Suspect this is real feature. Data are acceptable.
102	Several tries to get two readings to agree. The first readings gave better results and are used in this salinity calculation. Salinity is acceptable.

Station 023

Cast 1	No comments on the Sample Log.
116	Salinity is low compared to CTD. Salinity, oxygen and nutrients low. Salinity and O$_2$ would be higher if the bottle leaked. Data are acceptable.
110	Salinity is high compared to CTD. Oxygen is a little high, nutrients are a little low. Oxygen agrees with CTDO. Data are acceptable.
105-110	SiO$_3$ low. Nutrient Analyst: "Data are acceptable."

Station 024

Cast 1	No comments on the Sample Log.
129	Oxygen is high. Other data are acceptable. Flask 1149. No analytical problems noted. Footnote oxygen questionable.
116	Salinity appears low compared to CTD. But, plotted vs Potemp, it agrees with Station 023 025 and 022. Salinity is acceptable.

| 113 | Oxygen appears low compared with adjoining stations. No analytical problem noted. Compared vs. SiO_3, oxygen appears acceptable. |
| 109 | Salinity is a little high. No analytical problem noted. PI: "High gradient." Salinity is acceptable. There is a feature in the CTD trace and a slight difference between the down and up trace. |

Station 025

Cast 1	Sample Log: "Forgot to remove O_2 sensor cover." No CTDO sampled.
122	SiO_3 appears low. Nutrient Analyst: "Large gradient in nutrients." Data are acceptable.
118	Salinity is slightly high. No analytical problem found. PI: "High gradient." Salinity is acceptable.
117-120	NO_3 and PO_4 are high. Nutrient Analyst: "Large gradient in nutrients." Data are acceptable.
101	Salinity is high. Autosal diagnostics indicate 4 tries to get a good reading, indicating a problem with the samples. The first readings gave better results and are used in this salinity calculation. Salinity is acceptable.
101-131	Oxygen sensor cover left on. CTDO lost.

Station 026

Cast 1	No comments on the Sample Log.
130	Oxygen appears high vs. CTDO, but agrees with adjoining stations. Oxygen is acceptable.
129	Oxygen appears low, agrees with CTDO, gradient area. Feature not seen in other data. PI: "Checked with Freon analysts, data are acceptable."
125	Oxygen appears high, agrees with CTDO, gradient area. Feature not seen in other data. PI: "Checked with Freon analysts, data are acceptable."
117	Oxygen appears high, agrees with CTDO, gradient area. Feature not seen in other data. PI: "Checked with Freon analysts, data are acceptable."
107	Salinity is high. Autosal diagnostics indicate 4 tries to get a good reading, indicating a problem with the samples. The first readings gave better results and are used in this salinity calculation. Salinity is acceptable. Oxygen is high. Oxygen overtitrated, no endpoint. Overtitration process evidentaly was not done correctly. Footnote oxygen bad.
104	Oxygen is 0.02 high. No analytical problem noted, within WOCE specs. Oxygen is acceptable.

Station 027

| Cast 1 | No comments on the Sample Log. |

Station 028

Cast 1	No comments on the Sample Log.
117	Delta-S at 1415db is -0.0064. Salinity also high compared with adjoining stations. No analytical problem noted. Gradient and "spike" feature in CTD trace. PI: "Salinity is acceptable."
115	Delta-S at 1720db is 0.0048. Salinity agrees with adjoining stations.

Station 029

121   Oxygen appears low. Feature does not show in other data. No analytical problem noted. Footnote oxygen questionable. Also appears low vs. CTDO.

119   Sample Log: "Vent left open." Oxygen as well as other data are acceptable.

118   Salinity had a large difference as compared with the CTD. Autosal diagnostics indicate 5 tries to get a good reading. The first readings gave better results and are used in this salinity calculation.

109   Oxygen appears low. Feature shown in high nutrients. No analytical problem noted. Oxygen is acceptable.

101   Delta-S at 4035db is 0.0025. Salinity agrees with adjoining stations.

101-109 NO_3 and PO_4 appear high. Feature does not show in S, O_2, or SiO_3. Nutrient analyst: "F1s look high a bit compared to adjacent stations. Adjusted F1s to match adjacent stations."

Station 030

Cast 1   No comments on the Sample Log.

123   Oxygen appears ~0.1 high. No analytical problem found. Oxygen agrees with CTDO. PI: "Oxygen is acceptable."

Station 031

Cast 1   No comment on the Sample Log.

117   Oxygen low and nutrients (NO_3, PO_4 SiO_3) high.

109   Delta-S at 1110db is -0.0076. No analytical problem noted.

Station 032

Cast 1   No comments on the Sample Log.

108   Oxygen low, nutrients high. Salinity appears to be acceptable. Feature probably real.

107   Oxygen low, nutrients high. Salinity appears to be acceptable. Feature probably real.

102   Delta-S at 1261db is -0.0067. No analytical problem found. Salinity lower than adjoining stations. Other data are acceptable. Gradient area. PI: "Salinity is acceptable."

101   Delta-S at 1509db is 0.004. No analytical problem found. Salinity higher than adjoining stations. Other data are acceptable. Gradient area. PI: "Salinity is acceptable."

Station 033

116   Sample Log: "Leak from bottom end cap when vent cracked." Oxygen as well as other data are acceptable.

101   Salinity was ~.01 high. Autosal diagnostics indicate 4 tries to get a good reading. The first readings gave better results and are used in this salinity calculation. Salinity is acceptable.

Station 034

Cast 1   No comments on the Sample Log. Duplicate salts were drawn and analyzed by third salinity analyst. Bottle 8 had no water left in it, but the other salts agreed except 6 which was 0.001 high and 1 was .003 high.

Station 035

Cast 1   No comments on the Sample Log.
106   PO_4 is ~0.03 high. Nutrient analyst: "No analytical problem found, data is acceptable."

