CRUISE REPORT: A24

(Updated: 27 NOV 2006)

A. HIGHLIGHTS

A.1. Cruise Summary Information

WOCE section designation	**A24**
Expedition designation (EXPOCODE)	**316N151_2**
Chief Scientist	**Lynne Talley/SIO**
Dates	1997.MAY.30 – 1997.JUL.05
Ship	R/V KNORR
Ports of call	Ponta Delgada, Azores to Halifax, Nova Scotia
Number of stations	153
Stations' geographic boundaries	64° 46' N 47° 40' W 9° 20' W 38° 49' N
Floats and drifters deployed	12 PALACE floats and 17 RAFOS floats
Moorings deployed or recovered	1 URI RAFOS Mooring 2 RAFOS sources on initial transit
Contributing Authors (in order of appearance)	F. Delahoyde, K. Sanborn E. Firing M. Vollmer, L. Arlen, S. Khatiwala

Lynne Talley
Scripps Institution of Oceanography • UCSD
9500 Gilman Dr. • MS 0230 • La Jolla, CA • 92093-0230
Phone: 858-534-6610 • Fax: 858-534-9820 • email: ltalley@ucsd.edu
WWW homepage: http://sam.ucsd.edu

Cruise and Data Information

(Click on items below to locate text location)

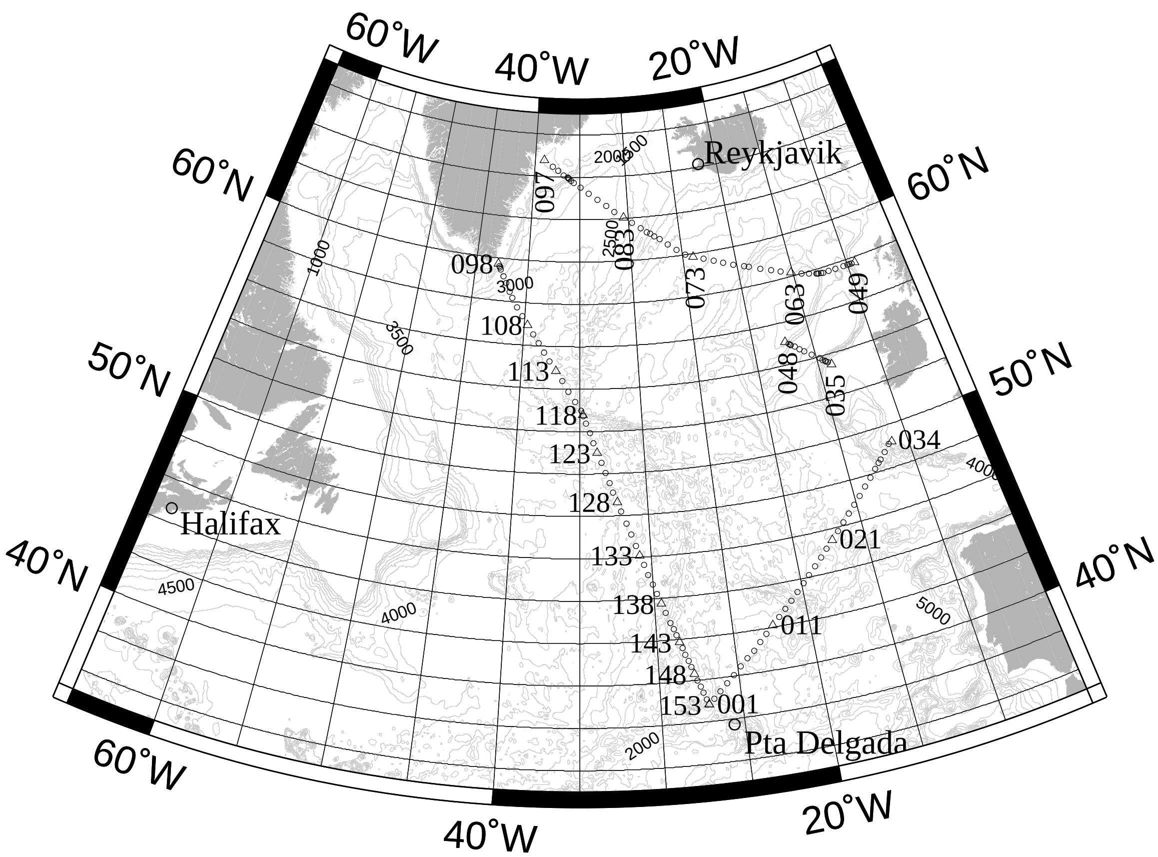
Cruise Summary Information	Hydrographic Measurements
Description of scientific program	CTD - general
	CTD - pressure
Geographic boundaries of the survey	CTD - temperature
Cruise track (figure)	CTD - conductivity/salinity
Description of stations	CTD - dissolved oxygen
Description of parameters sampled	
Bottle depth distributions (figure)	Salinity
Floats and drifters deployed	Oxygen
Moorings deployed or recovered	Nutrients
	CFCs
Principal Investigators for all measurements	Helium
Cruise Participants	Tritium
	Radiocarbon
Problems and goals not achieved	CO2 system parameters
Other incidents of note	Other parameters
Underway Data Information	**Acknowledgments**
Navigation	**DQE Reports**
Bathymetry	CTD
Acoustic Doppler Current Profiler (ADCP)	S/O2/nutrients
Thermosalinograph and related measurements	CFCs
XBT and/or XCTD	14C
Meteorological observations	
Atmospheric chemistry data	
References: CTD/S/O/NUTs CO2	**CCHDO Data Processing Notes**

World Ocean Circulation Experiment
A24

R/V Knorr Voyage 151/2

WHPO Expocode: 316N151/2

Final ODF Cruise Report
October 18, 2006



WOCE A24 Cruise Track

Shipboard Technical Support

(Oceanographic Data Facility/Shipboard Electronics Group)

Scripps Institution of Oceanography

La Jolla, Ca. 92093-0214

Summary

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.

Scientific Personnel		
Name	Affiliation	Duties
Talley, Lynne	SIO/PORD	Chief Scientist
Arlen, Linda	LDEO	TCO2
Becker, Susan	SIO/STS/ODF	Nutrients
Boaz, John	SIO/STS/ODF	Watch Leader/O2/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	BNL	TCO2
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	O2/Rosette
Sanborn, Kristin	SIO/STS/ODF	Bottle data/Salinities/Rosette/O2
Smith, Daniel	LDEO	Helium, Tritium, O-18
Van Woy, Frederick	SIO/GRD	CFC
Vollmer, Martin	SIO/GRD	CFC
Wilson, Angela	LDEO	pCO2

Table 0.0 Scientific Personnel WOCE A24

Narrative

The R/V Knorr left Ponta Delgada, Azores at 11:00 on May 30, 1997 to begin the one-time WHP survey sections A24 in the subpolar North Atlantic. 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 47N, 39W and 47N, 31W.

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.

Programs

The principal programs of A24 are shown in Table 0.1. The SIO ODF hydrographic measurements program is described in detail in this report.

Analysis	Institution	Principal Investigator
Basic Hydrography (Salinity, O2, Nutrients, CTD)	SIO	Lynne Talley
CFC	SIO	Ray Weiss
He/Tr/ ^{18}O	LDEO	Peter Schlosser
TCO2	BNL	Doug Wallace
TCO2 (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 and Mike Prater
pCO2	LDEO	Taro Takahashi, Dave Chipman
UW pH, TCO2 (Transit only)	WHOI	Catherine Goyet
UW pH, TCO2	BNL	Doug Wallace
UW Meteorology/XBTs	WHOI	Barry Walden
UW Thermosalinograph	SIO	Lynne Talley
UW Sea surface & air gas analysis, pCO2, pN2O, pCH4, CH4, CO2, N20	SIO	Ray Weiss

Table 0.1 Principal Programs of WOCE A24

DESCRIPTION OF MEASUREMENT TECHNIQUES AND CALIBRATIONS

1. Basic Hydrography Program

The basic hydrography 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.

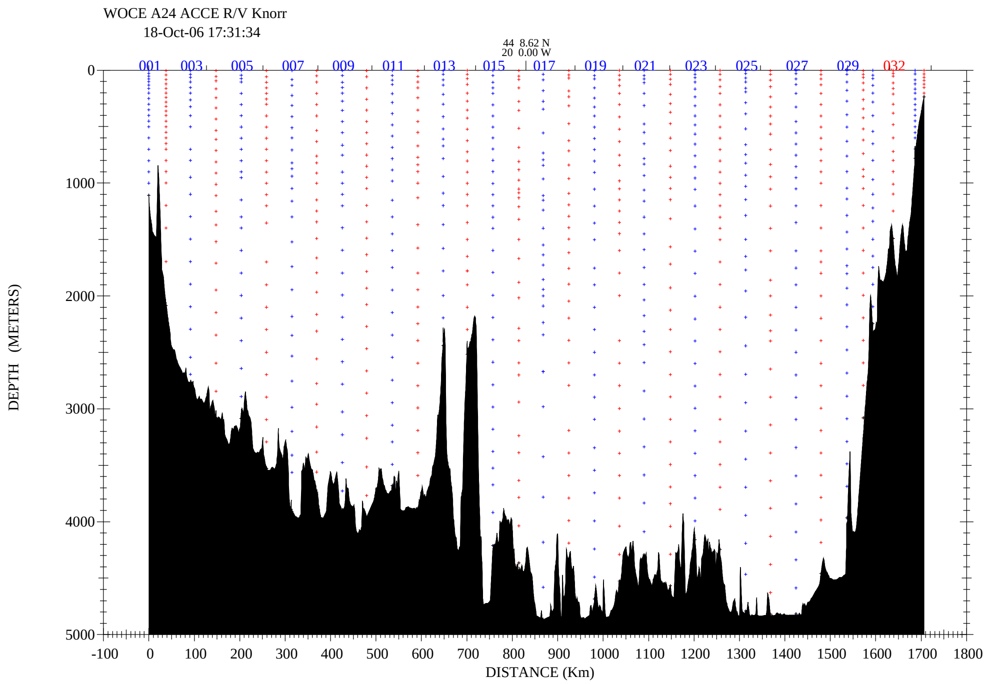


Figure 1.0 Sample distribution, stations 1-34.

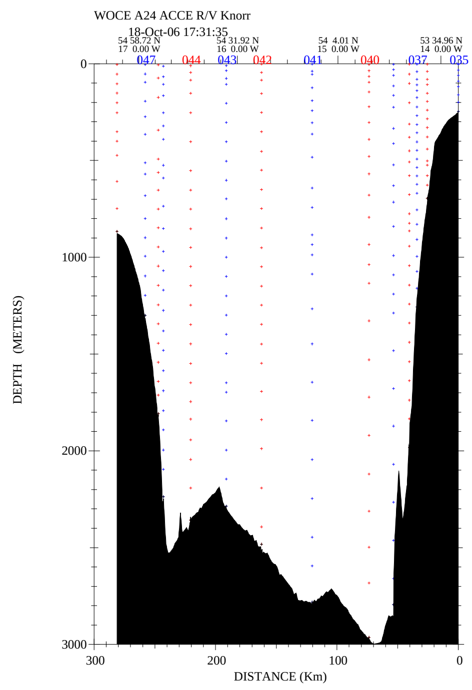


Figure 1.1 Sample distribution, stations 35-48.

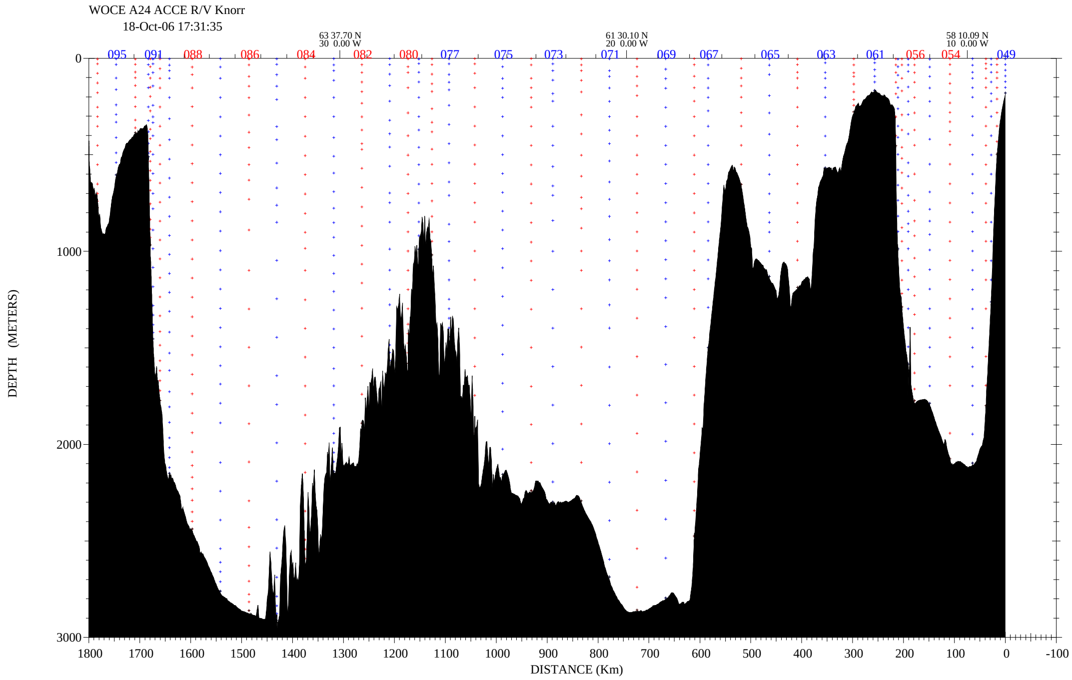


Figure 1.2 Sample distribution, stations 49-97.

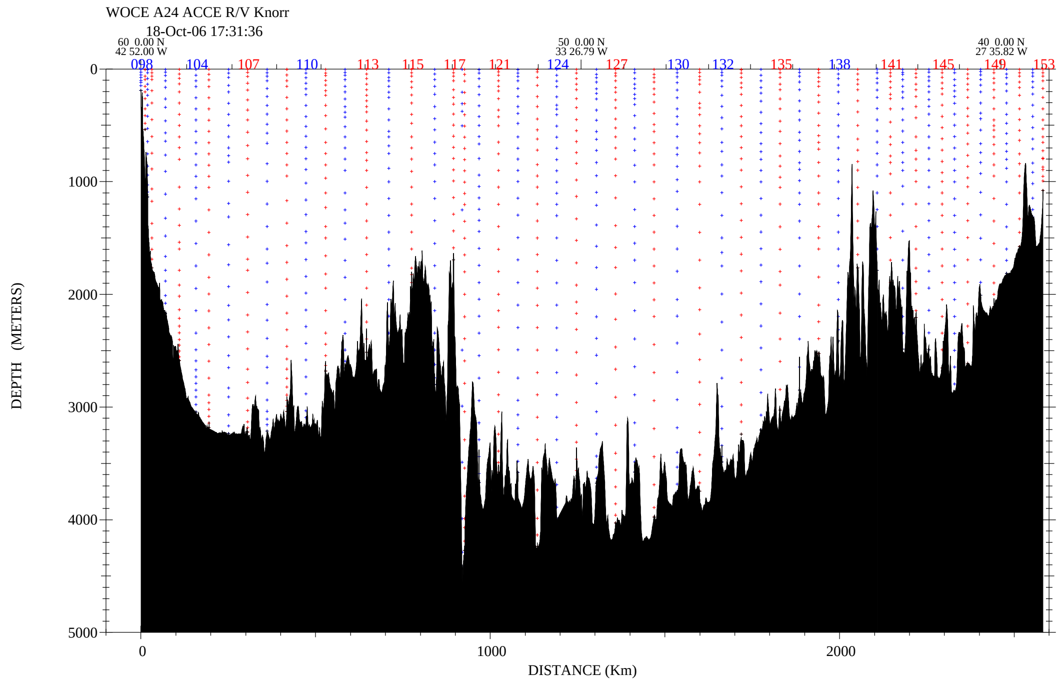


Figure 1.3 Sample distribution, stations 98-153.

2. 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" electro-mechanical (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.

3. 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 multiplexer channels; an elapsed-time channel; instrument id in the polarity byte and power supply voltages channels. The instrument sensor configuration is provided in Table 3.0.

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 3.0 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.

4. Navigation and Bathymetry Data Acquisition

Navigation data were acquired from the ship's Trimble 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 (centerbeam 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].

5. 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 performed on CTD #5 at the ODF Calibration Facility (La Jolla) in April 1997 and July/August 1997, both before and after 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 Gage pressure reference. Calibration curves were measured to two maximum loading pressures during April/July/August: -2.06/-0.98/-1.17°C to 6080 db and 28.74/30.66/30.00°C to 1190 db. Figures 5.0-2 summarize the laboratory pressure calibrations performed in April, July and August 1997.

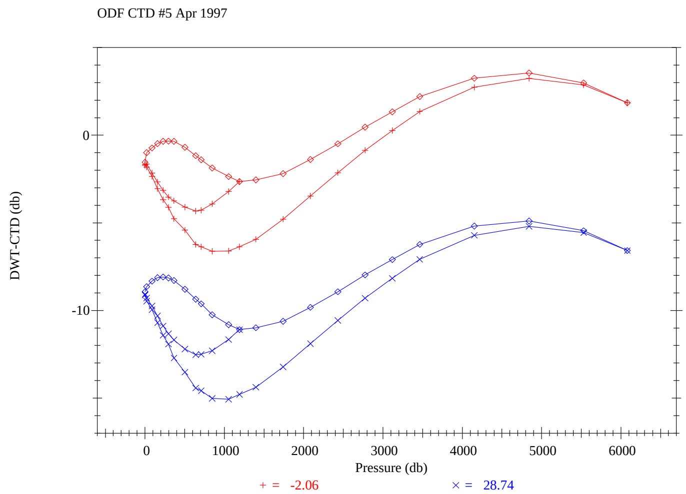


Figure 5.0 Pressure calibration for ODF CTD #5, April 1997.

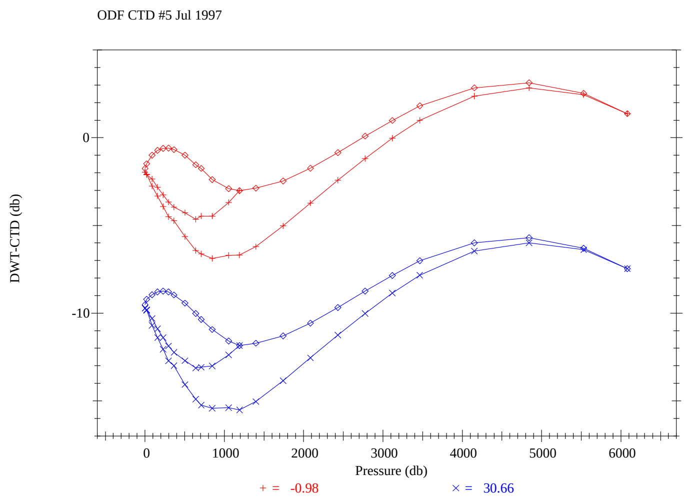


Figure 5.1 Pressure calibration for ODF CTD #5, July 1997.

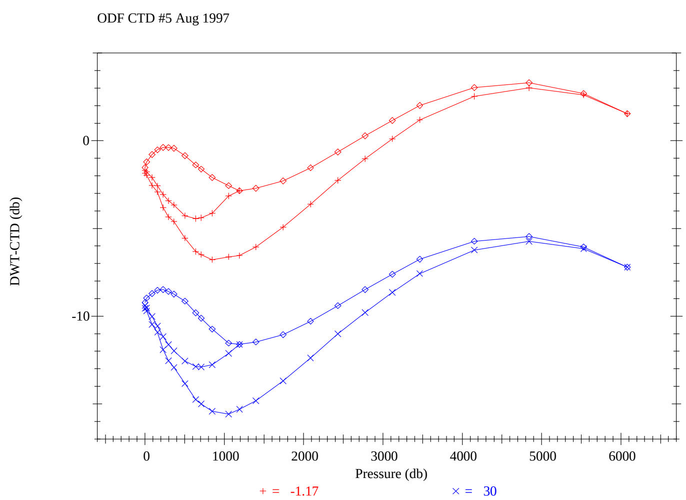


Figure 5.2 Pressure calibration for ODF CTD #5, August 1997.

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 1.5°C to avoid the 0-point discontinuity inherent in the internal digitizing circuitry. Figures 5.3-5 summarize the laboratory temperature calibration performed on the primary PRT in April, July and August 1997.

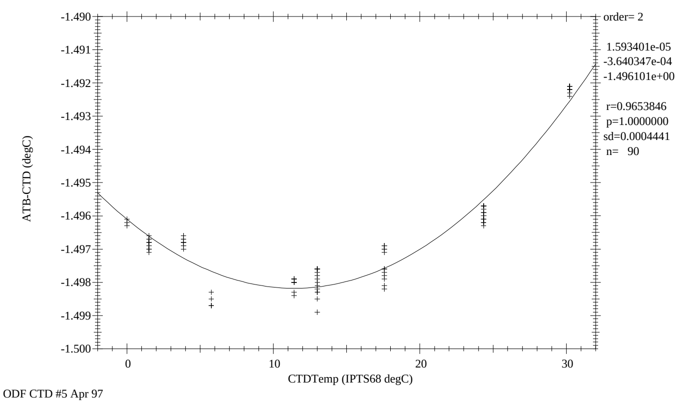


Figure 5.3 Primary Temperature calibration for ODF CTD #5, April 1997.

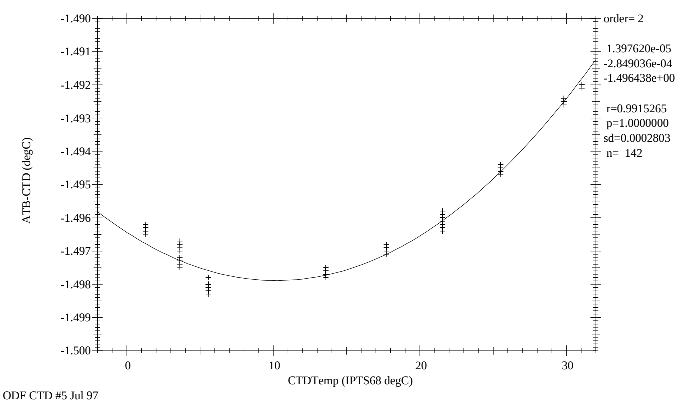


Figure 5.4 Primary Temperature calibration for ODF CTD #5, July 1997.

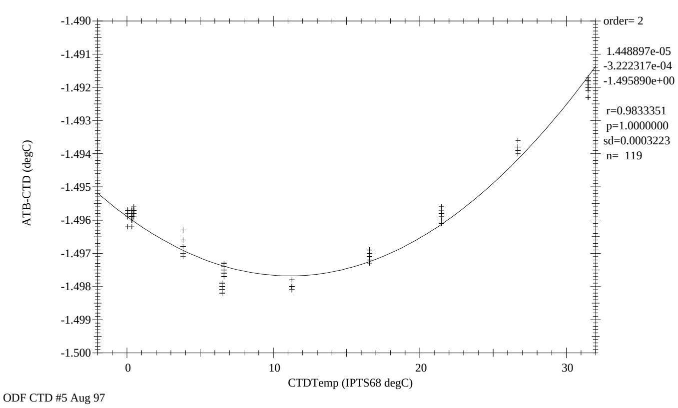


Figure 5.5 Primary Temperature calibration for ODF CTD #5, August 1997.

The calibrations for both Pressure and Temperature were essentially unchanged between April and July/August 1997.

6. 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 seacable 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 and provided for 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-232C binary data stream by the CTD deck unit. This data stream was fed to the Sun SPARCstation. The pylon confirmation signal was tied into the CTD data stream 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 displays of real-time raw and processed data, navigation, winch and rosette trips.

The CTD data acquisition, processing and control system was prepared by the console watch a few minutes before each 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 initiated by pointing and clicking a trackball cursor on the display at icons representing functions to perform. The system then presented the operator with short dialog prompts with automatically-generated choices that could either be accepted as defaults or overridden. The operator was instructed to turn on the CTD power supply, 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. A backup analog recording of the CTD signal was made on a VCR tape, which was started at the same time as the data acquisition. A rosette trip display and pylon control window popped up, giving visual confirmation that the cast was initialized 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 and informed the console operator that the rosette was at the surface (also confirmed by the computer displays), the console operator or watch leader provided the winch operator with a target depth (wire-out) and maximum lowering rate, normally 60 meters/minute or less for this package. The package then began its descent, typically starting at 20 meters/minute and building up to 60 meters/minute, continuing at a steady rate without any stops during the down-cast.

The console operator examined the processed CTD data during descent via interactive plot windows on the display, which could also be run at other workstations on the network. Additionally, the operator decided 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 watch leader assisted the console operator when the package was ~400 meters above the bottom by monitoring the range to the bottom using the distance between the rosette’s pinger signal and its bottom reflection displayed on the PDR. Between 100 and 60 meters above the bottom, depending on bottom conditions, the altimeter typically began signaling a bottom return on the console. 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

Bottles were closed on the up cast by pointing the console trackball cursor at a graphic firing control and clicking a button. The data acquisition system responded 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 then directed 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 directed the deck watch to bring the rosette on deck. Once the rosette was on deck, the console operator terminated the data acquisition and turned off the CTD, pylon and VCR recording. The VCR tape was filed. The *sample cop* (usually the console operator) brought the sample log to the rosette room and logged information for samples drawn.

7. CTD Data Processing

ODF CTD processing software consists of over 30 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 various 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
- 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 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 into a larger-interval time-series. The pressure calibration corrections are applied during reduction of the data to time-series. Temperature, conductivity and oxygen 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 Hz data from the CTD were filtered, response-corrected and averaged to a 2 Hz (0.5-second) 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, as well as the 20 Hz raw data, were stored on disk 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 theta-salinity comparisons between down- and up-casts as well as adjacent stations. The dissolved CTD 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. Some casts were subject to noise in the data stream caused by sea cable or slip-ring problems, or by moisture in interconnect cables between the CTD and external sensors (i.e. O_2). Intermittent noisy data were filtered out of the 2 Hz data using a spike-removal filter. A least-squares polynomial of specified order was fit to fixed-length segments of data. Points exceeding a specified multiple of the residual standard deviation were replaced by the polynomial value.

Density inversions can be induced in high-gradient regions by ship-generated vertical motion of the rosette. Detailed examination of the raw data shows significant mixing occurring in these areas because of "ship roll". In order to minimize density inversions, a ship-roll filter was applied to all casts during pressure-sequencing to disallow pressure reversals.

The first few seconds of in-water data were excluded from the pressure-series data, since the sensors were still adjusting to the going-in-water transition. Only station 15 exhibited a notable (-0.022 sigma theta) density drop during the top 10 db. 18 casts showed a sharply increasing density gradient (typically +0.1 to +0.25 in sigma theta) in the top few meters of the water column; however, the gradients for stations 140 and 95 were +0.33 and +0.86. A time-series data check verified these density features were probably real: the data were consistent over many frames of data at the same pressures. Sometimes the surface densities varied because of temperature instabilities as large as 0.5°C.

Pressure intervals with no time-series data can optionally be filled by double-quadratic interpolation/extrapolation. The only pressure intervals missing/filled during this leg were at 0-2 db, caused by chopping off going-in-water transition data during pressure-sequencing.

When the down-cast CTD data have excessive noise, gaps or offsets, the up-cast data are used instead. CTD data from down- and up-casts are not mixed together in the pressure-series data because they do not represent identical water columns (due to ship movement, wire angles, etc.). It was necessary to use two up-casts for final WOCE A24 pressure-series CTD data: stations 1 and 71.

There is an inherent problem in the internal digitizing circuitry of the NBIS Mark III CTD when the sign bit for temperature flips. Raw temperature can shift 1-2 millidegrees as values cross between positive and negative, a problem avoided by offsetting the raw PRT readings by ~1.5°C. The conductivity channel also can shift by 0.001-0.002 mS/cm as raw data values change between 32768/32767, where all the bits flip at once. This is typically not a problem in shallow to intermediate depths because such a small shift becomes negligible in higher gradient areas. Raw CTD conductivity traversed 32768/32767 during most A24 casts. The software was changed before station 23 was acquired to handle this discontinuity for the rest of the cruise; stations 1-22 were also re-processed with the updated software.

Appendix C contains a table of CTD casts requiring special attention.

8. CTD 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.

An SBE35 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

Pre-cruise calibrations were used to determine shipboard pressure and temperature corrections for CTD #5. There were no significant shifts apparent in the CTD pressure or temperature, based on the primary/secondary PRT comparisons and the conductivity calibration.

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 8.0 and 8.1 summarize the comparisons between the SBE 35 reference PRT and the primary and secondary PRT temperatures.

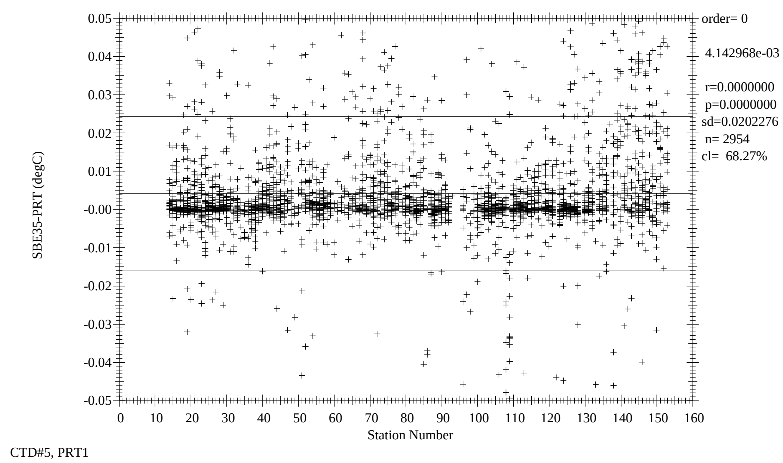


Figure 8.0 Comparison between SBE 35 reference and primary PRT temperatures.

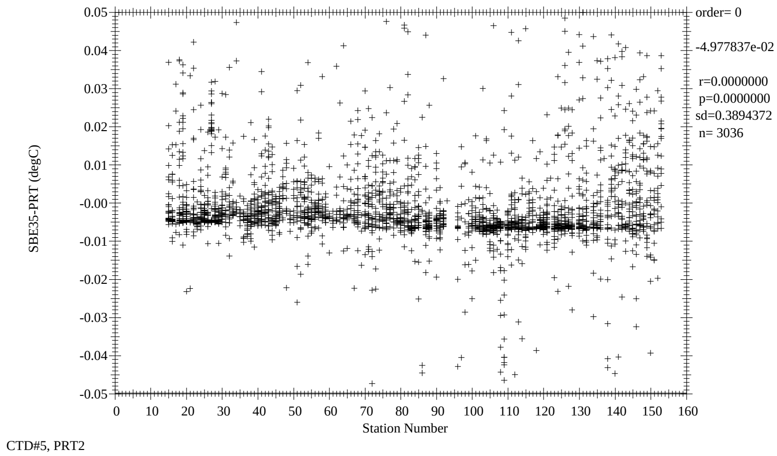


Figure 8.1 Comparison between SBE 35 reference and secondary PRT temperatures.

Pre- and post-cruise laboratory calibrations for CTD #5 were compared during the data finalization process.

CTD #5 pressure shifted 0.5 to 0.6 db between April and July for both cold and warm calibrations. The August results were one-third closer to the April calibration. Half of the cold-calibration difference, and almost all of the warm-calibration difference, can be accounted for by differences in bath temperatures, since there is a notable temperature effect on this pressure sensor. This means the pre-/post-cruise pressure shift was -0.3 db or smaller, well within WOCE specifications. No adjustments were made to pressure.

Pre-cruise calibrations were within 0.0004°C and halfway between the two post-cruise calibrations in the 0-3°C range. The April/July temperature corrections cross at 5°C; July/August corrections merge from 16-32 °C. The maximum difference is 0.0005°C, with the April correction more negative than both July/August above 5°C. Pre-cruise cold data is offset -0.00055°C or less from the August post-cruise calibration. Warmer data are within 0.00015°C for all 3 temperature calibrations. Nearly all of the CTD temperatures during A24 were below 18°C, where there is at most a -0.00055°C difference in pre- to post-cruise calibration corrections. The temperatures are well within WOCE specifications without further adjustment.

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.

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

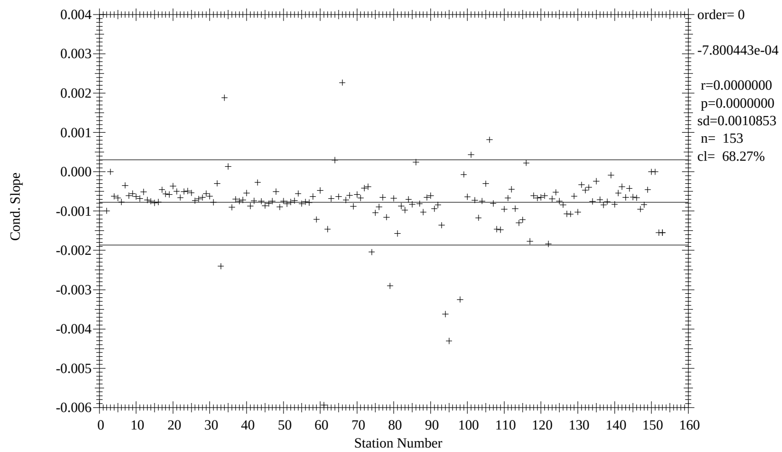


Figure 8.2 Conductivity correction slopes, per station.

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:

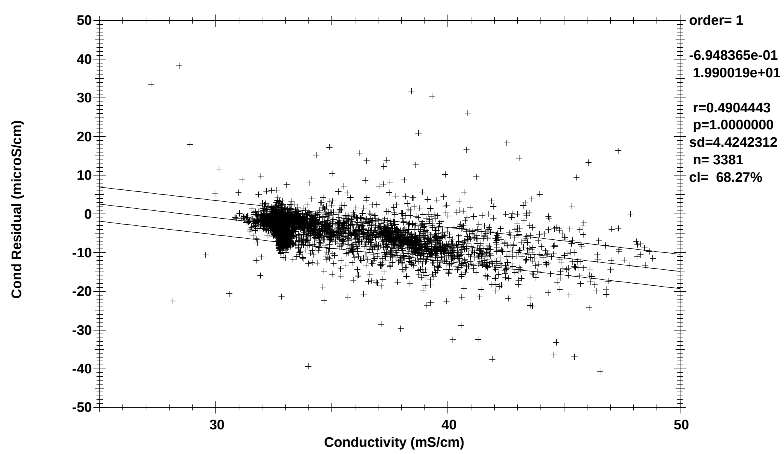


Figure 8.3 Mean conductivity correction slope, all stations.

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.

The final form of the applied conductivity correction was:

$$G_{corr} = G_{raw} - 9.13543e-11P^2 + 1.80848e-07P + 0.0000147071G_{raw}^2 - 0.00176569G_{raw} + c_{offset} \tag{8.0}$$

where:

G_{corr} = Corrected conductivity (mS/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.

Conductivity corrections were re-examined post-cruise. The final conductivity slope and non-linearity corrections had not been applied to stations 150-153. Since no adjustments were made to pressure or temperature post-cruise, the corrections determined shipboard were used. However, it was noted that conductivity offsets were not smoothed in groups of casts. While the statistical bottle-CTD differences would look quite good, CTD data can sometimes be shifted further apart on consecutive casts if there were any problems with drift or standardization when analyzing bottle salts.

CTD data at trips were re-extracted post-cruise, to generate a more consistent 2-2.5-second average at trips, like the realtime trip data. (7-second averages were used shipboard for casts reprocessed after a software improvement.) Conductivity offsets were recalculated for all casts, but processing time was cut short and they still were not smoothed. A plot of the offsets vs station number was examined to check casts with anomalous offsets as compared to nearby casts. Some of these were manually adjusted, based on deep theta-S comparisons as well as bottle-CTD differences (where an occasional larger difference could distort the automatically generated offset).

There was a consistent -0.001-2 mS/cm shift in the CTD conductivities at cast bottom that continued during the entire deep upcast, beginning with stations in the mid-40s. This persisted to the end of the cruise, and could affect conductivity offsets (generated by comparing upcast data at trips with bottle data) used to correct the reported downcast CTD conductivity. There was an additional intermittent problem from station 124 onward with low-level (usually -0.001-2 mS/cm, occasionally -0.004 mS/cm) back-and-forth offsetting problems during upcasts, which became persistent by the early 140s. These could affect bottle data differences, but time was not allowed to re-examine these casts more closely. However, it was observed on deep theta-S plots that the CTD signal often spiked back to the downcast values during trips.

Figure 8.4 illustrates the final offsets for CTD conductivity by station, after applying the linear and non-linear corrections.

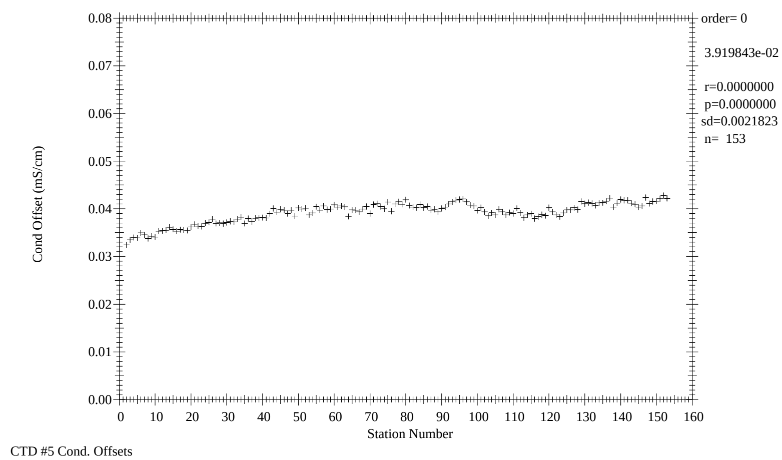


Figure 8.4 Final conductivity correction offsets, all stations.

Figures 8.5, 8.6 and 8.7 summarize the residual differences between bottle and CTD salinities after applying the final conductivity corrections.

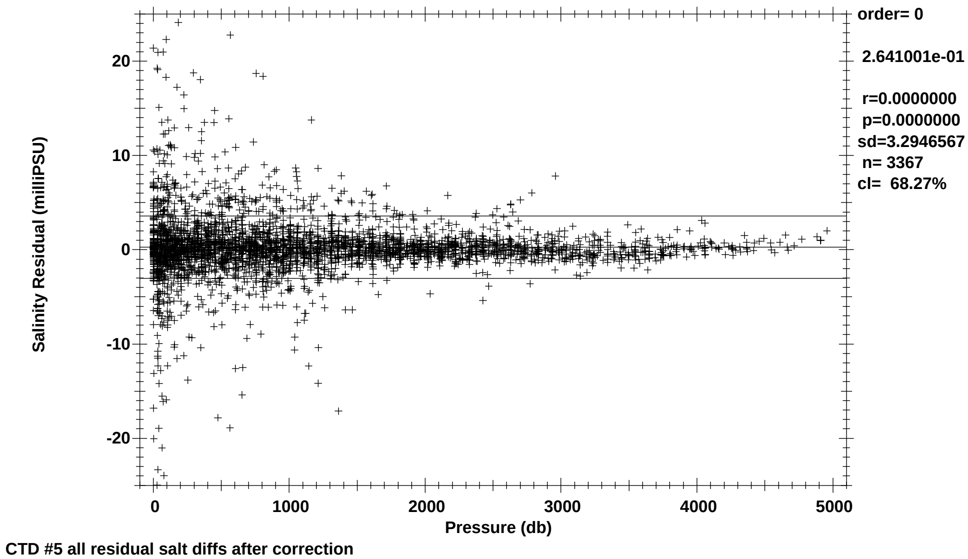


Figure 8.5 Salinity residual differences after correction, by pressure.

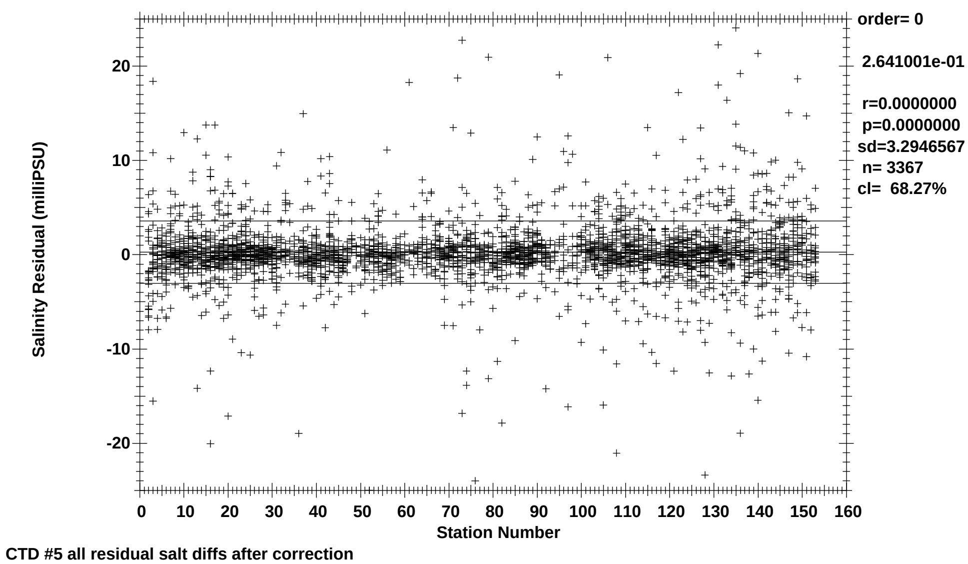


Figure 8.6 Salinity residual differences after correction, by station.

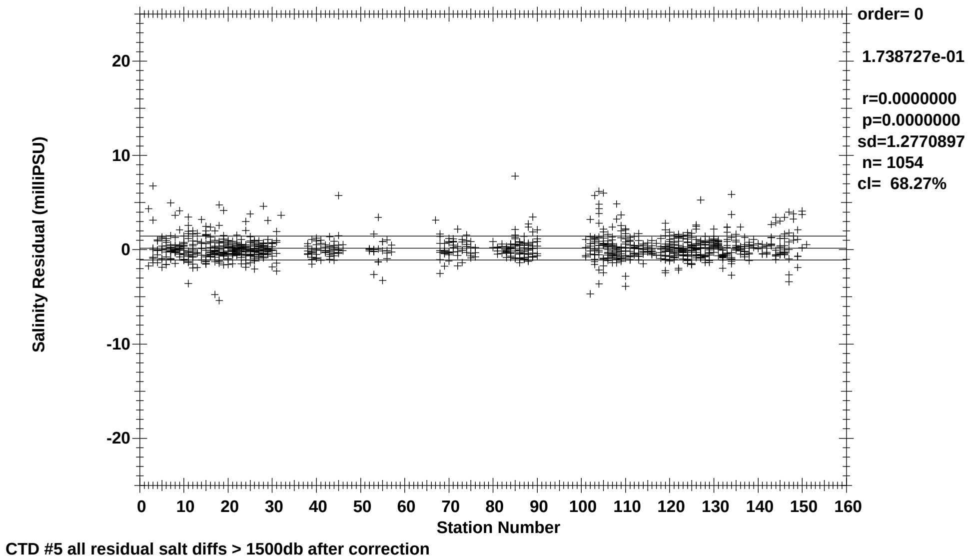


Figure 8.7 Deep salinity residual differences after correction, by station.

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

The CTD conductivity calibration represents a best estimate of the conductivity field throughout the water column. 3σ from the mean residual in Figures 8.6 and 8.7, or ±0.0063 PSU for all salinities and ±0.0020 PSU for deep salinities, represents the limit of repeatability of the bottle salinities, including all sources of variation (e.g., Autosal, rosette, operators and samplers). This limit agrees with station overlays of deep theta-salinity. Within most casts (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) was used for the entire cruise. There was an atypically higher noise level in the raw CTD O_2 data for many casts which remains in the final data set. There were also numerous problems with a very low signal at the start of many downcasts, affecting data in the top 50 db (or as much as 500 db in stations in the 70s and 80s). These low data were offset, when feasible and very shallow, to bring the CTD O_2 into the realm of reality. Generally, only very shallow (less than 20 db) data were offset, and any remaining problems were quality-coded as bad.

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. Stopping the rosette for as little as half a minute, or slowing down for a bottom approach, could cause shifts in the CTD O_2 profile as oxygen became depleted in water near the sensor. Because of these problems, CTD rosette trip data cannot be directly calibrated to O_2 check samples. Instead, down-cast CTD O_2 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.

Down-casts were deemed to be unusable for two casts (stations 1 and 71), so up-cast CTD O_2 data were processed despite the signal drop-offs typically seen at bottle stops. There were no bottle oxygens for station 153/1, so the corrections from station 152 were used to bring the profile as close as possible to 153/2 results.

Figures 8.8 and 8.9 show the residual differences between the corrected CTD O_2 and the bottle O_2 (ml/l) for each station, after the problem surface areas were offset and/or quality-coded.

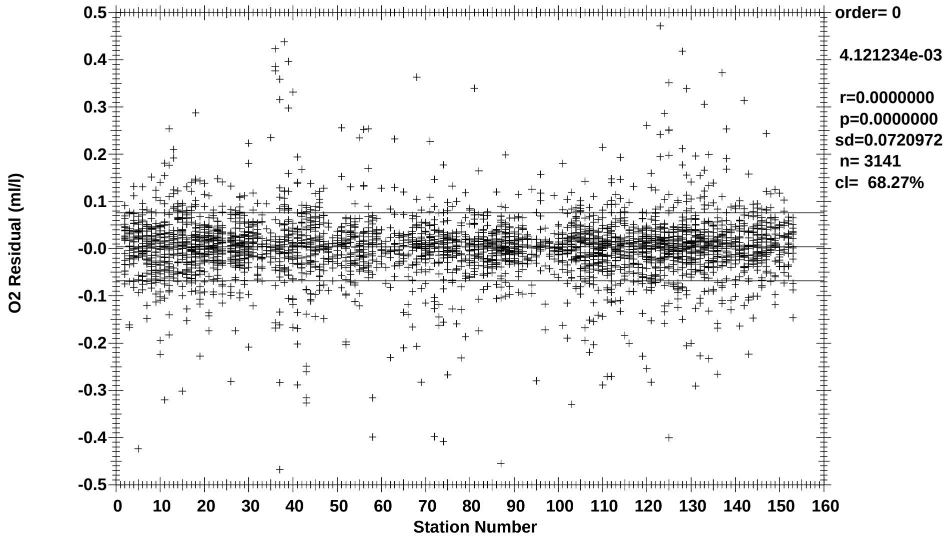


Figure 8.8 O_2 residual differences after correction, by station.

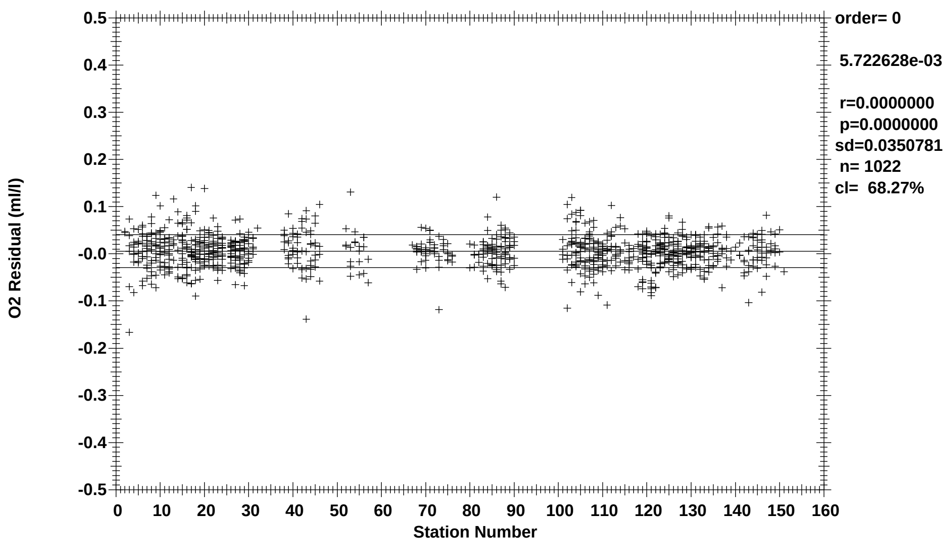


Figure 8.9 O_2 residual differences (>2000db).