Station 036

Cast 1   No comments on the Sample Log.
106   Oxygen appears low compared with adjoining stations. PI: "NO_3, PO_4, but not silicate show similar (high) feature, low CFC-11-12 also, likely real." Nutrient Analyst: "SiO_3 higher on chart, no problem." Oxygen is acceptable.
102   Oxygen appears high compared with adjoining stations. No complimentary feature in nutrients. Oxygen agrees with CTDO. Oxygen is acceptable

Station 037

Cast 1   No comments on the Sample Log.
122   Salinity had a large difference as compared with the CTD. Autosal diagnostics indicate 5 tries to get a good reading. The first readings gave better results and are used in this salinity calculation. Other data are acceptable. Salinity is acceptable.
115   Oxygen appears low, nutrients high. Data are acceptable.
111   Oxygen: "PC hung up, sample lost." Salinity had a large difference as compared with the CTD. Autosal diagnostics indicate 5 tries to get a good reading. The original reading gave better results. Salinity is acceptable. Other data are acceptable.
106   Oxygen appears high, nutrients low. Data are acceptable.
103   Salinity had a large difference as compared with the CTD. Autosal diagnostics indicate 5 tries to get a good reading. The original reading gave better results. Salinity is acceptable. Other data are acceptable.
101   Delta-S at 1272db is 0.0133. Autosal diagnostics indicate 5 tries to get a good reading. First reading was higher than the next set of readings. Footnote salinity bad. Other data are acceptable.

Station 038

Cast 1   No comments on the Sample Log.
118   Oxygen low, nutrients (NO_3, PO_4, SiO_3) high; Salinity low as well.
110   Delta-S at 1054db is 0.008. Autosal diagnostics indicate 5 tries to get a good reading. Autosal operator did not write down the first reading. Gradient area. Salinity and other data are acceptable.

106   Autosal diagnostics indicate 3 tries to get a good reading. First reading is a little better, but still high. Gradient area. Salinity and other data are acceptable.

Station 039

Cast 1   No comments on the Sample Log.
107   Oxygen low. No problems noted during analysis. Footnote oxygen bad. Flask 1509.
105   Salinity had a large difference as compared with the CTD. Autosal diagnostics indicate 5 tries to get a good reading. The first readings gave better results and are used in this salinity calculation. Salinity is acceptable.
104   Salinity had a large difference as compared with the CTD. Autosal diagnostics indicate 5 tries to get a good reading. The first readings gave better results and are used in this salinity calculation. Salinity is acceptable.

Station 040

Cast 1   No comments on the Sample Log.
120-121 Nutrients appear to be switched on NO_3 vs. PO_4 plot. N:P ratios are low. Salinity agrees with the CTD and it is unlikely that the bottle leaked, since the salinity is at the salinity max. Nutrient analyst can find no problem with the data. Oxygen for 120 appears low on the station profile, vs. pressure, but not so low, compared to previous stations, that it could be considered questionable. These are in the appropriate order, they were not switched.
104   Salinity had a large difference as compared with the CTD. Autosal diagnostics indicate 4 tries to get a good reading. The first readings gave better results and are used in this salinity calculation. Salinity is acceptable.

Station 041

124   Sample Log: "Closed partly out of water." No water for salinity sample.
111-112 Oxygen is low and nutrients are high. salinity is a little low compared to CTD, but acceptable for gradient area. Feature must be real.
105   Delta-S at 2073db is 0.0179. No analytical problem indicated. Other data are acceptable. Footnote salinity bad.
103   Salinity had a large difference as compared with the CTD. Autosal diagnostics indicate 4 tries to get a good reading. The first readings gave better results and are used in this salinity calculation. The salinity is still too high. Delta-S at 2481db is 0.0056. Footnote salinity bad.
102   Delta-S at 2632db is 0.0027. Autosal diagnostics indicate 3 tries to get a good reading. The first reading gave better results and are used in this salinity calculation, but still out of WOCE specs. Variation in the CTD trace. PI: "Salinity is acceptable."
101   Delta-S at 2824db is 0.0092. No analytical problem indicated. Other data are acceptable. Footnote salinity bad.

Station 042

124   Sample Log: "Closed partly out of water."

112	Delta-S at 1060db is -0.0065. Autosal diagnostics do not indicate a problem with the analyses. Other samples are acceptable. Agrees fairly well with adjoining stations for this gradient. Salinity is acceptable.
106	Delta-S at 1714db is 0.0261. Autosal diagnostics indicate 7 tries to get a good reading, indicating a problem with the samples. Other samples are acceptable. Footnote salinity bad.
101	Delta-S at 2518db is 0.0026. The first readings gave better results and are used in this salinity calculation. Salinity is out of WOCE specs. Footnote salinity questionable.

Station 043

Cast 1	No comments on the Sample Log.
110	Oxygen: "OT (No EP)." Delta-S at 1213db is 0.0072. Autosal diagnostics indicate 3 tries to get a good reading, indicating a problem with the samples. Salinity operator did not annotate the first reading. PI: "Doesn't look so far off on the plot, salinity is acceptable."
109	Large salinity difference. Suppression switch was set incorrectly. After correcting the data, the agreement is much better. Salinity is acceptable.

Station 044

106	Sample Log: "Vent not tightly closed." Oxygen as well as other data are acceptable.

Station 045

Cast 1	No comments on the Sample Log.
118	Oxygen is high on station profile, nutrients are low. Salinity agrees with CTD and adjoining stations. Data is acceptable.
115	Oxygen is high on station profile, nutrients are low. Salinity agrees with CTD and adjoining stations. Data is acceptable.
113	Salinity ran out of water before reading could be obtained during analysis. Footnote salinity lost. Other data are acceptable.
107	Delta-S at 1606db is 0.0065. No analytical problem found. Salinity is acceptable, feature also seen in CTD trace.
105	SiO_3 high, Oxygen low. Data are acceptable.

Station 046

Cast 1	No comments on the Sample Log.
103	Delta-S at 1662db is 0.0065. Autosal diagnostics indicate 5 tries to get a good reading, indicating a problem with the samples. The first readings gave better results and are used in this salinity calculation. Salinity still appears slightly high. Footnote salinity questionable.
101	Delta-S at 1831db is 0.0057. Autosal diagnostics indicate 5 tries to get a good reading, indicating a problem with the samples. The first readings gave better results and are used in this salinity calculation. Salinity still appears slightly high. Footnote salinity questionable.

Station 047

Cast 1   No comments on the Sample Log.
114   The first readings gave better results and are used in this salinity calculation.

Station 048

Cast 1   No comments on the Sample Log.
104   The first readings gave better results and are used in this salinity calculation. Oxygen appears low, nutrients appear high. Data is acceptable. PI: "Likely okay, matches CTD."