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 0.079 ml/l for all oxygens and 0.036 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:

$$O_{pp} = [c_1 O_c + c_2] \cdot f_{sat}(S,T,P) \cdot e^{(c_3 P_l + c_4 T_f + c_5 T_s + c_6 \frac{dO_c}{dt})} \tag{8.1}$$

where:

O_{pp}	= Dissolved O_2 partial-pressure in atmospheres (atm);
O_c	= Sensor current (μamps);
$f_{sat}(S,T,P)$	= 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);
$\frac{dO_c}{dt}$	= Sensor current gradient (μamps/secs).

9. Bottle Sampling

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

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

Note that some properties were subsampled 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 SPARCstations for centralized data analysis. The analyst for a specific property was responsible for insuring that their results updated the cruise database.

10. 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 O2 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 10.0 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 001-153								
	Reported Levels	WHP Quality Codes 1	2	3	4	5	7	9
Bottle	3450	0	3387	4	56	0	0	3
CTD Salt	3450	0	3440	6	0	0	4	0
CTD Oxy	3413	0	3194	133	86	35	0	2
Salinity	3438	0	3406	12	20	3	0	9
Oxygen	3434	0	3419	3	12	9	0	7
Silicate	3439	0	3431	5	3	3	0	8
Nitrate	3439	0	3436	0	3	3	0	8
Nitrite	3439	0	3436	0	3	3	0	8
Phosphate	3439	0	3435	0	4	3	0	8

Table 10.0 Frequency of WHP quality flag assignments.

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

11. 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. 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.

12. 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 end-point 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.

13. 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 4°C 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 PO4 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 μM); a correction for this non-linearity is applied in ODF's software. All silicates during this expedition were in the linear range (<100 μM).

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 flowcell 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 flowcell 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 flowcell 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 (±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, uncoded 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 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 soundspeed 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 subpolar front (about 50 N) and the East Greenland Current on leg 4. At and south of the subpolar 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 subpolar front and at other spots between there and the Azores.

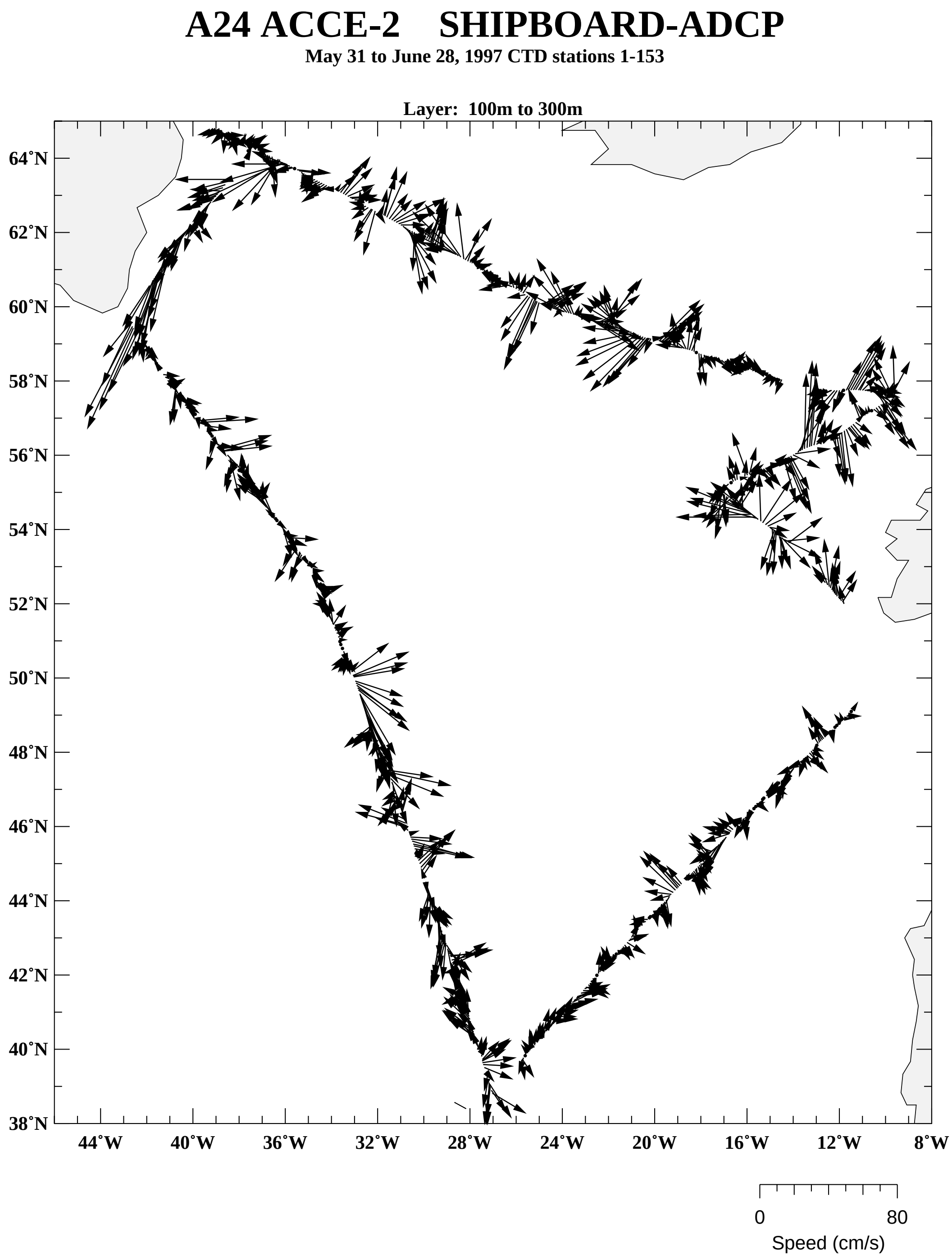

Figure 2.0 A24 Shipboard ADCP velocity vectors.

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 tranmitted and the time the backscattered 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).

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 sidelobe 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 backscatter 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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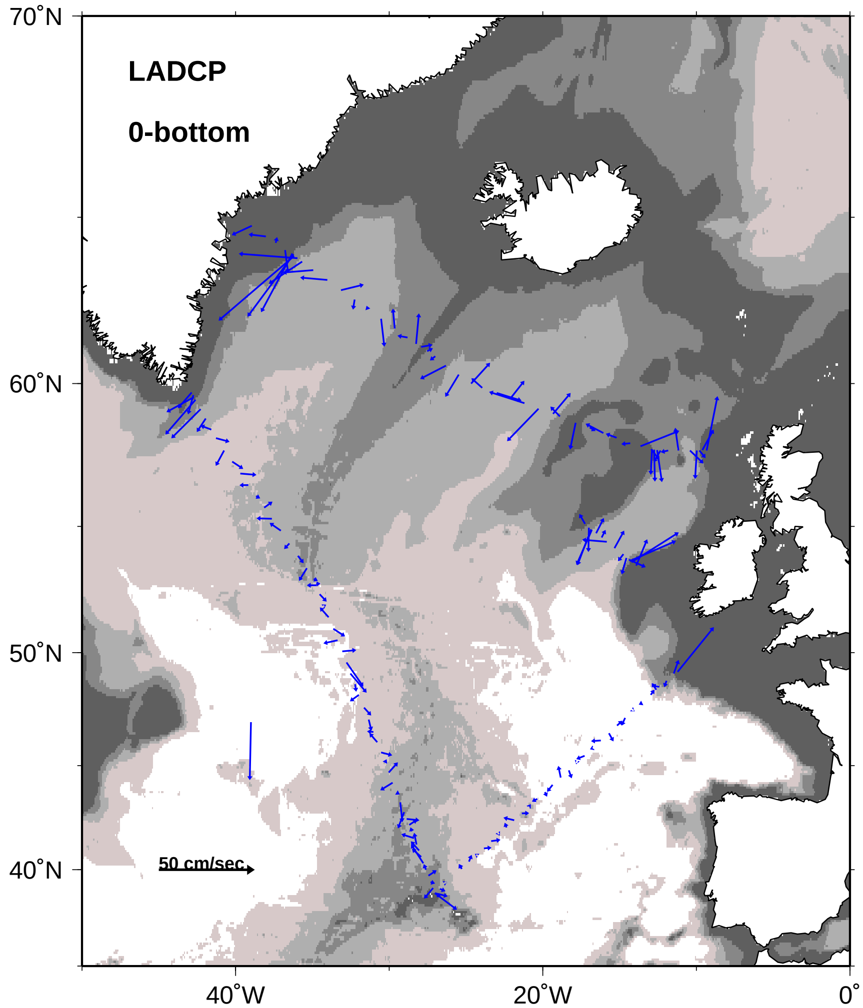

Figure 2.1 A24 Map of LADCP current vectors.

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 ground-glass 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 full-depth 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 (Paroscientific 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.

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4. 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.

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ORNL/CDIAC-143
NDP-082

CARBON DIOXIDE, HYDROGRAPHIC, AND CHEMICAL DATA OBTAINED DURING THE R/V *KNORR* CRUISES IN THE NORTH ATLANTIC OCEAN ON WOCE SECTIONS AR24 (NOVEMBER 2–DECEMBER 5, 1996) AND A24, A20, AND A22 (MAY 30–SEPTEMBER 3, 1997)

Contributed by
Kenneth M. Johnson,[1] Robert M. Key,[2] Frank J. Millero,[3] Christopher L. Sabine,[4]
Douglas W. R. Wallace,[5] Christopher D. Winn,[6] Linda Arlen,[7] Kenneth Erickson,[8]
Karsten Friis,[5] Meridith Galanter,[3] Jamie Goen,[3] Richard Rotter,[2] Carrie Thomas,[2]
Richard Wilke,[8] Taro Takahashi,[9] and Stewart C. Sutherland[9]

[1]Department of Applied Science, Brookhaven National Laboratory, Upton, NY, U.S.A.
Retired, now at P.O. Box 483, Wyoming, RI, U.S.A.
[2]Department of Geosciences, Princeton University, Princeton, NJ, U.S.A.
[3]Rosenstiel School of Marine and Atmospheric Science, University of Miami, Miami, FL, U.S.A.
[4]Pacific Marine Environmental Laboratory, NOAA, Seattle, WA, U.S.A.
[5]Institute for Marine Sciences, Kiel, Germany
[6]Hawaii Pacific University, Kaneohe, HI, U.S.A.
[7]James J. Howard Laboratory, NOAA, Sandy Hook, NJ, U.S.A.
[8]Department of Applied Science, Brookhaven National Laboratory, Upton, NY, U.S.A.
[9]Lamont-Doherty Earth Observatory, Palisades, NY, U.S.A.

Prepared by
Alexander Kozyr
Carbon Dioxide Information Analysis Center
Oak Ridge National Laboratory
Oak Ridge, Tennessee, U.S.A.

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Prepared by the
Carbon Dioxide Information Analysis Center
OAK RIDGE NATIONAL LABORATORY
Oak Ridge, Tennessee 37831-6335
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LIST OF FIGURES (links)

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ACRONYMS

ACCE	Atlantic Circulation and Climate Change Experiment
A/D	analog-to-digital
ADCP	acoustic Doppler current profiler
ALACE	autonomous Lagrangian circulation explorer
BOD	biological oxygen demand
BNL	Brookhaven National Laboratory
^{14}C	radiocarbon
CALFAC	calibration factor
CDIAC	Carbon Dioxide Information Analysis Center
CFC	chlorofluorocarbon
CMDL	Climate Monitoring and Diagnostics Laboratory
CO_2	carbon dioxide
CTD	conductivity, temperature, and depth sensor
CRM	certified reference material
DOE	U.S. Department of Energy
emf	electro-magnetic fields
EXPOCODE	expedition code
FTP	file transfer protocol
GMT	Greenwich mean time
GPS	global positioning system
IAPSO	International Association for the Physical Sciences of the Ocean
I/O	input-output
IR	infrared
JGOFS	Joint Global Ocean Flux Study
kn	knots
LADCP	lower ADCP
LDEO	Lamont-Doherty Earth Observatory
MATS	Miami University alkalinity titration systems
NBIS	Neil Brown Instrument system
NDP	numeric data package
NOAA	National Oceanic and Atmospheric Administration
nm	nautical mile
NSF	National Science Foundation
ODF	Ocean Data Facility
ODV	Ocean Data View
ORNL	Oak Ridge National Laboratory
OSU	Oregon State University
PC	personal computer
PDF	Portable Document Format
PI	principal investigator
PU	Princeton University
QA	quality assurance
QC	quality control
R/V	research vessel
RSMAS	Rosenstiel School of Marine and Atmospheric Sciences
SIO	Scripps Institution of Oceanography
SOMMA	single-operator multiparameter metabolic analyzer
SSW	standard seawater
TALK	total alkalinity

TCO_2	total carbon dioxide
TD	to-deliver
UH	University of Hawaii
UM	University of Miami
UW	University of Washington
VFC	voltage to frequency converter
WHOI	Woods Hole Oceanographic Institution
WHPO	WOCE Hydrographic Program Office
WOCE	World Ocean Circulation Experiment
WHP	WOCE Hydrographic Program

ABSTRACT

Johnson K., R. Key, F. Millero, C. Sabine, D. Wallace, C. Winn, L. Arlen, K. Erickson, K. Friis, M. Galanter, J. Goen, R. Rotter, C. Thomas, R. Wilke, T. Takahashi, and S. Sutherland. 2003. *Carbon Dioxide, Hydrographic, and Chemical Data Obtained During the R/V Knorr Cruises in the North Atlantic Ocean on WOCE Sections AR24 (November 2–December 5, 1996) and A24, A20, and A22 (May 30–September 3, 1997)* A. Kozyr (ed.) ORNL/CDIAC-143, NDP-082. Carbon Dioxide Information Analysis Center, Oak Ridge National Laboratory, U.S. Department of Energy, Oak Ridge, Tennessee, 41 pp.

This documentation describes the procedures and methods used to measure total carbon dioxide (TCO_2) total alkalinity (TALK), and partial pressure of CO_2 (pCO_2) at hydrographic stations on the North Atlantic Ocean sections AR24, A24, A20, and A22 during the R/V *Knorr* Cruises 147-2, 151-2, 151-3, and 151-4 in 1996 and 1997. Conducted as part of the World Ocean Circulation Experiment (WOCE), the expeditions began at Woods Hole, Massachusetts, on October 24, 1996, and ended at Woods Hole on September 3, 1997. Instructions for accessing the data are provided.

A total of 5,614 water samples were analyzed for discrete TCO_2 using two single-operator multiparameter metabolic analyzers (SOMMAs) coupled to a coulometer for extracting and detecting CO_2. The overall accuracy of the TCO_2 determination was ± 1.59 µmol/kg. The TALK was determined in a total of 6,088 discrete samples on all sections by potentiometric titration using an automated titration system developed at the University of Miami. The accuracy of the TALK determination was ± 3 µmol/kg. A total of 2,465 discrete water samples were collected for determination of pCO_2 in seawater on sections A24, A20, and A22. The pCO_2 was measured by means of an equilibrator-IR system by scientists from Lamont-Doherty Earth Observatory. The precision of the measurements was estimated to be about ± 0.15%, based on the reproducibility of the replicate equilibrations on a single hydrographic station.

The North Atlantic data set is available as a numeric data package (NDP) from the Carbon Dioxide Information Analysis Center. The NDP consists of 12 ASCII data files, one Ocean Data View–formatted data file, a NDP-082 ASCII text file, a NDP-082 PDF file, and this printed documentation, which describes the contents and format of all files, as well as the procedures and methods used to obtain the data.

Keywords: carbon dioxide; TCO_2; total alkalinity; partial pressure of CO_2; coulometry; gas chromatography; World Ocean Circulation Experiment; North Atlantic Ocean; hydrographic measurements; carbon cycle.

1. BACKGROUND INFORMATION

The World Ocean Circulation Experiment (WOCE) Hydrographic Program (WHP) was a major component of the World Climate Research Program. The primary WOCE goal was to understand the general circulation of the global ocean well enough to be able to model its present state and predict its evolution in relation to long-term changes in the atmosphere. The impetus for the carbon system measurements arose from concern over the rising atmospheric concentrations of carbon dioxide (CO_2). Increasing atmospheric CO_2 may intensify the earth's natural greenhouse effect and alter the global climate.

Although CO_2-related measurements [total CO_2 (TCO_2), total alkalinity (TALK), partial pressure of CO_2 (pCO_2), and pH] were not official WOCE measurements, a coordinated effort to make the carbon measurements was supported as a core component of the Joint Global Ocean Flux Study (JGOFS). This effort received support in the United States from the U.S. Department of Energy (DOE), the National Oceanic and Atmospheric Administration (NOAA), and the National Science Foundation (NSF) for WOCE cruises through 1998 to measure the global spatial and temporal distributions of CO_2 and related parameters. Goals were to estimate the meridional transport of inorganic carbon in a manner analogous to the oceanic heat transport (Bryden and Hall 1980; Brewer, Goyet, and Drysen 1989; Holfort et al. 1998; Roemmich and Wunsch 1985) and to build a database suitable for carbon-cycle modeling and the estimation of anthropogenic CO_2 increase in the oceans. The CO_2 survey took advantage of the sampling opportunities provided by the WOCE cruises during this period, and the final data set was expected to cover on the order of 23,000 stations. Wallace (2002) recently reviewed the goals, conduct, and initial findings of the survey.

This report discusses the results of the research vessel (R/V) *Knorr* expedition along the WOCE Sections AR24, A24, A20, and A22 [cruises 147-2, 151-2, 151-3, and 151-4, respectively (Fig. 1)]. The latter three cruises not only were part of WOCE but also were a component of the Atlantic Circulation and Climate Change Experiment (ACCE). The ACCE was intended to improve the understanding of the entrainment and transformation of warm saline subtropical water into the subpolar North Atlantic waters, with special emphasis on sampling the North Atlantic Current region. This region plays an important role in the exchange of CO_2 between the subtropical and subpolar gyres. The exchange between these gyres affects the magnitude and direction of air-sea CO_2 exchange in the North Atlantic and is therefore an important factor in the global carbon cycle. By 1997 the goal of high-quality measurements of chemical and physical parameters had been completed in all of the major oceans except the North Atlantic. Hence the cruises documented here also represent the concluding phase of the DOE-sponsored Global CO_2 Survey.

The expedition (section AR24) started at Woods Hole, Massachusetts, USA, on October 24, 1996, with a transit to the Azores; the station work began on November 2, 1996. The 1997 cruises started from Ponta Delgada, Azores, on May 30, 1997, and ended in Woods Hole on September 3, 1997, after stops in Halifax, N.S., Canada, and Port of Spain, Trinidad. The large-scale three-dimensional distribution of temperature, salinity, and chemical constituents, including the carbonate system parameters measured on these cruises (TCO_2, and TALK on the AR24 section and TCO_2, TALK, and pCO_2 on A24, A20, and A22 sections), will be plotted using the data from these sections. Knowledge of these parameters and their initial conditions will enable researchers to determine heat and water transport, as well as carbon transport, which will contribute to the understanding of processes affecting climate change. The sections described in this report include WOCE Section A22, the only Caribbean transect of the WOCE program. In addition, the stations occupied on these cruises repeat some sections sampled during the International Geophysical Year during the 1950s. They also include measurements from the eastern subpolar gyre of source and overflow waters from the Labrador, Norwegian, Greenland, and Iceland Seas. They give good coverage of boundary currents, particularly the Deep Western Boundary Current; and repeating AR24 and A24 provides some insight into seasonal variation in the North Atlantic.

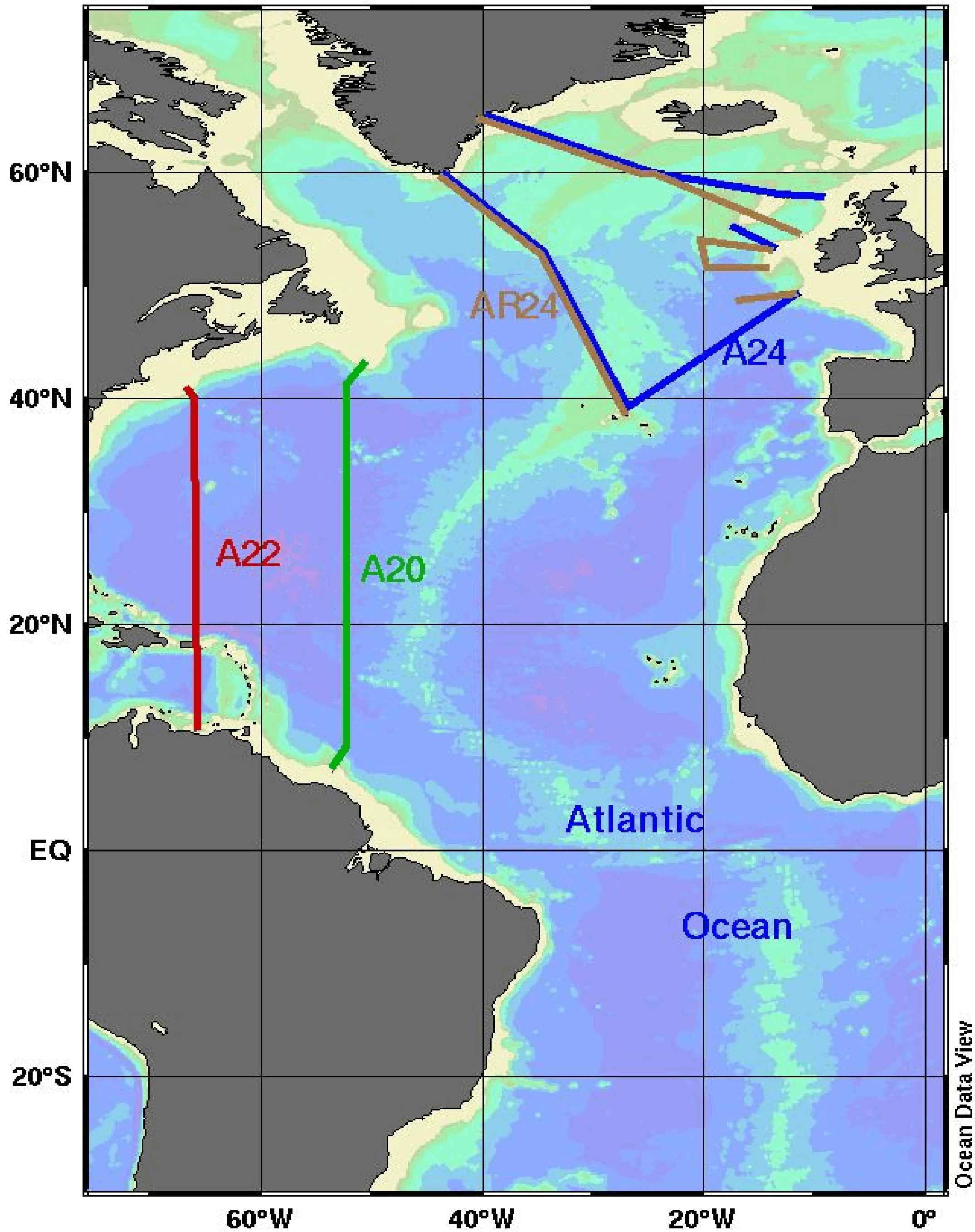

Fig. 1. **The cruise tracks during the North Atlantic survey expeditions along WOCE Sections AR24, A24, A20, and A22.**

This data documentation is the result of the cooperative efforts of chemical oceanographers from Brookhaven National Laboratory (BNL), the University of Hawaii (UH), Lamont-Doherty Earth Observatory (LDEO), and the University of Miami's Rosenstiel School of Atmospheric and Marine Science (RSMAS), U.S.A. The work aboard the R/V *Knorr* was supported by DOE under contract DE-ACO2-76CH00016 and DE-FG02-93ER61540. The authors are also especially grateful to the Sonderforschungsbereich 460 at the University of Kiel (Dr. F. Schott, Leader), funded by the Deutsche Forschungsgemeinschaft, for their support and assistance in completing the written documentation.