Station 049

Cast 1   No comments on the Sample Log.
106-107   Oxygen flasks changed during sampling. Data recorded properly and is acceptable.

Station 050

Cast 1   No comments on the Sample Log.
108   Low N:P, the NO_3 and PO_4 stations profiles looked good. Nutrient Analyst: "No analytical problem, gradient."

Station 051

108   Sample Log: "Vent not closed." Oxygen as well as other data are acceptable.
105   Oxygen high, nutrients (NO_3, SiO_3, PO_4) low. Data are acceptable.
103   The first readings gave better results and are used in this salinity calculation. Salinity is acceptable.

Station 052

Cast 1   No comments from the Sample Log.
118   SiO_3 low ~0.9. Nutrient analyst: "Looks the same as Sta 051, in mixed layer."
102-103 SiO_3 0.4 low, within specs of the measurement. Nutrient analyst: "No problem noted."
101   PO_4 0.05 high, O_2 low. PO_4 agrees with Station 055.

Station 053

122   High on N:P plot. Nutrient analyst: "Gradient, data is acceptable."
108   Sample Log: "Vent is open." Oxygen as well as other data are acceptable. SiO_3 is low. Nutrient analyst: "Probably bad, code questionable."
105   Delta-S at 1618db is -0.0035. No analytical problems noted. Salinity agrees with adjoining stations. Gradient area, salinity is acceptable. 103 O_2 high. PI: "Doesn't fit

in CTDO. Freon did not measure to assist in this. Doesn't match CTDO, but similar to Stas. 054 & 055. Oxygen is acceptable."

102   Oxygen: "PC lock-up, lost sample.

Station 054

117   Oxygen: "PC locked up, sample lost."

114   Oxygen low, nutrients (NO_3, PO_4, SiO_3) high. Data are acceptable.

108   Sample Log: "Leaking when valve opened." Oxygen and other data are acceptable. DeltaS at 1159db is 0.0064. No analytical problem noted. Feature in CTD trace produced by bottle stop. Gradient area. Salinity agrees with adjoining stations. Salinity is acceptable.

104   Delta-S at 1565db is 0.0029. No analytical problem noted. Gradient area. Salinity is acceptable.

Station 055

Cast 1   No comments on the Sample Log.

110   O_2 maybe high. PI: "No freon sample, oxygen appears to be okay compared with plots of several stations."

109   PI: "Oxygen low, maybe match the upcast CTD, probably similar to 056.

Station 056

Cast 1   No comments on the Sample Log.

118   Oxygen is a little high, but nutrients are low. Salinity looks good on station profile. Nutrient Analyst: "Almost looks like sample 19 & 18 are reversed or reversal of trip."

114   Salinity appears high vs. CTD and adjoining stations. Gradient area. Salinity analyst had trouble getting readings to agree. First reading is better, but still high. Footnote salinity questionable.

108   O_2 low. PI: "Or 109 O_2 high? but both match upcast. Freon not sampled at all bottles. Oxygen is acceptable."

Station 057

Cast 1   No comments on the Sample Log.

102   Delta-S at 1513db is 0.0027. No analytical problem noted. Gradient area. Feature in CTD trace produced by ship roll during sampling may cause the difference in salinity values. Salinity is acceptable.

Station 058

Cast 1   No comments on the Sample Log.

111   Oxygen appears a little low, but nutrients appear a little high. Salinity agrees with the CTD and adjoining stations. Data are acceptable.

104   The first readings gave better results and are used in this salinity calculation. Salinity is acceptable.

Station 059

Cast 1   Sample Log: "Battery died on O_2 thermometer."
110   Oxygen appears a little high, but nutrients appear a little low. Salinity agrees with the CTD and adjoining stations. Data are acceptable.
104   Oxygen appears a little high, but nutrients appear a little low. Salinity agrees with the CTD and adjoining stations. Data are acceptable.
101   The first readings gave better results and are used in this salinity calculation.

Station 060

Cast 1   No comments on the Sample Log.
106   N:P ratio low. Nutrient Analyst: "N:P gradient, data are acceptable."

Station 061

Cast 1   No comments on the Sample Log.

Station 062

Cast 1   No comments on the Sample Log.

Station 063

Cast 1   No comments on the Sample Log.
102   Oxygen appears low but nutrients are high. Data are acceptable.

Station 064

Cast 1   No comments on the Sample Log.
113-115   N:P high. NO_3 and PO_4 look okay on property plots and the N:P plot agrees with Station 068.

Station 065

Cast 1   No comments on the Sample Log.
102   Delta-S at 1011db is 0.006. No analytical problem noted. Salinity is not any higher than bottles 3-5 compared with 064 and 067. Does not appear high when plotted on CTD trace. Salinity is acceptable. Oxygen is high and nutrients are low except SiO_3 which is also high. Oxygen also agrees with CTDO trace.

Station 066

Cast 1   No comments on the Sample Log.

101-102 PO_4 and SiO_3 appear a little high. Oxygen is lower than Stations 065 and 067, but higher than Station 068. Data are acceptable.

Station 067

Cast 1   No comments on the Sample Log.
101   Delta-S at 1518db is 0.0039. No analytical problem noted. CTD trace shows a mass of features which are created from the bottle trip. Salinity is acceptable.

Station 068

Cast 1   No comments on the Sample Log.
115   Oxygen high and nutrients low, salinity agrees with CTD. Data are acceptable.
107   Delta-S at 1617db is 0.0029. No analytical problems noted. Gradient area. Salinity is acceptable.
104   Delta-S at 2072db is 0.0031. No analytical problems noted. Gradient area. Salinity is acceptable.

Station 069

123   Sample Log: "Low on water for tritium; no water left for salts."
119-120 Console Ops: "20 tripped first then 19." This was done through the software, no levels were missed.
118   Console Ops: "No confirm, then confirm."
102   Delta-S at 2628db is 0.0025. The first readings gave better results and are used in this salinity calculation.

Station 070

108   Sample Log: "Vent not quite closed." Oxygen as well as other data are acceptable.
102   Oxygen is low, nutrients are high. Salinity agrees with adjoining stations. Data are acceptable.

Station 071

Cast 1   No comments on the Sample Log. Console Ops: "Down trace 30-75m, something stuck in conductivity cell?"
122   Oxygen high, nutrients low, salinity agrees with CTD.
103   Autosal diagnostics indicate 4 tries to get a good reading, indicating a problem with the samples. The first readings gave better results and are used in this salinity calculation. Salinity is acceptable.

Station 072

120   Delta-S at 3db is 0.0296. Autosal diagnostics do not indicate a problem. Salinity as well as other data are acceptable.

104   Delta-S at 1717db is -0.0026. Autosal diagnostics do not indicate a problem. Gradient area. Salinity is acceptable.
101   Sample Log: "Vent open." Oxygen as well as other data are acceptable.

Station 073

Cast 1   No comments on the Sample Log.
115   No nutrients drawn, sampling error.
112   Delta-S at 567db is 0.0227. Autosal diagnostics do not indicate a problem. Salinity agrees with adjoining stations and CTD down trace. Oxygen is low and nutrients are high. Data are acceptable.

Station 074

121   Sample Log: "Closed partially out of water." Oxygen as well as other data are acceptable compared to adjoining stations.
114   Low Oxygen, nutrients are a little high and overlay the adjoining stations, salinity is a little low compared to adjoining stations and CTD. Data are acceptable.
113   Delta-S is -0.0583. Salinity is low compared with adjoining stations and CTD down trace as well as up. Autosal diagnostics do not indicate a problem. Footnote salinity questionable. Other data are acceptable.

Station 075

Cast 1   No comments on the Sample Log.
108   Nutrients low, O_2 high, salinity agrees with CTD. Data are acceptable.

Station 076

Cast 1   No comments on the Sample Log.
115   Oxygen low, corresponding high feature not in nutrients. Low oxygen shown in CTDO trace.
103   SiO_3 appears low compared with following stations, it agrees with previous stations. Data are acceptable.

Station 078

Cast 1   No comments on the Sample Log.

Station 079

Cast 1   No comments on the Sample Log.
109   Oxygen: "Sample lost." No further explanation.

Station 080

Cast 1   No comments on the Sample Log.
113   Oxygen high, feature is also in nutrientslow. CTDO also indicates high O_2. Oxygen is acceptable.
106   Oxygen appears low, corresponding high feature not seen in nutrients. CTDO also indicates high O_2.
101   Oxygen appears high, corresponding low feature not seen in nutrients. CTDO also indicates high O_2.
101-104 NO_3 and PO_4 a little higher than previous stations, looks okay on N:P plot.

Station 081

113   Oxygen appears high. Feature does not show in nutrients. Could possibly show in CTDO, but difficult to tell. Does agree with Sta. 083.
111   Salinity appears high, O_2 low, but salinity and O_2 agree with CTD.
108   Sample Log: "Vent leaking." Oxygen as well as other data are acceptable.
108-113 SiO_3 slightly higher than adjoining stations, NO_3 too. PO_4 appears low. Nutrient Analyst: "PO_4 okay, N:P's look normal.

Station 082

Cast 1   No comments on the Sample Log.

Station 083

128   Sample Log: "3 micro-rinses on salinity." Salinity is acceptable.
113-116   Problem with the run, it appears to have shifted according to the data, but the shift does not show in the peaks. SiO_3 is questionable.

Station 084

Cast 1   No comments on the Sample Log.
103   PO_4 too high. Nutrient Analyst: "Higher on trace as well-doesn't look right-maybe contaminated? PO_4 is questionable." PI: "Code PO_4 bad."
101-125   Unrecoverable fitting problems for CTDO (<400M, apparent offset @ 450M down cast. Footnote CTDO lost.

Station 085

Cast 1   No comments on the Sample Log.
117   Duplicate O_2 drawn. SiO_3 1.0 low. Nutrient Analyst: "Okay on chart, peak okay. Agrees with Station 084 as well. Gradient area. SiO_3 is acceptable."
101   Delta-S at 2959db is 0.0078. Bottle salinity is acceptable. Large spikes in CTD data.
101-125   Unrecoverable fitting problems for CTDO (<200M, apparent offset @ 200M down cast. Footnote CTDO lost.

Station 086

Cast 1   No comments on the Sample Log.
119   Triplicate O_2 drawn.
104   Delta-S at 2751db is 0.0025. PI: "Noisy CTD profile, so okay." Footnote CTD salinity questionable.
103   Delta-S at 2821db is 0.0057. PI: "Noisy CTD profile, so okay." Footnote CTD salinity questionable.
102   Delta-S at 2862db is 0.0044. PI: "Noisy CTD profile, so okay." Footnote CTD salinity questionable.
101   Delta-S at 2908db is -0.0073. PI: "Noisy CTD profile, so okay." Footnote CTD salinity questionable.
101-127 Unrecoverable fitting problems for CTDO (<100M, apparent offset @ 100M down cast. Footnote CTDO lost.

Station 087

Cast 1   No comments on the Sample Log.
103   Delta-S at 2702db is 0.0037. PI: "Noisy CTD profile, bottle salinity okay." Footnote CTD salinity questionable. No CTDO is calculated because the CTD Salinity is coded questionable.
102   Delta-S at 2754db is -0.003. PI: "Noisy CTD profile, bottle salinity okay." Footnote CTD salinity questionable. No CTDO is calculated because the CTD Salinity is coded questionable.

Station 088

Cast 1   No comments on the Sample Log.
116   Salinity is higher than CTD profile. Autosal diagnostics do not indicate a problem. Salinity appears higher than adjoining stations, but not too much more than other salinity values in this gradient. It looks like it could be a drawing error. Footnote salinity questionable.
114   Salinity is higher than CTD profile. Autosal diagnostics do not indicate a problem. Salinity appears higher than adjoining stations, but not too much more than other salinity values in this gradient. It looks like it could be a drawing error. Footnote salinity questionable.
109   Delta-S at 1967db is 0.0066. Autosal diagnostics do not indicate a problem. Gradient. Salinity is acceptable. PI: "Code salinity as questionable."
108   Delta-S at 2068db is 0.0025. Autosal diagnostics do not indicate a problem. Gradient. Salinity is acceptable.

Station 089

127   Sample Log: "Running out of water." Salinity is acceptable.

119   Oxygen: "Sample is lost, thio tube was bent and not dispensing properly. Footnote oxygen lost.

109   Delta-S at 1639db is 0.003. Autosal diagnostics do not indicate a problem. Gradient area. Salinity is acceptable.

Station 090

Cast 1   No comments on the Sample Log.