3.2 Total CO_2 Measurements

As on previous cruises, TCO_2 was determined using automated dynamic headspace sample processors (SOMMA) with coulometric detection of the CO_2 extracted from acidified samples. A description of the SOMMA-Coulometry System and its calibration can be found in Johnson et al. (1987), Johnson and Wallace (1992), and Johnson et al. (1993). A schematic diagram of the SOMMA analytical sequence may be found in earlier cruise reports (see Johnson et al. 1995,1996), and further details concerning the coulometric titration can be found in Huffman (1977) and Johnson, King, and Sieburth (1985). The methods used for discrete TCO_2 on WOCE sections have been extensively dealt with in previous reports (Johnson et al. 1998a) and need only be briefly summarized.

The AR24 section required modification of the usual sampling procedures. As noted in Section 3.1.2, 4-L sampling bottles were employed on the rosette, limiting the amount of sample available for the carbonate system analysts to one 500-mL bottle. Hence, the TCO_2 coulometric titration analysis had to be completed before the partially empty 500-mL bottle was passed to the TALK group for the potentiometric alkalinity titration. There was enough sample to complete both measurements, but not enough time or sample for TCO_2 replicate analyses from the same 500-mL sample bottle. The 4-L sampling bottles also made it impossible to draw duplicate samples from the same sampling bottle. Without duplicate samples from the hydrographic stations, standard measures of sample precision (DOE 1994; Johnson et al. 1998b) could not be completed on the AR24 section. Samples were poisoned with 100 µL of a 50% solution of $HgCl_2$ and analyzed for TCO_2 within 24 hours of collection (DOE 1994).

For sections A24, A20, A22, single or duplicate samples were collected in 300-mL biological oxygen demand (BOD) bottles, poisoned with 100 µL of a 50% solution of $HgCl_2$, and analyzed for TCO_2 within 24 hours of collection, according to standard operating procedures (DOE 1994). The samples were stored in a dark refrigerator at 4–6°C until approximately 1–2 hours before analysis, when they were removed and placed in a temperature bath at 18–20°C and thermally equilibrated. The SOMMA sample pipette and sample bath were also kept at approximately 20°C. Duplicate samples were usually collected on each cast at the surface and from the bottom waters. For some casts, three sets of duplicates were taken. The duplicates were analyzed within the run of cast samples from which they originated so that the time elapsed between duplicate analyses was 3–12 hours. As per standard operating procedure (DOE 1994), CRM was routinely analyzed according to DOE (1994) guidelines. The CRM was supplied by Dr. Andrew Dickson of the SIO, and for the North Atlantic cruises, batches 33, 36, and 37 were used. The certified values for these batches were TCO_2 = 2009.85 µmol/kg @ salinity = 33.781 for batch 33; TCO_2 = 2050.21 µmol/kg @ salinity = 35.368 for batch 36; and TCO_2 = 2044.15 µmol/kg @ salinity = 34.983 for batch 37. The CRM TCO_2 concentration was determined by vacuum-extraction/manometry in the laboratory of C. D. Keeling at SIO.

An accurately known volume of seawater was injected from an automated to-deliver (TD) pipette into a stripping chamber. Following acidification, the resultant CO_2 from continuous gas extraction was dried and coulometrically titrated on a model 5011 UIC coulometer with a maximum titration current of 50 mA in the counts mode (the number of pulses or counts generated by the coulometer's VFC during the titration was displayed). In the coulometer cell, the acid (hydroxyethylcarbamic acid) formed from the reaction of CO_2 and ethanolamine is titrated coulometrically (electrolytic generation of OH^-) with photometric endpoint detection. The product of the time and the current passed through the cell during the titration (charge in coulombs) is related by Faraday's constant to the number of moles of OH^- generated and thus to the moles of CO_2 that reacted with ethanolamine to form the acid. The age of each titration cell is logged from its birth (time that electrical current is applied to the cell) until its death (time when the current is turned off). The age is measured in minutes from birth (chronological age) and in mgC titrated since birth (carbon age).

Each system was controlled with an IBM-compatible PC equipped with two RS232 serial ports (coulometer and barometer), a 24-line digital input/output card (solid state relays and valves), and an analog-to-digital card (temperature, conductivity, and pressure sensors). Real Time Devices (located in State College, PA 16803) manufactured the cards. The SOMMA temperature sensors (model LM34CH, National Semiconductor, Santa Clara, CA) with a voltage output of 10 mV/°F were calibrated against thermistors certified to 0.02ºF prior to the cruise using a certified mercury thermometer. These sensors monitored the temperature of SOMMA components, including the pipette, gas sample loops, and coulometer cell. The SOMMA software was written in GWBASIC Version 3.20 (Microsoft Corp., Redmond, WA), and the instruments were driven from an options menu appearing on the PC monitor. With the coulometers operated in the counts mode, conversions and calculations were made using the SOMMA software rather than the programs and the constants hardwired into the coulometer circuitry.

The SOMMA-coulometry systems were calibrated with pure CO_2 (calibration gas) using hardware consisting of an 8-port gas sampling valve (GSV) with two sample loops of known volume [determined gravimetrically by the method of Wilke, Wallace, and Johnson (1993)] connected to the calibration gas through an isolation valve; the vent side of the GSV was plumbed to a barometer. When a gas loop was filled with CO_2 at known temperature and pressure, the mass (moles) of CO_2 contained therein was calculated, and the ratio of the calculated mass to that determined coulometrically was the calibration factor (CALFAC); the CALFAC was used to correct the subsequent sample titrations for small departures from 100% recoveries (DOE 1994). The standard operating procedure was to make gas calibrations daily for each newly prepared titration cell [normally, one cell per day and three sequential calibrations per cell at a carbon age of 3–9 mgC (mean age @ 6 mgC), with the result of the third calibration taken as the CALFAC if it was consistent with the second (i.e., agreement to ± 0.1% or better)]. Daily gas calibrations were made on both systems throughout the cruises.

The "to-deliver" volume (V_{cal}) of the sample pipettes was determined (calibrated) gravimetrically prior to the cruise to ± 0.02% or better in October of 1996. The calibration was checked periodically during all cruises by collecting aliquots of deionized water dispensed from the pipette into pre-weighed serum bottles. The serum bottles were crimp-sealed and weighed immediately during the on-shore laboratory calibrations, or returned to shore where they were reweighed on a model R300S balance (Sartorius, Göttingen, Germany) as soon as possible. The apparent weight (g) of water collected (W_{air}) was corrected to the mass in vacuum (M_{vac}) with the "to-deliver" volume being M_{vac} divided by the density of the calibration fluid at the calibration temperature. After the AR24 section in 1996, the system pipettes were dismounted and replaced with chemically cleaned pipettes in March, 1997. For the 1997 sections, the calibration volumes (V_{cal}) at the calibration temperature (t_{cal}) of the sample pipettes were redetermined to ± 0.01% from a set of calibration samples taken on July 3, 1997, on board the *Knorr* at the completion of section A24 and were weighed on September 17. The TCO_2 pipette volumes for the four North Atlantic sections are summarized in Table 2.

Table 2. The "to-deliver" pipette volume (V_{cal}) and calibration temperature (t_{cal}) for the discrete SOMMA-Coulometer Systems (S/N 004 and 030) used on WOCE Section AR24 (1996) and Sections A24, A20, and A22 (1997)

Section	System S/N	V_{cal} (mL)	t_{cal} (°C)
AR24 (1996)	004	21.8927	19.91
A24/A20/A22 (1997)	004	21.2630	19.19
AR24 (1996)	030	21.3733	20.91
A24/A20/A22 (1997)	030	25.8544	19.52

The sample volume (V_t) at the pipette temperature was calculated from the expression:

$$V_t = V_{cal}\,[1 + a_v\,(t - t_{cal})]$$

where a_v is the coefficient of volumetric expansion for pyrex-type glass (1×10^{-5}/°C), and t is the temperature of the pipette at the time of a measurement. The mean pipette temperature on the AR24 section in 1996 was 20.32 ± 0.51°C (n = 948), and on the 1997 North Atlantic Sections it was 19.55 ± 0.52°C (n = 4666).

The factory-calibrated coulometers were electronically calibrated independently in the laboratory before the cruise as described in Johnson et al. (1993, 1996) and DOE (1994), and the terms INT_{ec} and $SLOPE_{ec}$ were obtained and entered into the software for each system. The micromoles of carbon titrated (M), whether extracted from water samples or the gas loops, was

$$M = [\text{Counts} / 4824.45 - (Blank \times T_t) - (INT_{ec} \times T_i)] / SLOPE_{ec}$$

where 4824.45 (counts/µmol) is a scaling factor obtained from the factory calibration; T_t is the length of the titration in minutes; *Blank* is the system blank in µmol/min; INT_{ec} is the intercept from electronic calibration in µmol/min; T_i is the time in minutes during the titration where current flow was continuous; and $SLOPE_{ec}$ is the slope from electronic calibration. Note that the slope obtained from the electronic calibration procedure applied for the entire length of the titration, but the intercept correction applied only for the period of continuous current flow (usually 3–4 min) because the intercept can be calculated only from calibrated levels of current flowing continuously.

Unfortunately, the coulometer system 030, which was electronically calibrated prior to the AR24 cruise and again in March 1997, had to be replaced at the start of section A24 in May 1997. However, the replacement coulometer (S/N CBE-9010-V) was calibrated at the factory on March 20, 1997. Hence we assumed that the replacement coulometer was properly calibrated, and we entered the default calibration coefficients into the software ($SLOPE_{ec}$ = 1.0 and INT_{ec} = 0.0). The system 004 was also recalibrated in March 1997 following the AR24 cruise with nearly identical results to those obtained in October 1996, and it was not recalibrated during the 1997 WOCE sections. The electronic calibration coefficients, along with the mean gas calibration factors determined for the North Atlantic section discrete TCO_2 coulometers, are given in Table 3.

Table 3 illustrates an advantage of the independent laboratory electronic calibration procedure. The mean CALFAC for systems 004 and 030 using the laboratory-determined electronic calibration coefficients was approximately 1.0036 (or 99.64% recovery of the theoretical mass of CO_2 calibration gas measured coulometrically) vs 1.0053 (99.47% recovery) for the factory-calibrated coulometer. Hence, a small percentage (0.17%) of the less than 100% recovery for known masses of CO_2 coulometrically

Table 3. The electronic calibration and the mean gas calibration coefficients for the discrete TCO_2 systems on WOCE Section AR24 (1996) and Sections A24, A20, and A22 (1997)

Section	System S/N	$SLOPE_{ec}$	INT_{ec} µmol/min	CALFAC(n)	St. dev.	Rel. st. dev. (%)
AR24	004	0.999372	0.002528	1.003892(9)	0.000650	0.06
A20/A22/A24	004	0.998905	0.001466	1.003361(63)	0.000740	0.07
AR24	030	0.999306	0.003550	1.003780(26)	0.000497	0.05
A20/A22/A24	030[a]	1.000000	0.000000	1.005344(59)	0.001369	0.13

[a]Factory-calibrated coulometer installed at the beginning of the A24 section in May 1997.

titrated can be explained by a factory-calibration procedure that is apparently slightly less accurate than the laboratory calibration. This difference has been consistent throughout the CO_2 survey.

For water samples, the discrete TCO_2 concentration in µmol/kg was calculated from

$$TCO_2 = M \times CALFAC \times [1 / (V_t \times \rho)] \times d_{Hg}$$

where ρ is the density of sea water in g/mL at the measurement temperature and sample salinity calculated from the equation of state given by Millero and Poisson (1981), and d_{Hg} is the correction for sample dilution with bichloride solution (for the AR24 section in 1996 dHg = 1.0002 and for the 1997 sections d_{Hg} = 1.000333).

One of the SOMMA-Coulometry Systems (S/N 004) was equipped with a conductance cell (Model SBE-4, Sea-Bird Electronics, Inc., Bellevue, WA) for the determination of salinity measurement as described by Johnson et al. (1993). Whenever possible SOMMA and CTD salinity were compared to identify mistrips or other anomalies, but the bottle salinity (furnished by the chief scientist) was used to calculate TCO_2.

Quality control-quality assurance (QC-QA) was assessed from the results of the 275 CRM analyses made using systems 004 and 030 during the four North Atlantic sections. These data are summarized in Table 4, and the temporal distribution of the differences is plotted in Fig. 2 for section AR24 (1996) and in Fig. 3 for sections A24, A20, and A24 (1997).

Table 4. The mean analytical difference (ΔTCO_2 = measured−certified) and the standard deviation of the differences between measured and certified TCO_2 on WOCE Sections AR24, A24, A20, and A22

Section	System S/N	Δ TCO_2 (µmol/kg)	St. dev. (µmol/kg)	n
AR24	004	1.42	2.10	16
AR24	030	1.54	1.88	49
Mean/total		**1.51**	**1.92**	**65**
A24	004	0.04	1.10	49
A20	004	0.23	1.20	42
A22	004	0.06	0.69	17
Mean/total		**0.10**	**1.08**	**108**
A24	030	0.79	1.00	48
A20	030	0.44	1.43	35
A22	030	0.26	1.22	19
Mean/total		**0.57**	**1.21**	**102**
Overall mean/total		**0.61**	**1.47**	**275**

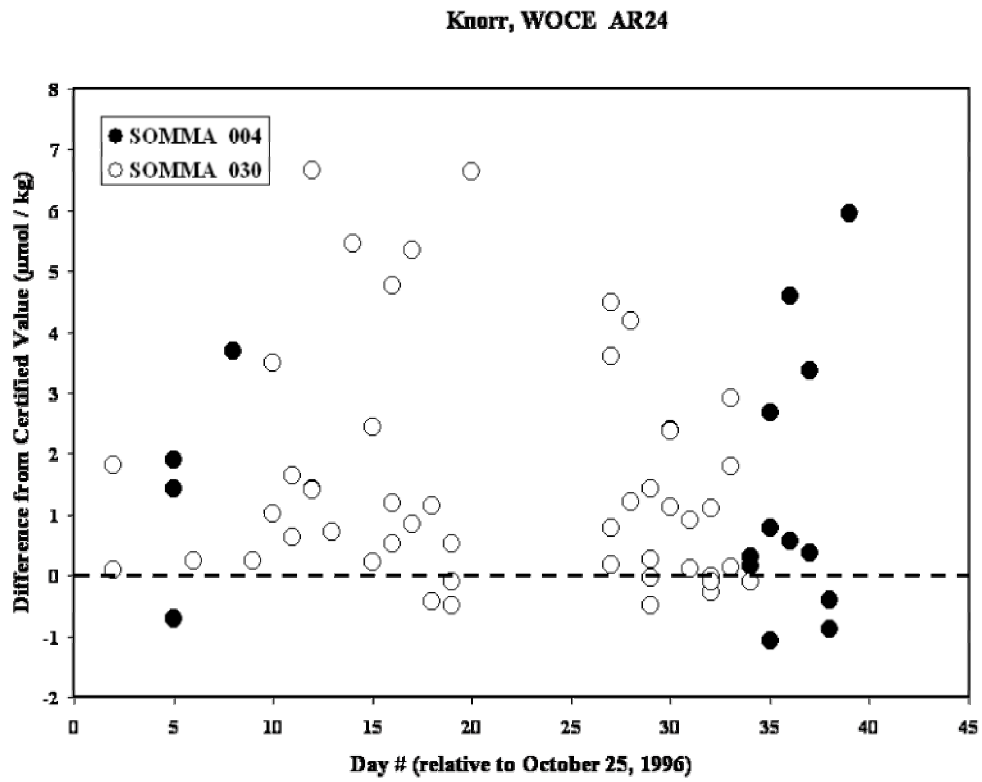

Fig. 2. The temporal distribution of differences between the measured and certified TCO_2 for CRM analyzed on SOMMA-coulometry systems 004 (closed circles) and 030 (open circles) during the WOCE North Atlantic Section AR24 in 1996. The differences were calculated by subtracting the certified TCO_2 from the measured TCO_2.

The overall accuracy of the CRM analyses was better than 1 µmol/kg on both systems for the four North Atlantic sections, with a combined overall mean difference of + 0.61 µmol/kg (n = 275). However, Table 4 shows that on the AR24 section (1996), the mean difference and the standard deviation of the differences were noticeably larger for both systems compared with the 1997 sections (A24/A20/A22). This may be due in part to mechanical problems experienced by the AR24 measurement group, operator procedures, and possibly the relatively short time available to service and re-calibrate the systems prior to the AR24 section. The latter was brought about by the fact that system 004 had been used in the Indian Ocean from 1994–1996 and was only returned to BNL for service, repair, and re-calibration in the fall of 1996. System 030, which was a newly built system returned to the laboratory after a test cruise in the North Atlantic, also was not returned until the summer of 1996. For the 1997 sections, both systems were available in the laboratory for servicing from January through May of 1997. Indeed, the 1997 WOCE sections represented the only opportunity during the CO_2 survey for the BNL measurement group to thoroughly service and test the systems, reagents, and analytical gases in the laboratory with real samples and CRM prior to shipment. As a result, the accuracy and precision of the CRM analyses made in 1997 (see Table 4) probably represent the highest quality possible for these systems under field conditions.

All CRM analyses made on the discrete systems (004 and 030) during the 1997 sections are reported in Table 4. However, for section AR24, two CRM analyses were classified as outliers and dropped from the data set. These were CRM No. 206 run on system 030 on November 23 (difference = +10.17 µmol/kg) at a cell carbon age of 39.5 mgC, and CRM No. 600 on system 030 on November

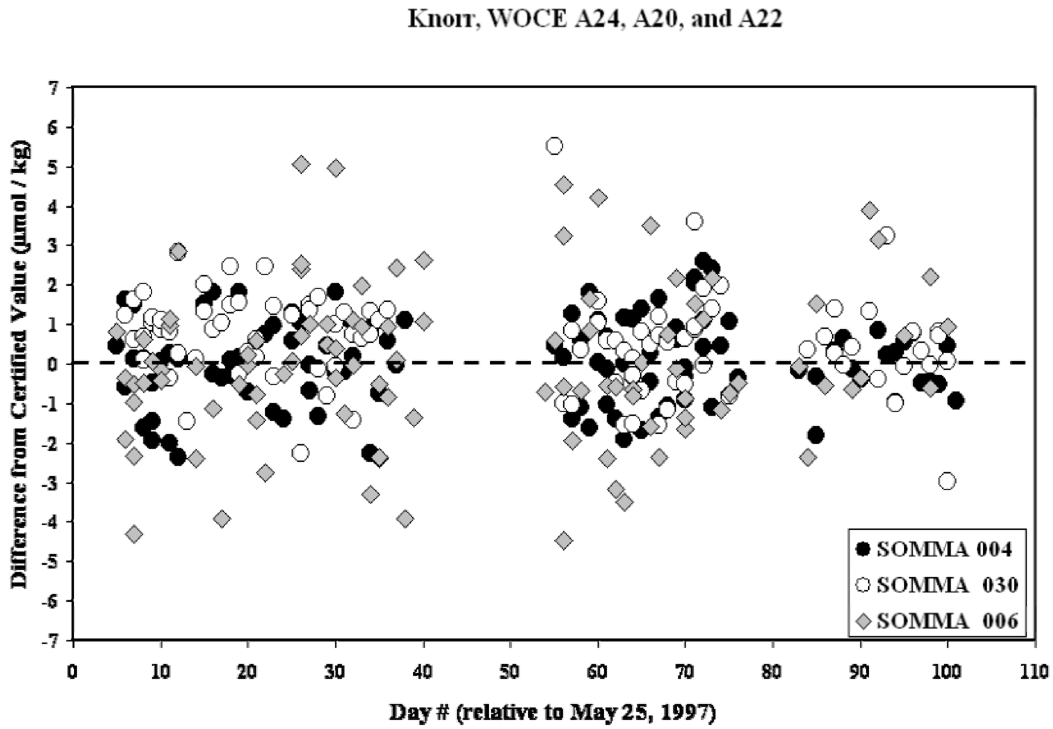

Fig. 3. The temporal distribution of differences among the measured and certified TCO_2 for CRM analyzed on SOMMA-coulometry systems 004 (closed circles) and 030 (open circles) and 006 (shaded diamonds) during the WOCE North Atlantic Sections A24, A20, and A22 in 1997. The differences were calculated by subtracting the certified TCO_2 from the measured TCO_2.

28 (difference = +7.99 µmol/kg) at a carbon age of 35.7 mgC. One CRM analysis (CRM No. 352) run on system 004 on December 1 is not included in the data set because the titration did not attain an endpoint.

The second phase of the QC-QA procedure was an assessment of precision. As described in the text, duplicate samples could not be taken during the AR24 section in 1996. Hence the only estimate of AR24 sample precision was the standard deviation of the differences between the measured and certified TCO_2 on both systems (see Table 4). Because differences from both systems have been combined, the CRM measurements are analogous to the sample duplicates analyzed on each system and should reflect both random and systemic error (bias). The decrease in precision for the CRM analyzed on the AR24 section in 1996 (±1.92 µmol/kg) compared with the CRM analyzed in 1997 (±1.20 µmol/kg) was consistent with the problems described for the 1996 leg. The good agreement in TCO_2 between systems in 1996 (see Table 4) suggests that analyzing duplicate seawater samples on each system, as was done in 1997, might have yielded a higher precision than the precision of the CRM differences. Nevertheless, without sample duplicates, the AR24 sample precision must be based on the CRM analyses. Hence the precision of the TCO_2 determination for the AR24 section in 1996 was ±1.92 µmol/kg (n = 65). Because procedures and performance varied from 1996 to 1997, separate estimates of sample precision were required for each year; the data for 1997 are given in Table 5.

By 1997 the deployment of two independent SOMMA systems side-by-side was routine, and the conventions employed for the estimation of precision in the earlier WOCE data reports are retained in Table 5. For sections A24, A20, and A22 in 1997, the single-system precision was determined from samples with duplicates analyzed on the same system (either 004 or 030). The sample precision was calculated using duplicates that were analyzed on both systems (004 and 030).

Table 5. Precision of the discrete TCO_2 analyses on WOCE Sections A24, A20, and A22

Section	Mean absolute difference			Pooled standard deviation			
	σ_{bs} (µmol/kg)	± St. dev.	K	S_p^2 (µmol/kg)	K	n	d.f.
Single-system precision							
A24	1.08	1.01	175	1.04	175	350	175
A20	0.95	1.14	84	1.04	84	168	84
A22	0.99	0.93	71	0.96	71	142	71
Sample precision							
All	1.76	1.41	56	1.59	61	122	61

Single-system and sample precision have been separately assessed in Table 5 as

- "between-sample" precision (σ_{bs}), which is the mean absolute difference between duplicates (n = 2) drawn from the same Niskin bottle; and
- the pooled standard deviation (S_p^2) calculated according to Youden (1951), where *K* was the number of samples with duplicates analyzed, *n* was the total number of replicates analyzed from *K* samples, and $n - K$ was the degrees of freedom (d.f.).

Single-system precision provided a measure of drift in system response during a sequence of sample analyses. This is because the time lapse between duplicate analyses on the same system using the same coulometer cell was deliberately kept at 3–12 hours, on the assumption that drift or change in response would be reflected in the single-system precision by an increase in the imprecision of the duplicate analyses. Sample precision, on the other hand, was measured because TCO_2 measurements were made on two separate systems, and an estimate of overall sample precision for the section (s), independent of which analytical system was used, was required. Sample precision is the most conservative estimate of precision, incorporating several sources of random or systematic (bias) error.