105   The first readings gave better results and are used in this salinity calculation.

102   Delta-S at 1745db is 0.0059. Autosal diagnostics do not indicate a problem. There is a "spike" in the CTD trace which is probably giving the large difference. This is real data at a bottle stop and is showing the difference in just a few seconds of sampling. Salinity is acceptable.

101-123 Unrecoverable fitting problems for CTDO (<100M, apparent offset @ 100M down cast. Footnote CTDO lost.

Station 091

Cast 1   No comments on the Sample Log.

Station 092

Cast 1   No comments on the Sample Log.

Station 093

Cast 1   No comments on the Sample Log.

Station 094

Cast 1   No comments on Sample Log. STD dial 5 units higher than previous and next runs. This would only be a difference if 0.001 PSU and is negligible on this shallow station.

110   Delta-S at 4db is 0.0455. CTD trace has a large "spike" in it. Footnote CTD salinity questionable. No CTDO is calculated because the CTD Salinity is coded bad.

109   Delta-S at 32db is 0.0431. CTD trace has a large "spike" in it. Footnote CTD salinity questionable. No CTDO is calculated because the CTD Salinity is coded bad.

Station 095

Cast 1   No comments on the Sample Log.

111   Delta-S at 3db is 0.0375. Autosal diagnostics do not indicate a problem. Lots of variation in CTD trace at the time of bottle trip. Footnote CTD salinity questionable, just not good for bottle trip. No CTDO is calculated because the CTD Salinity is coded bad.

109   Delta-S at 103db is -0.044. Autosal diagnostics do not indicate a problem. Footnote CTD salinity questionable, just not good for bottle trip. No CTDO is calculated because the CTD Salinity is coded bad.

Station 096

114   Delta-S at 4db is -0.0297. Autosal diagnostics do not indicate a problem.
113   The first readings gave better results and are used in this salinity calculation, but made a 0.005 difference.
108   Sample Log: "Leaking when vent opened." Oxygen as well as other data are acceptable.
102   Triplicate O_2 drawn.

Station 097

Cast 1   No comments on the Sample Log.
 110   Delta-S at 2db is 0.0409. Autosal diagnostics do not indicate a problem. Salinity is acceptable.
109   Delta-S at 44db is 0.049. Autosal diagnostics indicate 3 tries to get a good reading. Used the first reading The first readings gave better results and are used in this salinity calculation. Salinity is a little lower than adjoining stations. Salinity is acceptable.
108-109 N:P low. Nutrient Analyst: "NO_3 and PO_4 are acceptable."

Station 098

Cast 1   No comments on the Sample Log.

Station 099

Cast 1   No comments on the Sample Log.

Station 100

Cast 1   No comments on the Sample Log.
103   Delta-S at 1042db is -0.0167. No analytical problem. Large spike in CTD data.

Station 101

117   Oxygen appears low, however, it is higher than 100 and lower than 102. Lower nutrients show that the feature is real.
108   Sample Log: "Vent loose." Oxygen as well as other data are acceptable.

Station 102

106   PO_4 low, NO_3 low vs other stations, but SiO_3 is not. Nutrient analyst: "Yes, SiO_3 is lower, just not as pronounced. No analytical problem."

105	Sample Log: "oxygen redrawn." Oxygen as well as other data are acceptable. Delta-S at 1809db is 0.0028. Salinity is a little high Lots of variation seen in CTD profile. No analytical problem noted. PI: "Salinity is acceptable."
103	Delta-S at 2038db is -0.0051. Gradient area. No analytical problem noted. lots of variation seen in CTD profile at bottle trip. Salinity is acceptable.

Station 103

128	Sample Log: "No water for surface salts."

Station 104

129	O_2 appears high compared to adjoining stations, PO_4 and NO_3 are lower. Data are acceptable.
114	Delta-S at 1570db is 0.0052. Autosal diagnostics do not indicate a problem. Salinity minimum, data is acceptable.
110	Delta-S at 2378db is 0.0027. Autosal diagnostics do not indicate a problem. Salinity maximum, salinity is acceptable.
109	Delta-S at 2530db is 0.0032. Autosal diagnostics do not indicate a problem. Salinity maximum, salinity is acceptable.
108	Delta-S at 2631db is 0.0037. Autosal diagnostics do not indicate a problem. Lots of features in the salinity profile. Data are acceptable.
106	Delta-S at 2774db is -0.0052. Autosal diagnostics do not indicate a problem. Lots of features in the salinity profile. Data are acceptable.
104	Triplicate O_2 drawn.
103	Delta-S at 2957db is -0.0035. Autosal diagnostics do not indicate a problem. Lots of features in the salinity profile. Data are acceptable.
102	Triplicate O_2 drawn.

Station 105

Cast 1	No comments on the Sample Log.
129	Oxygen: "OT (No EP)." Oxygen as well as other data are acceptable.
126	O_2 low, high feature also seen in nutrients. Data are acceptable.
122	Salinity high compared to the CTD. The first readings gave better results and are used in this salinity calculation. The salinity is acceptable after the correction. O_2 high, feature is also seen in lower nutrients. Data are acceptable.
115	Delta-S at 1468db is 0.0086. Autosal diagnostics do not indicate a problem. Salinity appears high. Other data are acceptable. Footnote salinity questionable. PI: "Code salinity bad."
111-125	NO_3 low. Nutrient Analyst: "Reanalyzed data and made a correction to NO_3. Data are now acceptable."
107	Delta-S at 2786db is 0.0044. Autosal diagnostics do not indicate a problem. Lots of variation in CTD profile at bottle trip. Salinity as well as other data are acceptable.
105	Delta-S at 3010db is -0.0028. Autosal diagnostics do not indicate a problem. Lots of variation in CTD profile at bottle trip. Salinity as well as other data are acceptable.

104	Delta-S at 3070db is -0.0029. Autosal diagnostics do not indicate a problem. Lots of variation in CTD profile at bottle trip. Salinity as well as other data are acceptable.
103	Delta-S at 3132db is -0.0028. Autosal diagnostics do not indicate a problem. Lots of variation in CTD profile at bottle trip. Salinity as well as other data are acceptable.
102	Delta-S at 3194db is -0.0043. Autosal diagnostics do not indicate a problem. Lots of variation in CTD profile at bottle trip. Salinity as well as other data are acceptable.

Station 106

Cast 1   No comments on the Sample Log.

Station 107

| 108 | Sample Log: "Vent open." Vent is not as tight as the others. Oxygen as well as other data are acceptable. |

Station 108

Cast 1	No comments on the Sample Log.
128	Delta-S at 35db is -0.046. Autosal diagnostics do not indicate a problem. CTD profile indicates a lot of mixing "spikes". Salinity is acceptable.
122	Triplicate O_2 drawn.
111	Delta-S at 2119db is 0.0027. Autosal diagnostics do not indicate a problem. Gradient area. Salinity is acceptable.
110	Triplicate O_2 drawn.

Station 109

Cast 1	No comments on the Sample Log.
130	Nutrients not analyzed, no reason noted, suspect drawing problem. Footnote nutrients lost.
129	Oxygen: "Sample lost, PC Hung up during titration."
123	Oxygen: "Sample lost, PC glitch."
109	Delta-S at 2499db is 0.0027. Autosal diagnostics do not indicate a problem. Salinity agrees with adjoining stations.
108	Salinity appears high compared with CTD. Autosal diagnostics do not indicate a problem. Salinity agrees with adjoining stations.
101	NO_3 low. Nutrient Analyst: "Corrected data. NO_3 is acceptable."

Station 110

Cast 1	No comments on the Sample Log.
119	Oxygen: "Overtitrate." Oxygen as well as other data are acceptable.
107	Delta-S at 2470db is -0.0049. Gradient area. Salinity is acceptable.
106	Salinity disagreed with CTD data. The first readings gave better results and are used in this salinity calculation. Salinity is acceptable.

104   Oxygen: "Overtitrate." Oxygen as well as other data are acceptable.
103   Salinity disagreed with CTD data. The first readings gave better results and are used in this salinity calculation. Salinity is acceptable.
102   Delta-S at 3145db is -0.0041. CTD indicates a lower salinity at this level. Salinity is acceptable.

Station 111

Cast 1   No comments on the Sample Log.
119   Oxygen appears high, CTDO indicates higher oxygen is acceptable. PO_4, SiO_3 and NO_3 low verifying this as a real feature.

Station 112

Cast 1   No comments on the Sample Log.
119   Nutrients appear low, oxygen high. Salinity is acceptable. This feature is real.
115   Salinity appears high compared with CTD. CTD indicates a lot of mixing. Salinity is acceptable.

Station 113

Cast 1   No comments on the Sample Log.
109   Salinity: "Lip was cracked on the bottle." Replaced the bottle. Salinity is acceptable.

Station 114

125   Sample Log: "Ran out of water; no tritium, no salinity."
117   Oxygen high, nutrients low. Data are acceptable.
114   Delta-S at 689db is -0.0090. Autosal diagnostics do not indicate a problem. PI: "High gradient." Data are acceptable.

Station 115

Cast 1   No comments on the Sample Log.

Station 116

Cast 1   No comments on the Sample Log.
104   Delta-S at 2529db is -0.0025. Autosal diagnostics do not indicate a problem. Large difference between down and up trace. Also a large difference at this bottle trip. Salinity is acceptable.
101   Salinity appears a little high compared with adjoining stations and CTD. Footnote salinity questionable.

Station 117

Cast 1	No comments on the Sample Log.
113-114	SiO_3 low, and so is NO_3. Data are acceptable.
109	Triplicate O_2 drawn.
102	Triplicate O_2 drawn.

Station 118

Cast 1	No comments on the Sample Log.
101-102	Low SiO_3, NO_3 and PO_4 also show this low feature and O_2 a little higher than adjoining stations.

Station 119

Cast 1	No comments on the Sample Log.
119	Low NO_3 and PO_4, but SiO_3 does not show this low feature. Nutrient Analyst: "No analytical problems. NO_3 and PO_4 are within WOCE specs. Data are acceptable."
111	Delta-S at 2426db is -0.0025. Autosal diagnostics do not indicate a problem. Higher salinity value also seen in CTD down/up trace within a salinity minimum area. Salinity is acceptable.
101	Salinity a little high. The first readings gave better results and are used in this salinity calculation. Salinity is acceptable. Oxygen also appears slightly low, but nutrients are slightly compared with Station 118. Data are acceptable.

Station 120

Cast 1	No comments on the Sample Log.
128	Triplicate O_2 drawn.
126	Low nutrients, O_2 slightly high. Data are acceptable.

Station 121

Cast 1	No comments on the Sample Log.
124	Nuts appear high. CO_2 reports bottle problem. O_2 low but CTDO confirms O_2 is acceptable. Salinity agrees with CTD. Data are acceptable.
101-103	SiO_3 appears low. PO_4 is a little lower than adjoining stations. Nutrient Analyst: "No analytical problem found. Salinity also appears to be a little lower on the station profile." Data are acceptable.

Station 122

130-131	Sample Log: "Closed just below the surface to avoid contamination from deck washing." There are no samples taken here.
124	Triplicate O_2 drawn.
123	O_2 low, nutrients high, salinity agrees with CTD. Data are acceptable.

118	Triplicate O_2 drawn.
114	Delta-S at 1312db is 0.0061. Autosal diagnostics do not indicate a problem. Does not agree with down or up CTD trace. Does not agree with adjoining stations, but there was not sampling at this pressure. Footnote salinity questionable.
102	Delta-S at 3539db is -0.0025. Autosal diagnostics do not indicate a problem. There is also a difference between the down and up CTD trace indicated a lot of variations in the water being sampled. Salinity is acceptable.
101	Delta-S at 3639db is -0.0029. Autosal diagnostics do not indicate a problem. There is also a difference between the down and up CTD trace indicated a lot of variations in the water being sampled. Salinity is acceptable.

Station 123

Cast 1	No comments on the Sample Log.
113	Oxygen high compared with adjoining stations. Nutrients are low. Data are acceptable.
103	Salinity high compared to CTD. The first readings gave better results and are used in this salinity calculation. Salinity is acceptable.
101	Delta-S at 4313db is -0.0025. Autosal diagnostics do not indicate a problem. Salinity is lower than both the down and up CTD trace. It also appears low on the station profile. The adjoining stations are not as deep as this station. This is just slightly out of WOCE specs. Footnote salinity questionable.