As on other sections in the Atlantic Ocean (e.g., A8 and A10) where SOMMA-coulometer systems have been run in parallel, the sample precision was slightly less than the single-system precision. This indicated that changes in system response during the coulometer cell lifetime in 1997 were clearly within the precision of the method (±1.59 µmol/kg), while the slight but consistent decrease in sample precision compared with single-system precision was probably due at least in part to a small bias between the 004 and 030 systems. Although the precision was equivalent for both systems, system 030 gave on average slightly higher results than system 004. For example, the mean ΔTCO_2 for system 004 CRM was +0.10 µmol/kg, but it was +0.57 µmol/kg for system 030 CRM (see Table 4); while the mean of the seawater samples (n = 56, Table 5) analyzed on 030 was +1.17 µmol/kg higher than the mean for the same samples analyzed on system 004. Hence the uniformly excellent single-system precision for 1997 cannot be used for sample precision, and analyzing duplicate replicates on each system remains the definitive measure of the overall precision of the 1997 data set and the TCO_2 calibration procedures. The two discrete systems should give the same result for the same sample, and the extent to which they differ is a measure of the overall precision of the data set obtained with two independent systems. For TCO_2 on the 1997 North Atlantic WOCE sections, the precision of the TCO_2 determination was ± 1.59 µmol/kg (K = 56).

The North Atlantic sample precision for all four sections in 1996 and 1997 (±1.92 and ±1.59 µmol/kg, respectively) is in good agreement with the published and unpublished sample precision for other WOCE sections where systems were run in parallel: AE1, 1991 (±1.65 µmol/kg); P6, 1992 (±1.65 µmol/kg); A10, 1993 (±1.92 µmol/kg); A8, 1994 (±1.17 µmol/kg); Indian Ocean, 1995 (±1.20 µmol/kg). During the 1997 North Atlantic sections, a limited number of duplicate samples (K = 6) were analyzed from two different Niskin bottles closed at the same depth, and the mean absolute difference and standard deviation was 0.77 ± 0.50 µmol/kg, which was consistent with earlier findings (e.g., Johnson et al. 1998a; Johnson et al. 2001) that there were likely no significant analytical effects due to gas exchange with the overlying headspace of the Niskin bottles during sampling.

Tables 4 and 5 show an internally consistent data set of high quality with excellent accuracy (≤ 2.0 µmol/kg), high single-system precision (≤ ±1.0 µmol/kg), and a slightly higher imprecision for the sample precisions (±1.59–1.92 µmol/kg). Based on these data, the TCO_2 data clearly meet survey criteria for accuracy (≤ 4.0 µmol/kg) and precision, and as with previous data submissions, no correction for instrumental bias or CRM analytical differences has been applied to the TCO_2 data.

3.3 Total Alkalinity Measurements

TALK and pH were measured using an automated potentiometric titration system developed at the University of Miami (hereafter designated as MATS). MATS is described by Millero et al. (1993a). It consisted of two parts: a Metrohm model 665 Dosimat titrator and a pH meter (Orion, Model 720A) which are interfaced with a PC. A water-jacketed, fixed-volume (~200 mL), closed Plexiglass sample cell, of greater volume than but otherwise similar to those used by Bradshaw and Brewer (1988), was used to increase the precision of the measurements. The cell, titrant burette, and sample cell were theromstatted at 25 ±0.05°C using a constant temperature bath (Neslab, Model RTE 221). A Lab Windows/CVI program was used to run the titrators, record the volume of titrant added, and record the measured electromagnetic frequency (emf) of the electrodes through RS232 serial interfaces. The electrodes for measuring the emf during the titration consisted of a ROSS glass pH electrode (Orion, Model 810100) and a double-junction Ag/AgCl reference electrode (Orion, Model 900200).

Seawater samples were titrated by adding enough HCl to exceed the carbonic acid endpoint of the titration. During a typical titration, the emf readings were recorded until stable (±0.05 mV). Normally, at this point, a fixed volume of acid would be added; however, the MATS were designed to add enough acid to increase the voltage by a pre-assigned increment (13 mV). This was done to give an even distribution of data points over the course of a full titration, which consists of 25 data points and takes about 20 minutes. With two systems, approximately 7 hours was required to run a 31-bottle station cast. As noted in Sections 3.1 and 3.2, 4-L Niskin sampling bottles were employed on the rosette, which limited the amount of sample available for the carbonate system analysts to one 500-mL bottle. Hence there was not enough sample water to complete duplicate alkalinity analyses from the same bottle or to draw duplicate samples from the same sampling bottle.

The titrant (acid) used throughout the cruises was prepared, standardized, and stored in 500-mL borosilicate glass bottles for use in the field. A single 55-gal batch of 0.25-m HCl acid was prepared by dilution of concentrated HCl (AR Select Mallinckrodt). The acid was prepared in 0.45–m NaCl to yield a total ionic strength similar to that of seawater salinity 35.0 (I = ~0.7 M). The acid was standardized by coulometry (Taylor and Smith 1959; Marinenko and Taylor 1968). The acid molality was also checked by titration on seawaters with known alkalinities, and subsamples were sent to the laboratory of A. Dickson at SIO for an independent laboratory determination of the molality. The calibrated molality of the acid used for the North Atlantic WOCE Sections was 0.24892 ±0.00003 m HCl.

The consistency of the method was checked for each cast using low-nutrient surface seawater, and the accuracy of the method was checked by analyzing CRM Batches 33 (1996), 36, and 37 (1997) and comparing the analyzed values with the certified TALK in the same manner as for TCO_2 (see also Section 3.2 for batch data). The mean differences between at-sea measurements and the certified TALK values are given in Table 6. The TALK of each batch was also determined in the laboratory by weight titrations, which were found to agree with the certified values to ±2 µmol/kg. In addition, the pH of the CRM batches was determined in the laboratory spectrophotometrically according to the methods of Clayton and Byrne (1993) prior to the cruise. The at-sea titration pH measurements were also compared with the pre-cruise spectrophotometric values, and the reader is referred to Millero et al. (1999) for further details.

Table 6. The mean analytical difference between analyzed and certified TALK for the MATS on WOCE Section AR24 (1996), and Sections A24, A20, and A22 (1997)

Section	Cells	n	CRM TALK µmol/kg	Measured TALK µmol/kg	ΔTALK µmol/kg
AR24	2, 19, 17	59	2234.9	2233.3	−1.6
A24	2, 18, 12	148	2283.9	2283.3	−0.6
A20	2, 18, 12	96	2314.1	2217.1	3.0
A22	2, 12	65	2314.1	2215.4	1.3

The mean differences between the at-sea measurements and the certified TALK were within 3.0 µmol/kg (Table 6). Hence the measured and certified TALK were in good agreement. For pH and TCO_2, the corresponding results were 0.021 and 9 µmol/kg, respectively, with the larger deviation in pH attributable to the non-Nernstian behavior of the electrodes near a pH of 8 (Millero et al. 1993b).

The at-sea sample alkalinity titrations were corrected using the results for the CRM. For TALK, the CALFAC used to correct the at sea measurements was

$$CALFAC = CRM\ \text{(certified value)/(at-sea value)}\ ,$$

and for pH the CALFAC was

$$pH = pH\ \text{(CRM) / pH (at-sea)}\ .$$

Duplicate samples were usually taken for each station in the same manner as for TCO_2 (surface and deep) and analyzed to determine and monitor the precision of the MATS. The average difference between replicates was ±1.0, ±1.1, and ±1.1 µmol/kg for sections A24, A20, and A22, respectively, which demonstrated the high precision of the MATS throughout the study. A preliminary description of the major trends in the data and the behavior of alkalinity over time in the North Atlantic is given by Millero et al. (1999).

3.4 Discrete pCO_2 Measurements

The discrete measurements of pCO_2 were performed by the LDEO group on three of four sections of the North Atlantic survey. During the WOCE sections A24, A20, and A22, a total of 2,465 samples were analyzed onboard the R/V *Knorr* (1,103, 595, and 767 samples respectively). On the earlier WOCE section AR24, discrete pCO_2 was not measured.

An automated equilibrator-IR gas analyzer system was used during the expedition for the determination of partial pressure of CO_2 in the seawater samples. Its design is similar to that described by Chipman, Marra, and Takahashi (1993) with the exception that the gas chromatograph was replaced with an IR gas analyzer. The equilibrator-IR system is shown schematically in Fig. 4.

The system consists of a circulation pump plumbed to recirculate air in a closed system through porous plastic gas dispersers immersed in a 250-mL seawater sample. The seawater sample is contained in a 250-mL Pyrex reagent bottle with a standard taper-ground glass stopper that serves as an equilibration vessel. A Pyrex extension tube (~20 mL), which has a standard taper-ground glass male-joint to form an airtight seal with the reagent bottle, is connected to the mouth of the reagent bottle to provide an extra headspace to prevent seawater from entering the gas circulation line. Four sets of flasks and circulation pumps are used so that four water samples can be processed concurrently. Because the partial pressure of CO_2 is sensitive to temperature, the equilibration flasks are kept immersed in a water bath maintained at 20°C. The temperature at which the water sample is equilibrated with circulating gas is measured with a precision of ±0.01°C and is recorded.

An electrically driven Valco 10-port valve (the equilibrator selection valve in Fig. 4) is used to isolate each of the equilibrators during the initial equilibration. Manually operated 2-way and 3-way Whitey valves allow the headspace in each equilibrator to be filled with a calibration gas of known CO_2 concentration, creating a known initial condition for the headspace (about 40 mL) before equilibration. The equilibrator is open to the laboratory air through isolation coils attached to the low-pressure side of the equilibrator, keeping the total pressure of equilibration the same as the ambient atmospheric pressure. The atmospheric pressure is measured with a high-precision electronic barometer with an accuracy of better than 0.05% and is recorded. It takes about 20 minutes for each water sample to be thermally equilibrated with the constant-temperature water bath, and the headspace gas is recirculated through the water sample throughout the period to ensure CO_2 equilibration.

An electrically driven Valco 6-port valve (the sample selection valve in Fig. 4) is connected to the equilibrator selection valve and to the calibration gas selection valve. This allows selection of the gas sample to be analyzed for CO_2: the equilibrated sample gas or one of the four calibration gases. A 2-way normally-closed Skinner solenoid valve on the output of the calibration gas selection valve controls the flow of the calibration gases to the sample selection valve. It also provides a necessary second means of stopping the flow of the calibration gases to prevent their accidental loss in case of a control malfunction. The concentration of CO_2 in the gas equilibrated with the seawater sample is determined using an IR gas analyzer (LICOR Model 6125) in a flow-through mode. A 0.5-mL aliquot of equilibrated headspace gas, representing less than 1% of the circulating gas, is isolated using a gas pipette (attached to the sampling valve in Fig. 4) and swept with CO_2-free air (or pure nitrogen gas) flowing at a constant rate of about 50 mL/min. For low-pCO_2 samples, a 1-mL gas pipette (attached to the sampling valve) is used. The sample gas is passed through a permeation drying tube for the removal of water vapor and injected into the IR gas analyzer cell (about 7 mL in volume) filled previously with CO_2-free air. The displaced CO_2-free air is discharged out of the cell into the laboratory. The small volume of the gas sample ensures that all of the CO_2 from the gas pipette is found in the analyzer cell at the same time, so that the peak height is proportional to the amount of CO_2 present in the gas pipette. Drying of the sample gas avoids the effects of pressure-broadening of the CO_2 absorption spectra and of dilution caused by water vapor. The amount of CO_2 in the sampling pipette is a function of the loop volume, temperature, and pressure. The temperature is held constant and measured, and the pressure of the sample gas is same as the barometric pressure, which is measured with an accuracy of better than 0.05%. The peak height, which represents the number of moles of CO_2 in the sample gas, is calibrated every 1.5 hours using a quadratic equation fitted to three calibration gas mixtures (366.52, 788.8 and 1211.4 ppm mole fraction in dry air).

The analytical procedure begins with water samples being drawn from the 10-L Niskin bottles off a rosette directly into 250-mL Pyrex reagent bottles. These served as both sample containers and equilibration vessels. The samples were immediately inoculated with 100 µL of 50% saturated mercuric chloride solution, sealed airtight with ground glass stoppers to prevent biological modification of the pCO_2, and stored in the dark until analysis. Measurements were normally performed within 24 hours of sampling. A headspace of 3 to 5 mL was left above the water to allow for thermal expansion during storage. Prior to analysis, the sample flasks were brought to the water bath temperature of 20°C in the constant-temperature bath. The equilibrator headspace, including the extension tube and the gas circulation tubings, was filled with a calibration gas of known CO_2 concentration. The gas in the equilibrators, and in the tubing that connects them to the gas pipette loop, was recirculated continuously for about 20 minutes through a gas disperser immersed in the water. This provided a large surface area for gas exchange between the sample water and circulating gas, and equilibrium for CO_2 was attained in 15 min. The temperature of the bath water was assumed to be that of the sample water and was measured at the time of equilibration with a precision of ±0.01°C using a thermometer calibrated against a NIST-certified thermometer. This temperature is reported in the data tables as “TEMP_PCO2” and showed no variation at a limit of ±0.01ºC.

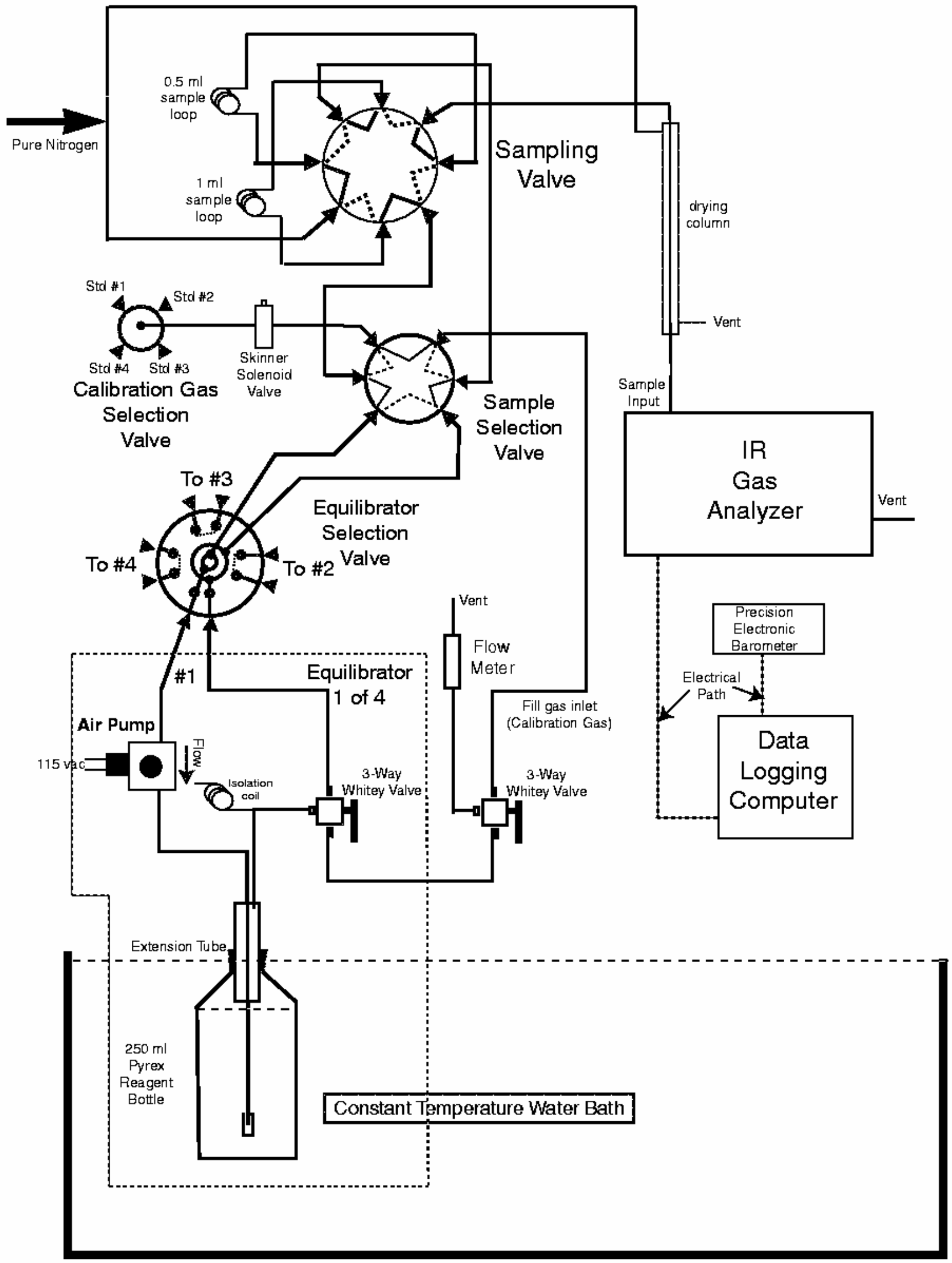

Fig. 4. Schematic diagram for one of the four equilibrator-IR systems used for the pCO2 determination in discrete seawater samples.

The equilibrated air samples were saturated with water vapor at the temperature of equilibration and had the same pCO_2 as the water. By injecting the air aliquot into the IR analyzer after the water vapor was removed, the concentration of CO_2 was measured. Therefore, the effect of water vapor must be taken into consideration for computing pCO_2 as follows:

$$pCO_2\ (\mu\text{atm}) = [C_{meas}\ (\text{ppm})] \times [\textit{total press. of equilibration}\ (\text{atm}) - \textit{water vapor press.}\ (\text{atm})]$$

where C_{meas} is the mole fraction concentration of CO_2 in dried equilibrated air. The total pressure of equilibrated air is measured by having the headspace in the equilibrator flask always at atmospheric pressure. The latter was measured with an electronic barometer at the time each equilibrated air sample was injected into the IR analyzer for CO_2 determination. The water vapor pressure was computed at the equilibration temperature, and salinity of the seawater. C_{meas} was determined by using a quadratic equation fit to three of the calibration gas mixtures.

The concentrations for standard gases used are traceable to the WMO reference scale through analysis in the laboratories of C. D. Keeling of SIO (La Jolla, California) and of Pieter P. Tans of NOAA/CMDL (Boulder, Colorado). The values of the standard gas mixtures used during this cruise were 366.52 ppm CO_2, 788.0 ppm CO_2, and 1211.4 ppm CO_2.

Corrections were made to account for the change in pCO_2 of the sample water due to the transfer of CO_2 between the water and circulating air during equilibration. We know the pCO_2 in equilibrated, perturbed water and the TCO_2 by coulometry before the equilibration. We can also calculate the change in TCO_2 in the water based on the change in pCO_2 between the post-equilibrium value and the known concentration in the pre-equilibrium condition. With the pre-equilibrium TCO_2 plus the perturbation in TCO_2 during equilibration, the post-equilibrium TCO_2 value was obtained. Using the post-equilibrium TCO_2 and measured pCO_2 values, TALK at the end of the equilibration was calculated, using the temperature, salinity, phosphate, and silicate data. Since the perturbation does NOT change the TALK, the pre-equilibrium pCO_2 from the pre-equilibrium TCO_2, the calculated TALK, and the temperature, salinity, etc., were calculated. This is the value that was reported as pCO_2, the pre-equilibrium calculated value. The magnitude of this correction is generally less than 2 µatm. Details of the computational scheme are presented in a DOE technical report by Takahashi, et al. (1998).

The pCO_2 values reported in this data set are expressed as micro-atmospheres at the temperature of equilibration. The precision of the pCO_2 measurement for a single hydrographic station was estimated to be about ±0.15% based on the reproducibility of replicate equilibrations. The station-to-station reproducibility was estimated to be about ±0.5%.

4. DATA CHECKS AND PROCESSING PERFORMED BY CDIAC

An important part of the numeric data packaging process at CDIAC involves the QA of data before distribution. Data received at CDIAC are rarely in a condition that would permit immediate distribution, regardless of the source. To guarantee data of the highest possible quality, CDIAC conducts extensive QA reviews that involve examining the data for completeness, reasonableness, and accuracy. The QA process is a critical component in the value-added concept of supplying accurate, usable data for researchers.

The following information summarizes the data processing and QA checks performed by CDIAC on the data obtained during the R/V *Knorr* cruise along WOCE Sections AR24, A24, A20, and A22 in the North Atlantic Ocean.

1. The final carbon-related data were provided to CDIAC by the ocean carbon measurement principal investigators listed in Section 2. The final hydrographic and chemical measurements and the station information files were provided by the WHPO after quality evaluation. A FORTRAN 90 retrieval code was written and used to merge and reformat all data files.

2. Every measured parameter for each station was plotted vs depth (pressure) to identify questionable data points using the Ocean Data View (ODV) software (Schlitzer 2001) Station Mode (Fig. 5).

3. Section plots for every parameter were generated using ODV's Section Mode in order to map a general distribution of each property along all North Atlantic Ocean sections (Fig. 6).

4. To identify "noisy" data and possible systematic, methodological errors, property-property plots were generated (Fig. 7) for all parameters, carefully examined, and compared with plots from previous expeditions in the North Atlantic.

5. All variables were checked for values exceeding physical limits, such as sampling depth values that are greater than the given bottom depths.

6. Dates, times, and coordinates were checked for bogus values (e.g., values of MONTH <1 or >12; DAY <1 or >31; YEAR <1996 or >1997; TIME <0000 or >2400; LATITUDE <7.000 or >67.000; LONGITUDE <-68.000 or >-8.000.

7. Station locations (latitudes and longitudes) and sampling times were examined for consistency with map and cruise information supplied by principal investigators.

8. The designation for missing values, given as −9.0 in the original files, was changed to −999.9 for consistency with other oceanographic data sets.

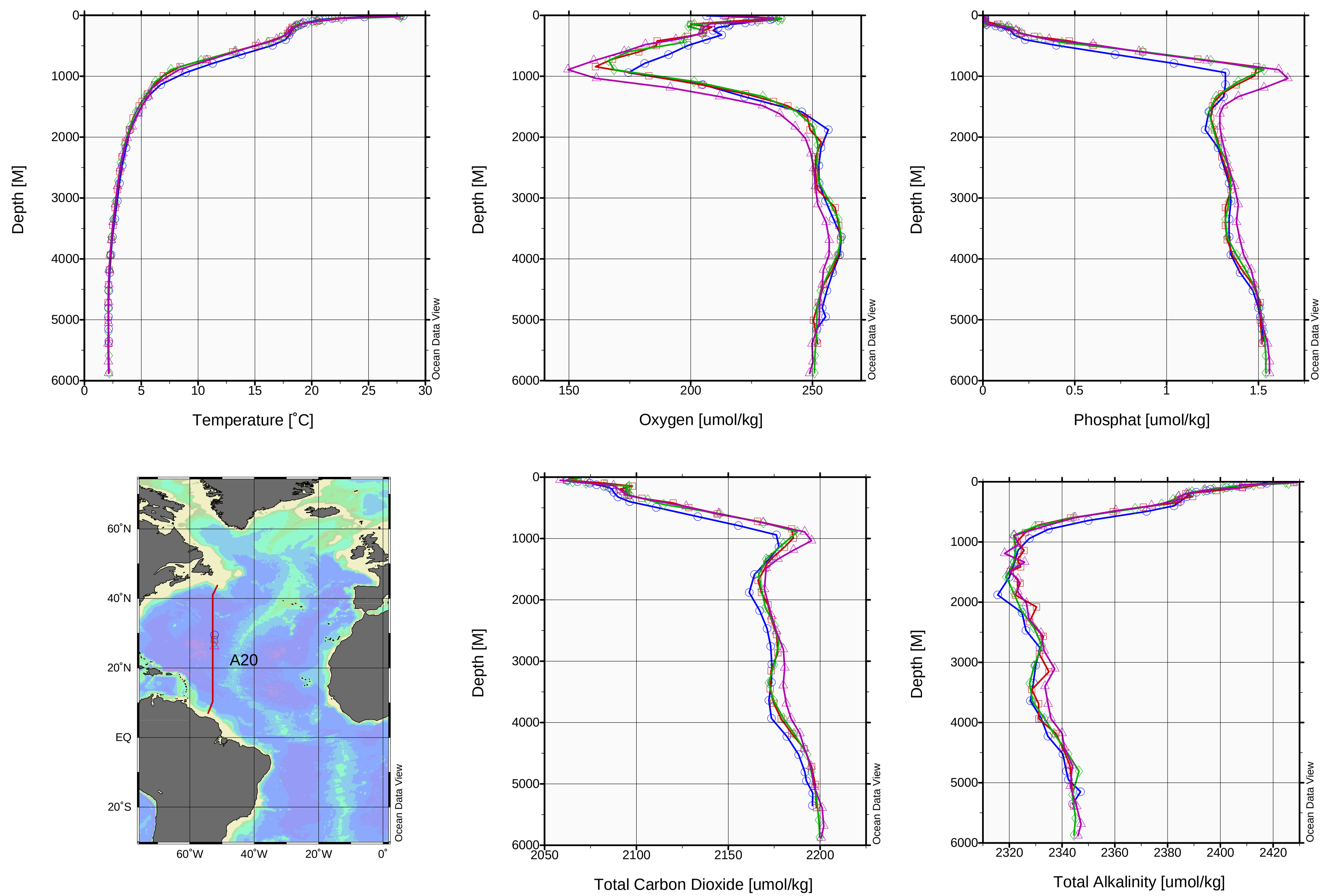

Fig. 5. Example of Ocean Data View station mode plot: Measurements vs depth for Stations 45–48 of Section A20.