Station 124

| Cast 1 | No comments on the Sample Log. |
| 109-110 | Nutrients low, oxygen high. Salinity agrees with CTD. Data are acceptable. |

Station 125

124	Oxygen low, nutrients high. Salinity agrees with CTD. Data are acceptable.
123	Oxygen high, nutrients low. Salinity agrees with CTD. Data are acceptable.
121	Oxygen high, nutrients low. Salinity agrees with CTD. Data are acceptable.
109	Oxygen: "Overtitrated, no end point." Oxygen is acceptable.
105	Sample Log: "Oxygen had to be redrawn, bubbles after stoppering." Oxygen is acceptable.

Station 126

Cast 1	No comments on the Sample Log.
130	Oxygen: "Overtitrate (No Endpoint)." Oxygen is acceptable.
127	Oxygen: "Overtitrate (No Endpoint)." Oxygen is acceptable.
126	Oxygen: "Overtitrate (No Endpoint)." Oxygen is acceptable.
120	Delta-S at 630db is 0.01. Autosal diagnostics do not indicate a problem. Salinity minimum, large variation in CTD trace at bottle trip. Salinity is acceptable. Oxygen: "Overtitrate (No Endpoint)." Oxygen is acceptable.

113	Oxygen: "Overtitrate (No Endpoint)." Oxygen is acceptable.
108	Oxygen: "Overtitrate (No Endpoint)." Oxygen is acceptable.
106	Oxygen: "Overtitrate (No Endpoint)." Oxygen is acceptable.

Station 127

119	Sample Log: "Had to redraw O_2." O_2 agrees with CTDO. Oxygen is acceptable.
115	Delta-S at 1406db is 0.008. Autosal diagnostics do not indicate a problem. Salinity agrees with CTD down trace; slight gradient. Salinity is acceptable.
109	Delta-S at 2704db is 0.0051. Autosal diagnostics indicate 3 tries to get a good reading, indicating a problem with the samples. But none of the other readings make the salinity lower. Gradient area. Salinity is acceptable.
108	Delta-S at 2957db is 0.0025. Autosal diagnostics do not indicate a problem.
103	Oxygen: "Overtitrate (No Endpoint)." Oxygen is acceptable.
102	Oxygen: "Overtitrate (No Endpoint)." Oxygen is acceptable.
101-104	SiO_3 appears low compared to adjoining stations, doesn't show in PO_4 or NO_3, but O_2 and salinity are higher than adjoining stations. Adjoining stations are not as deep as this station. Nutrient Analyst: "No analytical problems. Does agree with Station 126, also compares vs. oxygen. Data are acceptable."

Station 128

Cast 1	No comments on the Sample Log.
110	Delta-S at 1718db is 0.0029. salinity does appear slightly high compared with CTD. However, it does appear to agree with Station 127. Gradient area. Salinity is acceptable.
106	Triplicate O_2 drawn. Oxygen: "Overtitrate (No Endpoint), this was on one of the duplicate samples." Original oxygen agree with CTDO and appears okay on station profile.

Station 129

Cast 1	No comments on the Sample Log.
128	Oxygen: "bad end point." O_2 does appear slightly high. Footnote O_2 questionable.
127	Oxygen: "bad end point." O_2 appears to be acceptable, agrees with CTDO and station profile.
122	Oxygen: "Overtitrated (No EP)." O_2 appears a little low, but in gradient area. Oxygen is acceptable.
120	Oxygen: "Overtitrated (No EP)." O_2 appears a little high, but in gradient area. Oxygen is acceptable. Delta-S at 660db is -0.0124. Variation in CTD trace. Salinity is acceptable.
119	Oxygen: "Overtitrated (No EP)." O_2 appears okay on station profile and agrees with CTDO, in gradient area. Oxygen is acceptable.
116	Delta-S at 1164db is 0.0327. Autosal diagnostics indicate 3 tries to get a good reading, indicating a problem with the samples. However, they were all fairly close and does not account for this large of a difference. It appears to be a drawing error.

114   Oxygen: "Overtitrated (No EP)." O_2 appears okay on station profile and agrees with CTDO. Oxygen is acceptable.

Station 130

Cast 1   No comments on the Sample Log.
119   Oxygen: "Overtitrated (No EP)." Oxygen as well as other data are acceptable.
116   Oxygen: "Overtitrated (No EP)." Oxygen as well as other data are acceptable.

Station 131

Cast 1   No comments on the Sample Log.
128   Delta-S at 31db is -0.0293. Autosal diagnostics do not indicate a problem. Variation in CTD trace. Salinity as well as other data are acceptable.
126   Large difference with CTD. Autosal diagnostics do not indicate a problem. Variation in CTD trace. Salinity as well as other data are acceptable.
122   Large difference with CTD. Autosal diagnostics do not indicate a problem. Variation in CTD trace. Salinity as well as other data are acceptable.

Station 132

Cast 1   No comments on the Sample Log.
102   Triplicate O_2 drawn.
101-107 SiO_3 may be high. Compared with adjoining stations and Station 034 and 031, it appears to be acceptable.

Station 133

Cast 1   No comments on the Sample Log.
121   Oxygen appears high, nutrients low. O_2 agrees with CTDO.

Station 134

Cast 1   No comments on the Sample Log.
122   Oxygen: "Overtitration (No EP)." There is a feature in the CTD trace, which shows the oxygen low. Comparing to adjoining stations it may be a little high. Oxygen is acceptable.
115   Oxygen high, does not fit station profile or CTDO. Other data are acceptable. Footnote O_2 bad.
110   Delta-S at 1612db is 0.0063. Autosal diagnostics do not indicate a problem. Gradient area. Salinity is acceptable.
108   Delta-S at 1912db is 0.0043. Autosal diagnostics do not indicate a problem. Variation in the CTD at the bottle trip and between the down and up.

Station 135

Cast 1   No comments on the Sample Log.
120   Delta-S at 185db is 0.0262. Autosal diagnostics do not indicate a problem. Variation in CTD trace looking like a "spike", at the bottle trip. Salinity is acceptable.
118   Large difference between salinity and CTD. Autosal diagnostics do not indicate a problem. Variation in CTD trace looking like a "spike", at the bottle trip. Salinity is acceptable.
116   Delta-S at 558db is 0.0129. Autosal diagnostics do not indicate a problem. Variation in CTD trace looking like a "spike", at the bottle trip. Salinity is acceptable.