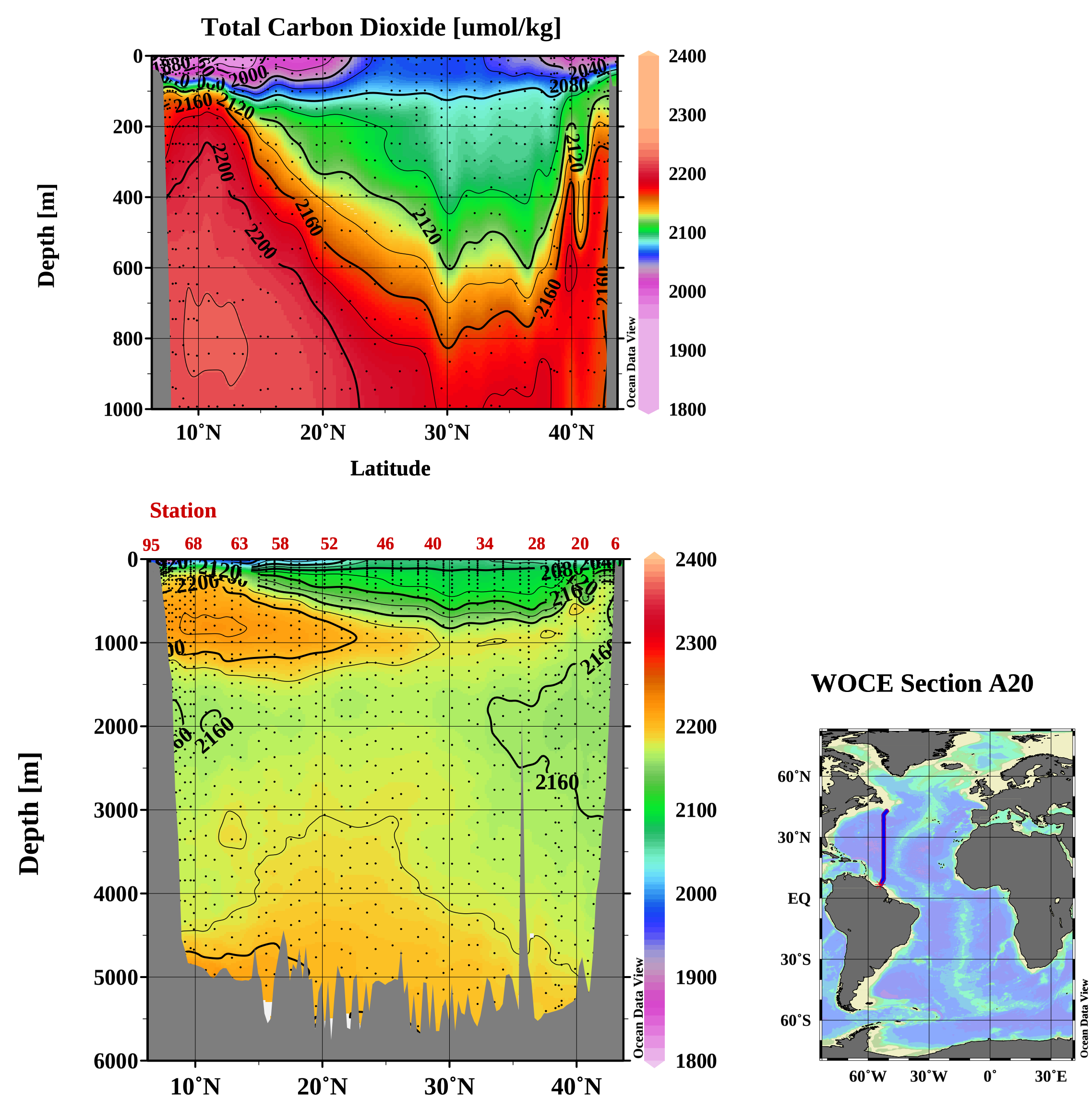

Fig. 6. Distribution of TCO_2 in seawater along WOCE Section A20.

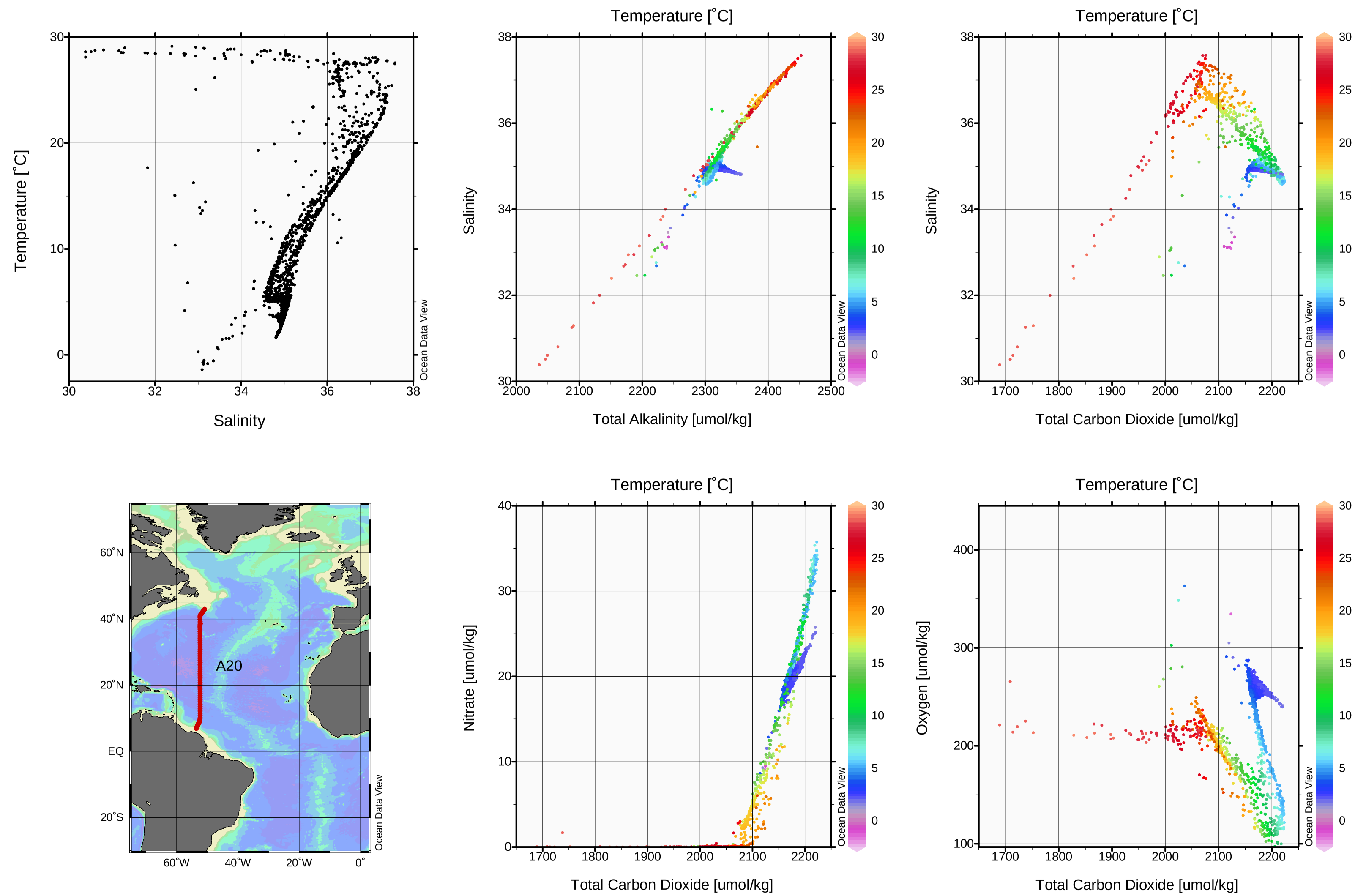

Fig. 7. Property-property plots for all stations occupied during the R/V *Knorr* cruise along WOCE Section A20.

5. HOW TO OBTAIN THE DATA AND DOCUMENTATION

This data base (NDP-082) is available free of charge from CDIAC. The complete documentation and data can be obtained from the CDIAC oceanographic Web site (http://cdiac.ornl.gov/oceans/doc.html), through CDIAC's online ordering system (http://cdiac.ornl.gov/pns/how_order.html), or by contacting CDIAC (see below).

The data are also available from CDIAC's anonymous file transfer protocol (FTP) area via the Internet. Please note that, to access these files, your computer must have FTP software loaded on it (this is built into most newer operating systems). Use the following commands to obtain the data base.

```
ftp cdiac.ornl.gov or >ftp 160.91.18.18
Login: "anonymous" or "ftp"
Password: your e-mail address
ftp> cd pub/ndp082/
ftp> dir
ftp> mget (files)
ftp> quit
```

Contact information:

Carbon Dioxide Information Analysis Center
Oak Ridge National Laboratory
P.O. Box 2008
Oak Ridge, Tennessee 37831-6335
U.S.A.

Telephone: (865) 574-3645

Telefax: (865) 574-2232

E-mail: cdiac@ornl.gov
Internet: http://cdiac.ornl.gov/

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Appendix A

WOCE97-A24: CTD Temperature and Conductivity Corrections Summary

PRT Response Time used for all casts: 0.34 secs

Sta/	ITS-90 Temperature Coefficients $corT = t2*T^2 + t1*T + t0$			Conductivity Coefficients $corC = cp2*corP^2 + cp1*corP + c2*C^2 + c1*C + c0$				
Cast	t2	t1	t0	cp2	cp1	c2	c1	c0
001/01	1.2241e-05	-7.5330e-04	-1.5033	0.00000e+00	0.00000e+00	0.00000e+00	-3.74944e-03	0.09374
002/01	1.6032e-05	-3.6366e-04	-1.4962	-9.13543e-11	1.80848e-07	1.47071e-05	-1.76569e-03	0.03246
003/01	1.6032e-05	-3.6366e-04	-1.4962	-9.13543e-11	1.80848e-07	1.47071e-05	-1.76569e-03	0.03350
004/01	1.6032e-05	-3.6366e-04	-1.4962	-9.13543e-11	1.80848e-07	1.47071e-05	-1.76569e-03	0.03398
005/01	1.6032e-05	-3.6366e-04	-1.4962	-9.13543e-11	1.80848e-07	1.47071e-05	-1.76569e-03	0.03393
006/01	1.6032e-05	-3.6366e-04	-1.4962	-9.13543e-11	1.80848e-07	1.47071e-05	-1.76569e-03	0.03495
007/01	1.6032e-05	-3.6366e-04	-1.4962	-9.13543e-11	1.80848e-07	1.47071e-05	-1.76569e-03	0.03454
008/01	1.6032e-05	-3.6366e-04	-1.4962	-9.13543e-11	1.80848e-07	1.47071e-05	-1.76569e-03	0.03381
009/01	1.6032e-05	-3.6366e-04	-1.4962	-9.13543e-11	1.80848e-07	1.47071e-05	-1.76569e-03	0.03426
010/01	1.6032e-05	-3.6366e-04	-1.4962	-9.13543e-11	1.80848e-07	1.47071e-05	-1.76569e-03	0.03409
011/01	1.6032e-05	-3.6366e-04	-1.4962	-9.13543e-11	1.80848e-07	1.47071e-05	-1.76569e-03	0.03534
012/01	1.6032e-05	-3.6366e-04	-1.4962	-9.13543e-11	1.80848e-07	1.47071e-05	-1.76569e-03	0.03542
013/01	1.6032e-05	-3.6366e-04	-1.4962	-9.13543e-11	1.80848e-07	1.47071e-05	-1.76569e-03	0.03552
014/01	1.6032e-05	-3.6366e-04	-1.4962	-9.13543e-11	1.80848e-07	1.47071e-05	-1.76569e-03	0.03613
015/01	1.6032e-05	-3.6366e-04	-1.4962	-9.13543e-11	1.80848e-07	1.47071e-05	-1.76569e-03	0.03570
016/01	1.6032e-05	-3.6366e-04	-1.4962	-9.13543e-11	1.80848e-07	1.47071e-05	-1.76569e-03	0.03531
017/01	1.6032e-05	-3.6366e-04	-1.4962	-9.13543e-11	1.80848e-07	1.47071e-05	-1.76569e-03	0.03564
018/01	1.6032e-05	-3.6366e-04	-1.4962	-9.13543e-11	1.80848e-07	1.47071e-05	-1.76569e-03	0.03558
019/01	1.6032e-05	-3.6366e-04	-1.4962	-9.13543e-11	1.80848e-07	1.47071e-05	-1.76569e-03	0.03547
020/01	1.6032e-05	-3.6366e-04	-1.4962	-9.13543e-11	1.80848e-07	1.47071e-05	-1.76569e-03	0.03619
021/01	1.6032e-05	-3.6366e-04	-1.4962	-9.13543e-11	1.80848e-07	1.47071e-05	-1.76569e-03	0.03677
022/01	1.6032e-05	-3.6366e-04	-1.4962	-9.13543e-11	1.80848e-07	1.47071e-05	-1.76569e-03	0.03638
023/01	1.6032e-05	-3.6366e-04	-1.4962	-9.13543e-11	1.80848e-07	1.47071e-05	-1.76569e-03	0.03634
024/01	1.6032e-05	-3.6366e-04	-1.4962	-9.13543e-11	1.80848e-07	1.47071e-05	-1.76569e-03	0.03698
025/01	1.6032e-05	-3.6366e-04	-1.4962	-9.13543e-11	1.80848e-07	1.47071e-05	-1.76569e-03	0.03716
026/01	1.6032e-05	-3.6366e-04	-1.4962	-9.13543e-11	1.80848e-07	1.47071e-05	-1.76569e-03	0.03785
027/01	1.6032e-05	-3.6366e-04	-1.4962	-9.13543e-11	1.80848e-07	1.47071e-05	-1.76569e-03	0.03693
028/01	1.6032e-05	-3.6366e-04	-1.4962	-9.13543e-11	1.80848e-07	1.47071e-05	-1.76569e-03	0.03707
029/01	1.6032e-05	-3.6366e-04	-1.4962	-9.13543e-11	1.80848e-07	1.47071e-05	-1.76569e-03	0.03691
030/01	1.6032e-05	-3.6366e-04	-1.4962	-9.13543e-11	1.80848e-07	1.47071e-05	-1.76569e-03	0.03714
031/01	1.6032e-05	-3.6366e-04	-1.4962	-9.13543e-11	1.80848e-07	1.47071e-05	-1.76569e-03	0.03736
032/01	1.6032e-05	-3.6366e-04	-1.4962	-9.13543e-11	1.80848e-07	1.47071e-05	-1.76569e-03	0.03726
033/01	1.6032e-05	-3.6366e-04	-1.4962	-9.13543e-11	1.80848e-07	1.47071e-05	-1.76569e-03	0.03785
034/01	1.6032e-05	-3.6366e-04	-1.4962	-9.13543e-11	1.80848e-07	1.47071e-05	-1.76569e-03	0.03829
035/01	1.6032e-05	-3.6366e-04	-1.4962	-9.13543e-11	1.80848e-07	1.47071e-05	-1.76569e-03	0.03694
036/01	1.6032e-05	-3.6366e-04	-1.4962	-9.13543e-11	1.80848e-07	1.47071e-05	-1.76569e-03	0.03794
037/01	1.6032e-05	-3.6366e-04	-1.4962	-9.13543e-11	1.80848e-07	1.47071e-05	-1.76569e-03	0.03734
038/01	1.6032e-05	-3.6366e-04	-1.4962	-9.13543e-11	1.80848e-07	1.47071e-05	-1.76569e-03	0.03805
039/01	1.6032e-05	-3.6366e-04	-1.4962	-9.13543e-11	1.80848e-07	1.47071e-05	-1.76569e-03	0.03811
040/01	1.6032e-05	-3.6366e-04	-1.4962	-9.13543e-11	1.80848e-07	1.47071e-05	-1.76569e-03	0.03819

Sta/ Cast	ITS-90 Temperature Coefficients corT = t2∗T^2 + t1∗T + t0			Conductivity Coefficients corC = cp2∗corP^2 + cp1∗corP + c2∗C^2 + c1∗C + c0				
	t2	t1	t0	cp2	cp1	c2	c1	c0
041/01	1.6032e-05	-3.6366e-04	-1.4962	-9.13543e-11	1.80848e-07	1.47071e-05	-1.76569e-03	0.03809
042/01	1.6032e-05	-3.6366e-04	-1.4962	-9.13543e-11	1.80848e-07	1.47071e-05	-1.76569e-03	0.03900
043/01	1.6032e-05	-3.6366e-04	-1.4962	-9.13543e-11	1.80848e-07	1.47071e-05	-1.76569e-03	0.04006
044/01	1.6032e-05	-3.6366e-04	-1.4962	-9.13543e-11	1.80848e-07	1.47071e-05	-1.76569e-03	0.03933
045/01	1.6032e-05	-3.6366e-04	-1.4962	-9.13543e-11	1.80848e-07	1.47071e-05	-1.76569e-03	0.03992
046/01	1.6032e-05	-3.6366e-04	-1.4962	-9.13543e-11	1.80848e-07	1.47071e-05	-1.76569e-03	0.03974
047/01	1.6032e-05	-3.6366e-04	-1.4962	-9.13543e-11	1.80848e-07	1.47071e-05	-1.76569e-03	0.03902
048/01	1.6032e-05	-3.6366e-04	-1.4962	-9.13543e-11	1.80848e-07	1.47071e-05	-1.76569e-03	0.03975
049/01	1.6032e-05	-3.6366e-04	-1.4962	-9.13543e-11	1.80848e-07	1.47071e-05	-1.76569e-03	0.03847
050/01	1.6032e-05	-3.6366e-04	-1.4962	-9.13543e-11	1.80848e-07	1.47071e-05	-1.76569e-03	0.04019
051/01	1.6032e-05	-3.6366e-04	-1.4962	-9.13543e-11	1.80848e-07	1.47071e-05	-1.76569e-03	0.03999
052/01	1.6032e-05	-3.6366e-04	-1.4962	-9.13543e-11	1.80848e-07	1.47071e-05	-1.76569e-03	0.04016
053/01	1.6032e-05	-3.6366e-04	-1.4962	-9.13543e-11	1.80848e-07	1.47071e-05	-1.76569e-03	0.03875
054/01	1.6032e-05	-3.6366e-04	-1.4962	-9.13543e-11	1.80848e-07	1.47071e-05	-1.76569e-03	0.03911
055/01	1.6032e-05	-3.6366e-04	-1.4962	-9.13543e-11	1.80848e-07	1.47071e-05	-1.76569e-03	0.04046
056/01	1.6032e-05	-3.6366e-04	-1.4962	-9.13543e-11	1.80848e-07	1.47071e-05	-1.76569e-03	0.03975
057/01	1.6032e-05	-3.6366e-04	-1.4962	-9.13543e-11	1.80848e-07	1.47071e-05	-1.76569e-03	0.04061
058/01	1.6032e-05	-3.6366e-04	-1.4962	-9.13543e-11	1.80848e-07	1.47071e-05	-1.76569e-03	0.03984
059/01	1.6032e-05	-3.6366e-04	-1.4962	-9.13543e-11	1.80848e-07	1.47071e-05	-1.76569e-03	0.03995
060/01	1.6032e-05	-3.6366e-04	-1.4962	-9.13543e-11	1.80848e-07	1.47071e-05	-1.76569e-03	0.04087
061/01	1.6032e-05	-3.6366e-04	-1.4962	-9.13543e-11	1.80848e-07	1.47071e-05	-1.76569e-03	0.04034
062/01	1.6032e-05	-3.6366e-04	-1.4962	-9.13543e-11	1.80848e-07	1.47071e-05	-1.76569e-03	0.04061
063/01	1.6032e-05	-3.6366e-04	-1.4962	-9.13543e-11	1.80848e-07	1.47071e-05	-1.76569e-03	0.04042
064/01	1.6032e-05	-3.6366e-04	-1.4962	-9.13543e-11	1.80848e-07	1.47071e-05	-1.76569e-03	0.03841
065/01	1.6032e-05	-3.6366e-04	-1.4962	-9.13543e-11	1.80848e-07	1.47071e-05	-1.76569e-03	0.03977
066/01	1.6032e-05	-3.6366e-04	-1.4962	-9.13543e-11	1.80848e-07	1.47071e-05	-1.76569e-03	0.03971
067/01	1.6032e-05	-3.6366e-04	-1.4962	-9.13543e-11	1.80848e-07	1.47071e-05	-1.76569e-03	0.03935
068/01	1.6032e-05	-3.6366e-04	-1.4962	-9.13543e-11	1.80848e-07	1.47071e-05	-1.76569e-03	0.03997
069/01	1.6032e-05	-3.6366e-04	-1.4962	-9.13543e-11	1.80848e-07	1.47071e-05	-1.76569e-03	0.04048
070/01	1.6032e-05	-3.6366e-04	-1.4962	-9.13543e-11	1.80848e-07	1.47071e-05	-1.76569e-03	0.03903
071/01	1.6032e-05	-3.6366e-04	-1.4962	-9.13543e-11	1.80848e-07	1.47071e-05	-1.76569e-03	0.04090
072/01	1.6032e-05	-3.6366e-04	-1.4962	-9.13543e-11	1.80848e-07	1.47071e-05	-1.76569e-03	0.04110
073/01	1.6032e-05	-3.6366e-04	-1.4962	-9.13543e-11	1.80848e-07	1.47071e-05	-1.76569e-03	0.04050
074/01	1.6032e-05	-3.6366e-04	-1.4962	-9.13543e-11	1.80848e-07	1.47071e-05	-1.76569e-03	0.04004
075/01	1.6032e-05	-3.6366e-04	-1.4962	-9.13543e-11	1.80848e-07	1.47071e-05	-1.76569e-03	0.04144
076/01	1.6032e-05	-3.6366e-04	-1.4962	-9.13543e-11	1.80848e-07	1.47071e-05	-1.76569e-03	0.03950
077/01	1.6032e-05	-3.6366e-04	-1.4962	-9.13543e-11	1.80848e-07	1.47071e-05	-1.76569e-03	0.04104
078/01	1.6032e-05	-3.6366e-04	-1.4962	-9.13543e-11	1.80848e-07	1.47071e-05	-1.76569e-03	0.04151
079/01	1.6032e-05	-3.6366e-04	-1.4962	-9.13543e-11	1.80848e-07	1.47071e-05	-1.76569e-03	0.04096
080/01	1.6032e-05	-3.6366e-04	-1.4962	-9.13543e-11	1.80848e-07	1.47071e-05	-1.76569e-03	0.04193
081/01	1.6032e-05	-3.6366e-04	-1.4962	-9.13543e-11	1.80848e-07	1.47071e-05	-1.76569e-03	0.04070
082/01	1.6032e-05	-3.6366e-04	-1.4962	-9.13543e-11	1.80848e-07	1.47071e-05	-1.76569e-03	0.04040
083/01	1.6032e-05	-3.6366e-04	-1.4962	-9.13543e-11	1.80848e-07	1.47071e-05	-1.76569e-03	0.04025
084/01	1.6032e-05	-3.6366e-04	-1.4962	-9.13543e-11	1.80848e-07	1.47071e-05	-1.76569e-03	0.04090
085/01	1.6032e-05	-3.6366e-04	-1.4962	-9.13543e-11	1.80848e-07	1.47071e-05	-1.76569e-03	0.04025

Sta/ Cast	ITS-90 Temperature Coefficients corT = $t2*T^2 + t1*T + t0$ t2	t1	t0	Conductivity Coefficients corC = $cp2*corP^2 + cp1*corP + c2*C^2 + c1*C + c0$ cp2	cp1	c2	c1	c0
086/01	1.6032e-05	-3.6366e-04	-1.4962	-9.13543e-11	1.80848e-07	1.47071e-05	-1.76569e-03	0.04049
087/01	1.6032e-05	-3.6366e-04	-1.4962	-9.13543e-11	1.80848e-07	1.47071e-05	-1.76569e-03	0.03971
088/01	1.6032e-05	-3.6366e-04	-1.4962	-9.13543e-11	1.80848e-07	1.47071e-05	-1.76569e-03	0.03990
089/01	1.6032e-05	-3.6366e-04	-1.4962	-9.13543e-11	1.80848e-07	1.47071e-05	-1.76569e-03	0.03934
090/01	1.6032e-05	-3.6366e-04	-1.4962	-9.13543e-11	1.80848e-07	1.47071e-05	-1.76569e-03	0.04007
091/01	1.6032e-05	-3.6366e-04	-1.4962	-9.13543e-11	1.80848e-07	1.47071e-05	-1.76569e-03	0.04039
092/01	1.6032e-05	-3.6366e-04	-1.4962	-9.13543e-11	1.80848e-07	1.47071e-05	-1.76569e-03	0.04100
093/01	1.6032e-05	-3.6366e-04	-1.4962	-9.13543e-11	1.80848e-07	1.47071e-05	-1.76569e-03	0.04146
094/01	1.6032e-05	-3.6366e-04	-1.4962	-9.13543e-11	1.80848e-07	1.47071e-05	-1.76569e-03	0.04187
095/01	1.6032e-05	-3.6366e-04	-1.4962	-9.13543e-11	1.80848e-07	1.47071e-05	-1.76569e-03	0.04197
096/01	1.6032e-05	-3.6366e-04	-1.4962	-9.13543e-11	1.80848e-07	1.47071e-05	-1.76569e-03	0.04209
097/01	1.6032e-05	-3.6366e-04	-1.4962	-9.13543e-11	1.80848e-07	1.47071e-05	-1.76569e-03	0.04146
098/01	1.6032e-05	-3.6366e-04	-1.4962	-9.13543e-11	1.80848e-07	1.47071e-05	-1.76569e-03	0.04079
099/01	1.6032e-05	-3.6366e-04	-1.4962	-9.13543e-11	1.80848e-07	1.47071e-05	-1.76569e-03	0.04060
100/01	1.6032e-05	-3.6366e-04	-1.4962	-9.13543e-11	1.80848e-07	1.47071e-05	-1.76569e-03	0.03966
101/01	1.6032e-05	-3.6366e-04	-1.4962	-9.13543e-11	1.80848e-07	1.47071e-05	-1.76569e-03	0.04027
102/01	1.6032e-05	-3.6366e-04	-1.4962	-9.13543e-11	1.80848e-07	1.47071e-05	-1.76569e-03	0.03936
103/01	1.6032e-05	-3.6366e-04	-1.4962	-9.13543e-11	1.80848e-07	1.47071e-05	-1.76569e-03	0.03857
104/01	1.6032e-05	-3.6366e-04	-1.4962	-9.13543e-11	1.80848e-07	1.47071e-05	-1.76569e-03	0.03918
105/01	1.6032e-05	-3.6366e-04	-1.4962	-9.13543e-11	1.80848e-07	1.47071e-05	-1.76569e-03	0.03871
106/01	1.6032e-05	-3.6366e-04	-1.4962	-9.13543e-11	1.80848e-07	1.47071e-05	-1.76569e-03	0.03992
107/01	1.6032e-05	-3.6366e-04	-1.4962	-9.13543e-11	1.80848e-07	1.47071e-05	-1.76569e-03	0.03938
108/01	1.6032e-05	-3.6366e-04	-1.4962	-9.13543e-11	1.80848e-07	1.47071e-05	-1.76569e-03	0.03872
109/01	1.6032e-05	-3.6366e-04	-1.4962	-9.13543e-11	1.80848e-07	1.47071e-05	-1.76569e-03	0.03922
110/01	1.6032e-05	-3.6366e-04	-1.4962	-9.13543e-11	1.80848e-07	1.47071e-05	-1.76569e-03	0.03903
111/01	1.6032e-05	-3.6366e-04	-1.4962	-9.13543e-11	1.80848e-07	1.47071e-05	-1.76569e-03	0.04009
112/01	1.6032e-05	-3.6366e-04	-1.4962	-9.13543e-11	1.80848e-07	1.47071e-05	-1.76569e-03	0.03918
113/01	1.6032e-05	-3.6366e-04	-1.4962	-9.13543e-11	1.80848e-07	1.47071e-05	-1.76569e-03	0.03814
114/01	1.6032e-05	-3.6366e-04	-1.4962	-9.13543e-11	1.80848e-07	1.47071e-05	-1.76569e-03	0.03874
115/01	1.6032e-05	-3.6366e-04	-1.4962	-9.13543e-11	1.80848e-07	1.47071e-05	-1.76569e-03	0.03901
116/01	1.6032e-05	-3.6366e-04	-1.4962	-9.13543e-11	1.80848e-07	1.47071e-05	-1.76569e-03	0.03797
117/01	1.6032e-05	-3.6366e-04	-1.4962	-9.13543e-11	1.80848e-07	1.47071e-05	-1.76569e-03	0.03837
118/01	1.6032e-05	-3.6366e-04	-1.4962	-9.13543e-11	1.80848e-07	1.47071e-05	-1.76569e-03	0.03879
119/01	1.6032e-05	-3.6366e-04	-1.4962	-9.13543e-11	1.80848e-07	1.47071e-05	-1.76569e-03	0.03859
120/01	1.6032e-05	-3.6366e-04	-1.4962	-9.13543e-11	1.80848e-07	1.47071e-05	-1.76569e-03	0.04025
121/01	1.6032e-05	-3.6366e-04	-1.4962	-9.13543e-11	1.80848e-07	1.47071e-05	-1.76569e-03	0.03937
122/01	1.6032e-05	-3.6366e-04	-1.4962	-9.13543e-11	1.80848e-07	1.47071e-05	-1.76569e-03	0.03872
123/01	1.6032e-05	-3.6366e-04	-1.4962	-9.13543e-11	1.80848e-07	1.47071e-05	-1.76569e-03	0.03836
124/01	1.6032e-05	-3.6366e-04	-1.4962	-9.13543e-11	1.80848e-07	1.47071e-05	-1.76569e-03	0.03916
125/01	1.6032e-05	-3.6366e-04	-1.4962	-9.13543e-11	1.80848e-07	1.47071e-05	-1.76569e-03	0.03978
126/01	1.6032e-05	-3.6366e-04	-1.4962	-9.13543e-11	1.80848e-07	1.47071e-05	-1.76569e-03	0.03979
127/01	1.6032e-05	-3.6366e-04	-1.4962	-9.13543e-11	1.80848e-07	1.47071e-05	-1.76569e-03	0.04023
128/01	1.6032e-05	-3.6366e-04	-1.4962	-9.13543e-11	1.80848e-07	1.47071e-05	-1.76569e-03	0.03985
129/01	1.6032e-05	-3.6366e-04	-1.4962	-9.13543e-11	1.80848e-07	1.47071e-05	-1.76569e-03	0.04156
130/01	1.6032e-05	-3.6366e-04	-1.4962	-9.13543e-11	1.80848e-07	1.47071e-05	-1.76569e-03	0.04107

Sta/ Cast	ITS-90 Temperature Coefficients corT = t2∗T^2 + t1∗T + t0 t2	t1	t0	Conductivity Coefficients corC = cp2∗corP^2 + cp1∗corP + c2∗C^2 + c1∗C + c0 cp2	cp1	c2	c1	c0
131/01	1.6032e-05	-3.6366e-04	-1.4962	-9.13543e-11	1.80848e-07	1.47071e-05	-1.76569e-03	0.04132
132/01	1.6032e-05	-3.6366e-04	-1.4962	-9.13543e-11	1.80848e-07	1.47071e-05	-1.76569e-03	0.04115
133/01	1.6032e-05	-3.6366e-04	-1.4962	-9.13543e-11	1.80848e-07	1.47071e-05	-1.76569e-03	0.04072
134/01	1.6032e-05	-3.6366e-04	-1.4962	-9.13543e-11	1.80848e-07	1.47071e-05	-1.76569e-03	0.04123
135/01	1.6032e-05	-3.6366e-04	-1.4962	-9.13543e-11	1.80848e-07	1.47071e-05	-1.76569e-03	0.04130
136/01	1.6032e-05	-3.6366e-04	-1.4962	-9.13543e-11	1.80848e-07	1.47071e-05	-1.76569e-03	0.04162
137/01	1.6032e-05	-3.6366e-04	-1.4962	-9.13543e-11	1.80848e-07	1.47071e-05	-1.76569e-03	0.04227
138/01	1.6032e-05	-3.6366e-04	-1.4962	-9.13543e-11	1.80848e-07	1.47071e-05	-1.76569e-03	0.04041
139/01	1.6032e-05	-3.6366e-04	-1.4962	-9.13543e-11	1.80848e-07	1.47071e-05	-1.76569e-03	0.04121
140/01	1.6032e-05	-3.6366e-04	-1.4962	-9.13543e-11	1.80848e-07	1.47071e-05	-1.76569e-03	0.04196
141/01	1.6032e-05	-3.6366e-04	-1.4962	-9.13543e-11	1.80848e-07	1.47071e-05	-1.76569e-03	0.04179
142/01	1.6032e-05	-3.6366e-04	-1.4962	-9.13543e-11	1.80848e-07	1.47071e-05	-1.76569e-03	0.04180
143/01	1.6032e-05	-3.6366e-04	-1.4962	-9.13543e-11	1.80848e-07	1.47071e-05	-1.76569e-03	0.04120
144/01	1.6032e-05	-3.6366e-04	-1.4962	-9.13543e-11	1.80848e-07	1.47071e-05	-1.76569e-03	0.04098
145/01	1.6032e-05	-3.6366e-04	-1.4962	-9.13543e-11	1.80848e-07	1.47071e-05	-1.76569e-03	0.04038
146/01	1.6032e-05	-3.6366e-04	-1.4962	-9.13543e-11	1.80848e-07	1.47071e-05	-1.76569e-03	0.04059
147/01	1.6032e-05	-3.6366e-04	-1.4962	-9.13543e-11	1.80848e-07	1.47071e-05	-1.76569e-03	0.04237
148/01	1.6032e-05	-3.6366e-04	-1.4962	-9.13543e-11	1.80848e-07	1.47071e-05	-1.76569e-03	0.04111
149/01	1.6032e-05	-3.6366e-04	-1.4962	-9.13543e-11	1.80848e-07	1.47071e-05	-1.76569e-03	0.04157
150/01	1.6032e-05	-3.6366e-04	-1.4962	-9.13543e-11	1.80848e-07	1.47071e-05	-1.76569e-03	0.04163
151/01	1.6032e-05	-3.6366e-04	-1.4962	-9.13543e-11	1.80848e-07	1.47071e-05	-1.76569e-03	0.04213
152/01	1.6032e-05	-3.6366e-04	-1.4962	-9.13543e-11	1.80848e-07	1.47071e-05	-1.76569e-03	0.04280
153/01	1.6032e-05	-3.6366e-04	-1.4962	-9.13543e-11	1.80848e-07	1.47071e-05	-1.76569e-03	0.04221
153/02	1.6032e-05	-3.6366e-04	-1.4962	-9.13543e-11	1.80848e-07	1.47071e-05	-1.76569e-03	0.04220

Appendix B

Summary of WOCE97-A24 CTD Oxygen Time Constants

(time constants in seconds)

Station	Temperature Fast(τ_{Tf})	Temperature Slow(τ_{Ts})	Pressure (τ_p)	O_2 Gradient (τ_{og})
061	10.0	400.0	16.0	16.0
All Others	32.0	515.0	6.0	16.0

Note: used station 61 shipboard corrections as better fit for very shallow cast.

WOCE97-A24: Conversion Equation Coefficients for CTD Oxygen

(refer to Equation 8.4.0)

Sta/ Cast	O_cSlope (c_1)	Offset (c_2)	$P_l$coeff (c_3)	$T_f$coeff (c_4)	$T_s$coeff (c_5)	$\frac{dO_c}{dt}$coeff (c_6)
001/01	1.59155e-04	1.80606e-01	-1.67936e-05	-2.42667e-02	-1.05835e-03	-2.04542e-04
002/01	3.29530e-04	-1.69661e-01	1.06956e-05	-3.94112e-03	-5.56021e-02	-5.59454e-04
003/01	2.20195e-04	2.67266e-01	-8.59507e-06	2.27063e-02	-6.71860e-02	-1.14262e-04
004/01	2.08158e-04	4.58399e-02	9.28639e-05	-1.09227e-02	-3.01051e-02	-6.54384e-04
005/01	2.03459e-04	1.25688e-01	6.74639e-05	-1.17646e-03	-3.93739e-02	-3.67590e-04
006/01	2.03284e-04	9.99630e-02	7.91762e-05	1.98649e-03	-4.11089e-02	-4.26553e-04
007/01	1.99903e-04	3.86616e-02	1.11502e-04	-2.43107e-03	-3.41172e-02	-6.34835e-04
008/01	1.96544e-04	2.41953e-02	1.21763e-04	4.07521e-03	-3.71913e-02	-1.62776e-04
009/01	2.15291e-04	-5.36765e-02	1.40467e-04	2.21202e-03	-3.85272e-02	-1.81221e-04
010/01	2.09784e-04	3.41741e-02	1.02138e-04	-3.54145e-03	-3.65743e-02	-3.96415e-04
011/01	2.22733e-04	-8.70568e-03	1.07363e-04	1.37323e-02	-5.09050e-02	-2.43484e-04
012/01	2.10327e-04	-6.71762e-02	1.44093e-04	-4.03790e-03	-3.26629e-02	-2.73662e-04
013/01	2.35427e-04	1.54534e-01	1.14679e-05	1.00860e-02	-6.24270e-02	-6.75866e-04
014/01	2.20314e-04	1.07755e-01	4.26790e-05	1.54560e-03	-4.91234e-02	-5.99597e-04
015/01	2.15297e-04	1.26329e-02	9.02960e-05	1.27057e-02	-5.16387e-02	-1.12151e-04
016/01	1.84136e-04	9.49351e-02	8.66736e-05	-7.04758e-03	-3.23125e-02	-4.95509e-04
017/01	1.89372e-04	-4.13260e-02	1.42300e-04	-2.24965e-03	-3.12172e-02	-9.46711e-04
018/01	1.73978e-04	-2.15571e-03	1.39843e-04	-1.17417e-02	-2.26272e-02	7.38213e-07
019/01	1.62492e-04	1.08743e-01	9.42972e-05	-1.19787e-02	-2.53778e-02	-2.46025e-06
020/01	1.74190e-04	1.83679e-02	1.17258e-04	-7.37559e-04	-3.51708e-02	1.39682e-06
021/01	1.70363e-04	-3.33210e-02	1.46005e-04	3.67402e-03	-3.64047e-02	-2.15345e-04
022/01	1.67833e-04	8.20616e-03	1.27974e-04	-5.82974e-03	-3.13278e-02	7.37800e-08
023/01	1.69521e-04	2.52103e-02	1.16119e-04	-1.22881e-02	-2.90536e-02	2.61161e-07
024/01	1.67831e-04	-1.59422e-02	1.35863e-04	-1.43772e-02	-2.31590e-02	-1.15078e-06
025/01	9.74036e-04	2.74161e-02	1.38260e-04	1.13660e-02	-3.74159e-02	1.35937e-04
026/01	1.57765e-04	-1.96677e-03	1.38479e-04	-1.43833e-02	-2.08002e-02	-2.74488e-04
027/01	1.56240e-04	6.41501e-02	1.08874e-04	-6.80935e-03	-3.09823e-02	-3.38017e-04
028/01	1.56613e-04	6.57770e-02	1.07595e-04	-1.28844e-02	-2.47557e-02	-1.70818e-04
029/01	1.54641e-04	-3.41163e-02	1.61835e-04	-1.40613e-02	-1.86196e-02	-7.93446e-04
030/01	1.57645e-04	6.78776e-02	1.02978e-04	-1.60396e-02	-2.24801e-02	-3.64876e-04
031/01	1.80078e-04	1.43807e-01	3.31975e-05	-1.54686e-02	-3.48746e-02	-3.79686e-04
032/01	2.62701e-04	-1.39345e-01	1.26039e-04	3.96602e-02	-1.02436e-01	-5.00108e-04

Sta/ Cast	O_c Slope (c_1)	Offset (c_2)	P_l coeff (c_3)	T_f coeff (c_4)	T_s coeff (c_5)	$\frac{dO_c}{dt}$ coeff (c_6)
033/01	8.53791e-05	5.02634e-02	2.72122e-04	-4.76358e-03	8.91434e-03	-6.56397e-05
034/01	6.32460e-05	2.53628e-01	3.17185e-04	3.19715e-02	-2.44634e-02	-2.38888e-05
035/01	5.13115e-05	8.11760e-01	-8.77855e-05	1.68051e-02	-3.86008e-02	-2.41569e-05
036/01	5.32958e-05	1.06826e-01	1.99469e-04	-5.10487e-02	8.01151e-02	2.39381e-04
037/01	1.47180e-04	-1.11558e-01	1.93362e-04	-3.30723e-02	4.26096e-03	-4.77214e-04
038/01	1.78402e-04	-1.24014e-02	8.22548e-05	-1.21045e-02	-3.59573e-02	-3.22818e-04
039/01	1.73511e-04	4.02025e-02	7.37872e-05	-3.07540e-03	-4.37149e-02	-3.48811e-04
040/01	1.68455e-04	2.76831e-02	9.01043e-05	5.98810e-03	-4.80168e-02	-5.06492e-04
041/01	1.48302e-04	5.80631e-01	-8.09000e-05	-1.70292e-02	-4.98590e-02	3.73003e-05
042/01	1.81649e-04	1.33321e-01	2.47216e-05	-7.70114e-03	-4.89017e-02	1.82620e-07
043/01	1.84280e-04	-1.17431e-01	1.29382e-04	-1.47953e-04	-4.26872e-02	-6.14003e-04
044/01	2.22596e-04	2.39913e-01	-5.66631e-05	8.65999e-03	-8.09534e-02	-2.77091e-04
045/01	1.99890e-04	5.97511e-01	-1.19629e-04	1.53675e-02	-9.40520e-02	1.76438e-04
046/01	1.64375e-04	3.21820e-01	-8.95318e-06	4.01608e-03	-6.19019e-02	5.16775e-05
047/01	1.38712e-04	2.13737e-01	3.29168e-05	-1.09980e-02	-2.88248e-02	1.66050e-06
048/01	1.16646e-04	-1.55556e-01	3.06793e-04	-4.93577e-02	4.06853e-02	1.55321e-06
049/01	6.51004e-05	5.38463e-01	3.64842e-04	2.65331e-02	-4.62661e-02	-2.45320e-08
050/01	1.46803e-05	5.79445e-01	8.78170e-05	4.76692e-02	-1.86353e-02	3.20479e-05
051/01	2.21550e-04	-2.22787e-01	1.10075e-04	-2.91259e-02	-3.17552e-02	-2.69001e-04
052/01	1.57911e-04	2.31671e-01	2.76457e-05	3.74426e-03	-5.24188e-02	-1.97205e-06
053/01	1.90199e-04	1.75495e-01	-6.83434e-07	-1.69616e-02	-4.47097e-02	-4.31444e-05
054/01	1.53884e-04	2.49577e-01	1.94185e-05	-6.65853e-03	-4.20702e-02	2.18828e-06
055/01	1.47946e-04	2.66047e-01	3.09519e-05	3.94468e-03	-5.01139e-02	-3.03193e-06
056/01	2.00052e-04	1.70718e-01	-3.34300e-05	-2.16987e-02	-4.63603e-02	-5.84131e-04
057/01	1.40257e-04	-9.24808e-02	2.22813e-04	-7.96132e-03	-1.76007e-02	1.83640e-05
058/01	3.62386e-04	3.91253e-01	-9.58735e-05	2.79407e-02	-1.49356e-01	-4.02783e-04
059/01	3.18965e-04	1.77058e+00	-2.65215e-04	3.88343e-02	-1.77461e-01	-1.47914e-04
060/01	4.75255e-06	4.67242e-01	1.35183e-04	2.99944e-02	3.18173e-02	5.25432e-07
061/01	1.17016e-05	3.68093e-01	7.83863e-05	7.42281e-02	6.24189e-04	-3.19465e-06
062/01	-2.11599e-05	9.10071e-01	-3.08415e-04	1.02234e-01	-6.04671e-02	-9.69222e-07
063/01	3.05587e-04	6.13982e+00	-4.56691e-04	1.78191e-02	-2.25350e-01	4.93646e-06
064/01	9.44448e-05	-4.21474e-04	1.78401e-04	-3.35232e-02	4.15171e-02	-3.55106e-04
065/01	2.55248e-04	2.22077e-01	-2.46706e-05	7.30396e-03	-1.00220e-01	-3.47292e-04
066/01	5.78257e-05	1.74586e-01	2.09361e-04	5.03461e-02	-1.87118e-02	-3.07015e-04
067/01	1.35920e-04	-5.80805e-02	2.29970e-04	-1.08813e-03	-2.30935e-02	-3.17104e-04
068/01	1.65333e-04	2.09512e-01	2.83571e-05	4.00289e-03	-5.82649e-02	-1.94853e-05
069/01	1.62541e-04	7.82076e-02	7.92763e-05	5.65559e-03	-5.01923e-02	-1.99766e-04
070/01	1.54127e-04	2.33048e-02	1.22218e-04	-1.48401e-02	-2.42903e-02	-1.70699e-05
071/01	1.55263e-04	7.45321e-02	8.48367e-05	-1.54318e-02	-2.47681e-02	-1.95415e-04
072/01	1.52123e-04	1.26169e-01	7.52181e-05	9.65746e-03	-4.85348e-02	1.06806e-05
073/01	1.64175e-04	3.48164e-02	1.07172e-04	-1.60265e-02	-3.54140e-02	6.89268e-04
074/01	1.58162e-04	1.01610e-01	8.62109e-05	-1.56577e-02	-3.66920e-02	-1.29237e-04
075/01	1.68999e-04	8.84703e-02	6.46341e-05	-2.35657e-03	-5.01491e-02	1.44827e-05
076/01	1.79874e-04	1.72598e-01	1.64208e-05	3.69450e-03	-6.52063e-02	-3.19630e-04
077/01	1.29119e-04	3.08484e-02	1.75418e-04	-1.15002e-02	-1.24011e-02	7.04111e-06
078/01	1.13134e-04	-6.55551e-02	2.95307e-04	-2.14336e-02	1.96644e-02	-4.37889e-05