Station 136

Cast 1   No comments on the Sample Log.
123   Large difference with CTD salinity. Autosal diagnostics do not indicate a problem. Variation in CTD at bottle trip showing as a "spike".
119   Large difference with CTD salinity. Autosal diagnostics do not indicate a problem. Compared with down and up salinity is acceptable.
116   Delta-S at 567db is -0.0199. Autosal diagnostics do not indicate a problem. Gradient area. Salinity is acceptable.
114   Delta-S at 739db is 0.0105. Autosal diagnostics do not indicate a problem. Variation in CTD at bottle trip showing as a "spike".

Station 137

Cast 1   No comments on the Sample Log.
117   Nutrients low and oxygen high. Data are acceptable.

Station 138

Cast 1   No comments on the Sample Log.
115   Delta-S at 607db is -0.0158. Autosal diagnostics do not indicate a problem. Gradient area, also a variation in the CTD trace resulting in a "spike" at the bottle trip. Salinity is acceptable.
103   Triplicate O_2 drawn.
101   Oxygen is a little low on the station profile. Nutrients do not confirm this as a real feature. But it is difficult to explain a low oxygen. CTDO confirms the lower oxygen "tail".

Station 139

Cast 1   No comments on the Sample Log.

Station 140

Cast 1   No comments on the Sample Log.

109   Delta-S at 656db is -0.014. No analytical problem noted. Gradient area, feature in the CTD trace. Data are acceptable.

Station 141

Cast 1   No comments on the Sample Log.
115   CTD profile shows variation in the water which may cause a difference between the salinity and the CTD. Salinity is acceptable.

Station 142

Cast 1   No comments on the Sample Log.
121   Delta-S at 30db is -0.0279. Autosal diagnostics do not indicate a problem. Variations in CTD profile indicating an explanation for a large difference with the salinity. Salinity is acceptable.
120   Duplicate O_2 drawn. Delta-S at 49db is -0.0255. Autosal diagnostics do not indicate a problem. Variations in CTD profile indicating an explanation for a large difference with the salinity. Salinity is acceptable.
115   Nutrients low and oxygen high. Data are acceptable.
108   Delta-S at 1050db is 0.01. Autosal diagnostics do not indicate a problem. CTD profile indicates a "spike" at the bottle trip. Salinity is acceptable.

Station 143

Cast 1   No comments on the Sample Log.
114   Oxygen is high and nutrients are low. Data are acceptable.

Station 144

Cast 1   No comments on the Sample Log.
110   Delta-S at 1058db is -0.0073. Autosal diagnostics do not indicate a problem. Difference between down and up CTD profile. Salinity is acceptable.
105   Delta-S at 1815db is -0.0027. Autosal diagnostics do not indicate a problem. Gradient area. Salinity is acceptable.

Station 145

Cast 1   No comments on the Sample Log.
105   Triplicate O_2 drawn.
102   Triplicate O_2 drawn.
101   Delta-S at 2689db is 0.0029. Autosal diagnostics do not indicate a problem. Difference between the down and up CTD trace. Salinity is acceptable.

Station 146

Cast 1   No comments on the Sample Log.

109   Delta-S at 1767db is 0.0031. Autosal diagnostics do not indicate a problem. Gradient area. Data are acceptable.

101   Oxygen: "Overtitrate, (No End Point)." Oxygen is acceptable. Difference with the CTD salinity. The first readings gave better results and are used in this salinity calculation. Salinity is acceptable.

Station 147

Cast 1   No comments on the Sample Log.

116   Nutrients are high, oxygen is low. CTD agrees with salinity and oxygen. Feature is real.

110   Delta-S at 1056db is 0.009. Autosal diagnostics do not indicate a problem. Salinity agrees with adjoining stations. Salinity is acceptable.

106   Delta-S at 1713db is 0.0026. Autosal diagnostics do not indicate a problem. Salinity agrees with adjoining stations. Salinity is acceptable.

105   Oxygen: "Overtitrate (No End Point)." Oxygen is acceptable.

101   Delta-S at 2648db is 0.0054. Autosal diagnostics do not indicate a problem. Salinity agrees with adjoining stations. Variation in CTD trace as a "spike" at bottle trip. Salinity is acceptable.

Station 148

Cast 1   No comments on the Sample Log.

112   Oxygen: "Overtitrate, (No End Point). Oxygen is acceptable.

104   Oxygen appears low. Gradient area, oxygen is acceptable.

Station 149

Cast 1   No comments on the Sample Log.

115   Oxygen: "Overtitrate (No End Point)." Oxygen is acceptable.

110   Delta-S at 758db is 0.0178. Autosal diagnostics do not indicate a problem. Gradient in a maximum salinity feature as shown by the CTD. Salinity is acceptable.

103   Delta-S at 1921db is -0.0029. Autosal diagnostics do not indicate a problem. Feature in CTD up trace similar to a "spike" at bottle trip. Salinity is acceptable.

Station 150

Cast 1   No comments on the Sample Log.

115   High O_2. Feature does not show in nutrients. Salinity is acceptable. CTDO shows that oxygen is higher at this level. Oxygen is acceptable.

110   Delta-S at 668db is -0.0274. Gradient in a maximum salinity feature as shown by the CTD. Salinity is acceptable.

103   Delta-S at 1617db is 0.0031. Variation in CTD trace appearing as a "spike" at the bottle trip. Salinity is acceptable.

101   Delta-S at 1835db is 0.0027. Variation in CTD trace appearing as a "spike" at the bottle trip. Salinity is acceptable.

101-102 Nutrients high, O_2 low. Feature is real.

Station 151

Cast 1 No comments on the Sample Log.
102 Triplicate O_2 drawn.

Station 152

Cast 1 No comments on the Sample Log.
107 Nutrients high and oxygen and salinity low. Data are acceptable.
106 Oxygen: "Overtitrate, (No End Point)." Oxygen is acceptable.

Station 153

Cast 1 Console Ops: "Special cast for LADCP bottom tracking test, minimal sampling."
Only salinity drawn.
216 Sample Log: "Not enough water for salinity."
213 Oxygen: "Overtitrate, (No End Point)." Oxygen is acceptable.
211 O_2 appears high on station profile, but CTDO also shows this high feature. Oxygen
is acceptable.
101-103 No CTDO as planned.

* Figures not included.