Sta/ Cast	O_c Slope (c_1)	Offset (c_2)	P_l coeff (c_3)	T_f coeff (c_4)	T_s coeff (c_5)	$\frac{dO_c}{dt}$ coeff (c_6)
079/01	4.58113e-05	2.70100e-01	1.80287e-04	-4.36710e-03	4.28503e-02	6.69965e-04
080/01	7.57419e-05	1.08042e-01	2.62841e-04	-1.97040e-02	3.92492e-02	-7.86440e-05
081/01	3.27396e-05	9.15137e-01	-5.30475e-05	1.10495e-01	-1.21634e-01	9.35778e-04
082/01	1.38660e-04	1.97146e-01	8.11011e-05	-1.90118e-02	-3.27376e-02	5.05819e-06
083/01	1.48679e-04	1.27713e-01	7.88931e-05	1.69040e-02	-5.91502e-02	1.65829e-04
084/01	1.96761e-04	-1.96238e-01	1.32466e-04	7.59467e-02	-1.09398e-01	-9.54481e-04
085/01	1.62806e-04	-1.72652e-02	1.21975e-04	6.72395e-03	-4.87194e-02	-9.51015e-04
086/01	1.72915e-04	-6.16161e-02	1.33338e-04	3.09092e-03	-5.55399e-02	-1.26539e-03
087/01	1.56336e-04	1.85493e-01	8.25054e-05	1.38158e-03	-7.60130e-02	8.99418e-05
088/01	1.58864e-04	1.40157e-01	7.76994e-05	-3.02280e-03	-5.80744e-02	1.84770e-04
089/01	1.20414e-04	2.58597e-01	8.06108e-05	7.62351e-03	-4.33346e-02	-3.19876e-05
090/01	2.00251e-04	3.67408e-01	-6.61006e-05	1.41834e-02	-1.17829e-01	-2.08241e-03
091/01	1.43998e-04	1.94743e-01	5.24192e-05	-2.45385e-02	-2.89370e-02	-6.62329e-06
092/01	1.61620e-04	9.76973e-01	-1.91280e-04	-1.79680e-03	-1.17447e-01	2.98634e-05
093/01	-1.65003e-04	3.91744e+00	-2.48761e-04	2.21957e-01	-3.39978e-01	-3.57263e-06
094/01	1.08367e-04	1.69701e-01	4.16802e-04	1.02182e-02	-6.67263e-02	1.81922e-05
095/01	7.51653e-05	3.67382e-01	1.98314e-05	-5.29865e-03	2.66220e-02	8.79974e-06
096/01	1.24127e-04	-1.93243e-01	2.23659e-04	7.88128e-03	6.54977e-02	1.09028e-06
097/01	5.47117e-05	5.58920e-01	2.93238e-04	-1.09596e-03	-5.03112e-02	9.70853e-05
098/01	3.12625e-05	8.53141e-01	-3.34854e-04	3.84201e-02	-5.98532e-02	-1.56960e-06
099/01	3.37798e-05	3.46385e-01	-9.00466e-05	3.21554e-02	7.81963e-02	-3.68971e-06
100/01	4.26540e-05	8.66048e-01	-1.15063e-05	4.42543e-02	-8.38593e-02	-6.46673e-07
101/01	9.07370e-05	3.33641e-01	9.67244e-05	1.08855e-02	-2.71796e-02	-3.23032e-04
102/01	1.84932e-04	1.15484e-03	9.66055e-05	-3.20852e-02	-4.74004e-02	-8.84131e-04
103/01	1.56815e-04	1.47773e-01	9.24281e-05	1.00206e-02	-7.79217e-02	-3.74967e-04
104/01	1.23664e-04	2.98271e-01	7.13968e-05	1.78710e-03	-5.32447e-02	1.77077e-04
105/01	1.28922e-04	2.60560e-01	8.13513e-05	5.77435e-04	-5.69865e-02	2.73079e-06
106/01	1.42386e-04	1.10183e-01	1.12841e-04	-2.10571e-02	-2.71002e-02	-5.97384e-04
107/01	1.32868e-04	1.54122e-01	1.06468e-04	5.98032e-03	-4.10264e-02	-2.72775e-04
108/01	1.34774e-04	1.80867e-01	9.61094e-05	8.09162e-03	-4.99175e-02	-5.56872e-06
109/01	1.42966e-04	1.77125e-01	9.63899e-05	-2.35271e-02	-3.55805e-02	-1.44229e-04
110/01	1.45825e-04	1.19449e-01	1.02176e-04	-9.05651e-03	-3.75279e-02	6.51619e-07
111/01	1.61166e-04	3.22019e-02	1.17763e-04	-1.16368e-02	-3.75473e-02	-1.09855e-06
112/01	1.46859e-04	1.92283e-01	6.97896e-05	1.02282e-03	-5.14137e-02	2.27189e-05
113/01	1.46172e-04	1.92891e-01	7.60365e-05	-4.92483e-03	-4.35036e-02	-7.33963e-07
114/01	1.42122e-04	1.53444e-01	9.24123e-05	-4.79629e-03	-3.40317e-02	-6.45711e-06
115/01	1.45679e-04	5.95846e-02	1.43276e-04	-1.94852e-02	-1.60951e-02	7.68975e-07
116/01	1.48160e-04	1.64595e-01	9.12673e-05	-9.60357e-03	-3.69956e-02	-7.10422e-04
117/01	1.66033e-04	-2.76941e-02	1.63852e-04	-2.67531e-02	-1.76373e-02	-1.92720e-04
118/01	1.68243e-04	4.37283e-02	1.18478e-04	-2.01420e-02	-2.90367e-02	-7.80007e-07
119/01	1.32027e-04	2.32281e-01	8.25727e-05	-1.56361e-03	-3.44465e-02	5.64620e-06
120/01	1.24547e-04	2.70178e-01	7.46909e-05	7.03492e-03	-3.91348e-02	-5.67454e-04
121/01	1.54770e-04	1.42463e-01	9.35302e-05	-6.01811e-03	-3.69751e-02	1.91892e-06
122/01	1.57475e-04	1.89691e-01	8.13860e-05	-1.42671e-03	-4.65195e-02	-4.70624e-07
123/01	8.93644e-05	5.79771e-01	2.11988e-05	1.45019e-02	-4.53449e-02	3.18052e-04

Sta/ Cast	O_c Slope (c_1)	Offset (c_2)	P_l coeff (c_3)	T_f coeff (c_4)	T_s coeff (c_5)	$\frac{dO_c}{dt}$ coeff (c_6)
124/01	1.21482e-04	4.36304e-01	3.26018e-05	2.32352e-02	-5.36848e-02	-3.28635e-06
125/01	1.47437e-04	3.32449e-01	5.40093e-05	7.30531e-03	-4.91376e-02	3.54980e-06
126/01	2.01320e-04	6.17173e-02	9.08394e-05	2.07185e-03	-4.55805e-02	2.69658e-06
127/01	1.82328e-04	1.05672e-01	8.35850e-05	-2.64706e-03	-3.82617e-02	-2.80159e-04
128/01	1.98000e-04	1.25553e-01	6.65753e-05	-3.84737e-03	-4.88685e-02	1.20005e-05
129/01	1.72876e-04	1.36979e-01	7.86024e-05	-8.53686e-03	-3.66286e-02	-1.60125e-04
130/01	1.67146e-04	8.16034e-02	9.74321e-05	-3.80420e-04	-3.66838e-02	-2.07910e-04
131/01	1.52707e-04	1.59369e-01	8.09513e-05	-1.55165e-03	-3.50838e-02	-8.11806e-07
132/01	1.66998e-04	1.17860e-01	7.96167e-05	-4.29171e-03	-3.69767e-02	8.47650e-07
133/01	1.73625e-04	3.55268e-02	1.03040e-04	-8.85905e-03	-3.16113e-02	1.33115e-06
134/01	1.48204e-04	2.52858e-01	4.86067e-05	1.72511e-03	-3.81002e-02	-6.53886e-06
135/01	1.92096e-04	-2.74505e-02	1.27536e-04	-1.09422e-02	-2.95040e-02	-1.78041e-04
136/01	1.94472e-04	4.13933e-03	1.12769e-04	-7.62069e-03	-3.14675e-02	1.43475e-07
137/01	2.17106e-04	-3.01978e-02	1.12942e-04	-4.50373e-03	-4.02500e-02	4.96301e-06
138/01	2.22311e-04	-5.00321e-02	9.76468e-05	-1.58724e-02	-3.02823e-02	-4.36295e-06
139/01	1.52422e-04	2.02737e-02	1.97108e-04	-1.97796e-02	-1.13464e-02	1.36054e-04
140/01	1.46617e-04	-3.19478e-03	2.16811e-04	-2.17866e-02	-5.33996e-03	1.31272e-05
141/01	2.37081e-04	1.55902e-01	-3.40032e-05	1.13998e-02	-6.07683e-02	-6.54744e-07
142/01	1.98213e-04	-4.97505e-02	1.08182e-04	-8.69091e-03	-2.86842e-02	-1.41580e-06
143/01	2.17161e-04	-3.33819e-02	6.98944e-05	-1.13934e-02	-3.28713e-02	-5.48273e-04
144/01	2.33652e-04	2.05512e-04	4.31696e-05	-3.03195e-03	-4.66079e-02	-9.74762e-05
145/01	2.09580e-04	7.65830e-02	4.24723e-05	-3.11430e-03	-4.12493e-02	-1.52486e-04
146/01	2.17548e-04	7.38263e-02	5.38163e-05	3.85039e-03	-4.89278e-02	-1.12781e-06
147/01	1.77841e-04	-1.04150e-01	1.99303e-04	-4.48221e-02	4.56913e-03	-2.28104e-04
148/01	2.00754e-04	1.39430e-01	2.36437e-05	6.89890e-03	-4.75024e-02	-1.89062e-04
149/01	2.35974e-04	1.21863e-02	2.76438e-05	-1.12256e-03	-4.67145e-02	-3.54931e-04
150/01	1.97150e-04	6.36631e-02	6.66619e-05	-8.44385e-03	-3.31962e-02	9.23139e-07
151/01	4.53928e-04	1.72824e-01	-2.87270e-04	-1.44757e-03	-8.07508e-02	-4.24021e-06
152/01	1.99191e-04	-5.74273e-02	9.76922e-05	-2.54269e-02	-1.61357e-02	-9.68688e-06
153/01	1.99191e-04	-5.74273e-02	9.76922e-05	-2.54269e-02	-1.61357e-02	-9.68688e-06
153/02	9.61249e-05	6.94877e-02	3.30551e-04	1.43364e-02	-1.59927e-02	4.32862e-06

Appendix C

Tabulation of WOCE97-A24 Problem CTD Casts

Cast	Problems	Solutions
<001/01- 022/01>	Conductivity discontinuity at raw value 32767/32768	Software changed to detect/fix, first 22 casts re-averaged.
001/01	CTD #3 temp offsets (water in turret).	Switch to CTD #5 for rest of cruise.
001/01	Temperature drift on down cast.	Use upcast.
004/01	10.5-min. winch stop for maintenance at 2374-2384db downcast, CTDO signal drifted/dropped.	Offset raw CTDO from stop to bottom. Filtered near/after stop.
005/01	-0.015 sigma theta drop 1134-1190db	No action, down+up CTD features in T/C/S/O2
005/01	Acquisition crashed on upcast, restarted.	CTD time offset to match.
011/01	Switched to SBE32 pylon. Bottles tripped out-of-order after pylon reset.	Fixed CTD trip info.
013/01	CTDO spiking/drift near bottom.	Filtered.
014/01	Installed SBE35 T sensor prior to cast.	
014/01	Deck Unit blew fuse at 1836db upcast	Stopped for repairs at 1800db
015/01	-0.022 sigma theta inversion top 10db	No action, S stable and T rising.
018/01	-0.10 sigma theta drop 16-22db	No action, down+up CTD features in T/C/S/O2
019/01	Deck Unit blew fuse at 1720db downcast, not noticed until 2100+db. Power restored, returned from 2486db to 1514db, then continued down (30 mins. time elapsed). Fuse blew again at 4740db upcast.	First + repeat downcasts spliced at 1668db where TC matched best and after CTDO had time to adjust after reversing direction.
019/01	CTDO spiking/drift near bottom.	Filtered.
020/01	-0.025 sigma theta drop 1020-1044db	No action, down+up CTD features in T/C/S/O2
020/01	-0.03 sigma theta inversion 1262-1402db	No action, down+up CTD features in T/C/S/O2
025/01	CTDO sensor cover left on.	CTDO signal useless, not reported.
027/01	SBE32 pylon triggered time spikes in CTD signal and false-confirms at multiple trips.	Time source changed in software.
028/01	CTDO spike near 3100db downcast.	Filtered.
038/01	-0.87PSU Salinity spike 20-28db. Small-scale salinity spiking throughout cast.	Filtered.
040/01	-0.39PSU Salinity spike at 74-78db downcast.	Filtered.
040/01	Cast touched bottom, cond. spiking.	Press-sequencing cut off just above spikes.
053/01	CTDO spiking/drift near bottom.	Filtered.
055/01	-1.0PSU Salinity spike 6-11db downcast.	Filtered.
068/01	CTDO signal very low at surface.	No action. Code bad.
069/01	CTDO signal very low at surface.	No action. Code bad.
070/01	CTDO signal very low at surface.	No action. Code bad.
071/01	Cond. dropout 30-75m downcast, T+C problems top 300db: inversions do not look real.	Use upcast.
071/01	Time spike/jump 446db upcast	Shift time back to improve CTDO fit.
071/01	-.30PSU Salinity spike 4-6db upcast, just before trip.	Filtered.
072/01	CTDO signal very low at surface.	Filtered to improve CTDO fit.
073/01	CTDO signal very low at surface.	No action. Code bad.
074/01	CTDO signal very low at surface.	No action. Code bad.
076/01	CTDO signal very low at surface.	Filtered to improve CTDO fit.
076/01	CTDO spiking/drift near bottom.	Filtered.
079/01	CTDO signal very low at surface.	Filtered to improve CTDO fit.
081/01	CTDO signal very low at surface.	Filtered to improve CTDO fit.
082/01	CTDO signal very low at surface.	Filtered to improve CTDO fit.

Cast	Problems	Solutions
082/01	-0.08PSU Salinity spike 1000-1002db downcast.	Filtered.
083/01	CTDO signal low, top 40-50db.	Filtered to improve CTDO fit.
083/01	Time spike/jump 24db downcast	Shift time back to improve CTDO fit.
086/01	CTDO signal very low at surface.	No action. Code bad.
086/01	Salinity spiking on upcast at 4 deepest rosette trips.	Filtered.
088/01	Transmissometer signal intermittent.	Washed prior to cast
089/01	Discovered W. Gardner's transmissometer log.	Switched to instrument #266AD (from #265AD).
089/01	CTDO signal very low top 12db.	Filtered to improve CTDO fit.
090/01	CTDO signal very low top 140db.	No action. Code bad.
090/01	Salinity spiking on upcast at rosette trips.	Filtered.
095/01	CTDO signal very low at surface.	Filtered to improve CTDO fit.
096/01	CTDO spiking/drift near bottom.	Filtered.
097/01	-0.02 sigma theta inversion at 6db	No action, down+up CTD features in T/C/S/O2
097/01	+0.02 sigma theta rise 128-156db	No action, down+up CTD features in T/C/S/O2
109/01	CTDO signal very low at surface.	No action. Code bad.
111/01	CTDO spiking/drift near bottom.	Filtered.
118/01	CTDO spiking/drift near bottom.	Filtered.
123/01	CTDO spiking/drift near bottom.	Filtered.
<124/01-152/01>	Intermittent cond offsetting on upcasts.	Shift calibration as needed.
128/01	CTDO signal very low at surface.	Filtered to improve CTDO fit.
132/01	-0.38PSU Salinity spike 567-570db downcast.	Filtered.
133/01	-0.01 sigma theta drop 18-20db	No action, down+up CTD features in T/C/S/O2
141/01	CTDO signal very low at surface.	Filtered to improve CTDO fit.
145/01	CTDO signal very low at surface.	Filtered to improve CTDO fit.
147/01	CTDO signal very low at surface.	No action. Code bad.
147/01	-0.08PSU Salinity spike 608-610db downcast.	Filtered.
153/01	Special cast for LADCP bottom tracking test, minimal sampling: only 4 btls	
153/01	No bottle data for CTDO fit	Used sta.152 corrections for fit closest to cast 2 CTD/bottles.

Appendix D

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. NO3 appeared low, shallow, when plotted vs. pressure. Bottom NO3 appeared high, O2 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 endcap leak when vent cracked." Oxygen is high. Other samples appear to be acceptable. Footnote O2 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.

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.
121-123	Footnote CTDO questionable 0-90db.
116	PO4 appears 0.04 high. Nutrient analyst could not find any analytical problems. PO4 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. No analytical problem found.
108	Sample Log: "Vent not closed." O2 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	O2 is high, nutrients are low. Salinity agrees with the CTD. Data are acceptable. O2 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." O2 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." O2 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." O2 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.
125-126	Footnote CTDO questionable 52-110db.
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.
127	Footnote CTDO questionable 0-78db.
119	Sample Log: "Vent open." Oxygen as well as other data are acceptable.
117	PO4 ˜0.06 high, so is SiO3 high. Nutrient analyst: "No analytical problem found, peaks, calcs look okay, normal n:p."
111	SiO3 a little high. Nutrient analyst: "No analytical problem found, peaks, calcs look okay."
110	SiO3 ˜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.
127-128	Footnote CTDO questionable 0-100db.
125	Nutrients low, O2 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.
126-128	Footnote CTDO questionable 0-110db.
116	O2 looks high, but is okay, agrees with CTDO. Salinity gradient area acceptable. NO3 maybe 0.4 high, PO4 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	PO4 slightly low. Nutrient analyst: "No analytical problems found, N:P same as Sta 008."
101	SiO3 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 O2 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	O2 is a little low. SiO3 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	PO4 low, NO3 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	O2 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	PO4 appears high. Nutrient analyst: "NO3 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	SiO3 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 (NO3, SiO3, PO4)
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 SiO3 seems to follow that same pattern.

Station 016

Cast 1	No comments on the Sample Log. Nutrient analyst double checked entire SiO3 profile.
128-131	Footnote CTDO questionable 0-230db.
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

131	Footnote CTDO questionable 0-60db.
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: "O2 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	NO3 appears low, SiO3 low and O2 high. Nutrient Analyst: "No analytical problem noted, different water perhaps."

Station 018

124	Oxygen high and nutrients (NO3, SiO3,PO4) 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	NO3 and PO4 appear high. Nutrient Analyst: "Gradient here, probably real."
119	Salinity is high compared with CTD. No analytical problem found. Oxygen is high. NO3 and PO4 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	SiO3 low. Nutrient analyst: "No analytical problem found. Agrees with 102 and 103 which it should." Data are acceptable.
Station 020	
128-131	Footnote CTDO questionable 0-164db.
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	SiO3 ˜0.6 high. Nutrient analyst: "No analytical problem noted." SiO3 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."
125	Footnote CTDO bad 492-626db.
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	PO4 ˜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 O2 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	SiO3 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. Footnote CTDO questionable 80-104db.
116	Salinity appears low compared to CTD. But, plotted vs Pot.Temp., 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. SiO3, 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 O2 sensor cover." No CTDO reported.
122	SiO3 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	NO3 and PO4 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 evidently 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.
129-131	Footnote CTDO questionable 0-126db.
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	
127-128	Footnote CTDO questionable 0-104db.
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	NO3 and PO4 appear high. Feature does not show in S, O2, or SiO3. 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 (NO3, PO4 SiO3) high.
109	Delta-S at 1110db is -0.0076. No analytical problem noted.
Station 032	
Cast 1	No comments on the Sample Log.
115-117	Footnote CTDO questionable 0-74db.
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 PO4 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: "NO3, PO4, but not silicate show similar (high) feature, low CFC-11-12 also, likely real." Nutrient Analyst: "SiO3 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 (NO3, PO4, SiO3) 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.
124	Footnote CTDO questionable 0-32db.
120-121	Nutrients appear to be switched on NO3 vs. PO4 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.
122-124	Footnote CTDO questionable 0-62db.
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	SiO3 high, Oxygen low. Data are acceptable.
Station 046	
Cast 1	No comments on the Sample Log.
119	Footnote CTDO questionable 0-36db.
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 NO3 and PO4 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 (NO3, SiO3,PO4) 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	SiO3 low ˜0.9. Nutrient analyst: "Looks the same as Sta 051, in mixed layer."
102-103	SiO3 0.4 low, within specs of the measurement. Nutrient analyst: "No problem noted."
101	PO4 0.05 high, O2 low. PO4 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. SiO3 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	O2 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

123-124	Footnote CTDO questionable 0-38db.
117	Oxygen: "PC locked up, sample lost."
114	Oxygen low, nutrients (NO3, PO4, SiO3) high. Data are acceptable.
108	Sample Log: "Leaking when valve opened." Oxygen and other data are acceptable. Delta-S 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.
101	Footnote CTDO questionable 2066-2104db.

Station 055

Cast 1	No comments on the Sample Log.
110	O2 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.
108	Footnote CTDO bad 1098-1140db.

Station 056

Cast 1	No comments on the Sample Log.
119-121	Footnote CTDO questionable 0-80db.
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	O2 low. PI: "Or 109 O2 high? but both match upcast. Freon not sampled at all bottles. Oxygen is acceptable."

Station 057

Cast 1	No comments on the Sample Log.
116-117	Footnote CTDO questionable 140-240db.
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 O2 thermometer."
113-115	Footnote CTDO questionable 0-152db.
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. NO3 and PO4 look okay on property plots and the N:P plot agrees with Station 068. Footnote CTDO questionable 0-100db.

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 SiO3 which is also high. Oxygen also agrees with CTDO trace.

Station 066

Cast 1	No comments on the Sample Log.
101-102	PO4 and SiO3 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.

122-124	Footnote CTDO bad 0-106db.
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."
121-123	Footnote CTDO questionable 0-134db.
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.
101	Footnote CTDO bad 2806-2840db.
Station 070	
121-124	Footnote CTDO bad 0-192db.
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.
119-120	Footnote CTDO bad 0-42db.
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.
118-120	Footnote CTDO bad 0-100db.
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.
119-121	Footnote CTDO bad 0-138db.

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.
101	Footnote CTDO questionable 2240-2272db.
Station 075	
Cast 1	No comments on the Sample Log.
108	Nutrients low, O2 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	SiO3 appears low compared with following stations, it agrees with previous stations. Data are acceptable.
Station 077	
Cast 1	No comments on the Sample Log.
119-120	Footnote CTDO questionable 0-48db.
Station 078	
Cast 1	No comments on the Sample Log.
113-116	Footnote CTDO bad 0-160db.
Station 079	
Cast 1	No comments on the Sample Log.
114	Footnote CTDO bad 0-26db.
109	Oxygen: "Sample lost." No further explanation.
Station 080	
Cast 1	No comments on the Sample Log.
119-120	Footnote CTDO bad 0-64db.
113	Oxygen high, feature is also in nutrients-low. CTDO also indicates high O2. Oxygen is acceptable.
106	Oxygen appears low, corresponding high feature not seen in nutrients. CTDO also indicates high O2.
101	Oxygen appears high, corresponding low feature not seen in nutrients. CTDO also indicates high O2.
101-104	NO3 and PO4 a little higher than previous stations, looks okay on N:P plot.
Station 081	
121	Footnote CTDO bad 0-30db.
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, O2 low, but salinity and O2 agree with CTD.
108	Sample Log: "Vent leaking." Oxygen as well as other data are acceptable.
108-113	SiO3 slightly higher than adjoining stations, NO3 too. PO4 appears low. Nutrient Analyst: "PO4 okay, N:P's look normal.

Station 082	
Cast 1	No comments on the Sample Log.
120-122	Footnote CTDO bad 0-122db.
Station 083	
128	Sample Log: "3 micro-rinses on salinity." Salinity is acceptable.
124-128	Footnote CTDO questionable 0-280db.
113-116	Problem with the run, it appears to have shifted according to the data, but the shift does not show in the peaks. SiO3 is questionable.
Station 084	
Cast 1	No comments on the Sample Log.
119-125	Footnote CTDO bad 0-510db.
103	PO4 too high. Nutrient Analyst: "Higher on trace as well-doesn't look right-maybe contaminated? PO4 is questionable." PI: "Code PO4 bad."
Station 085	
Cast 1	No comments on the Sample Log.
121-125	Footnote CTDO bad 0-312db.
117	Duplicate O2 drawn. SiO3 1.0 low. Nutrient Analyst: "Okay on chart, peak okay. Agrees with Station 084 as well. Gradient area. SiO3 is acceptable."
101	Delta-S at 2959db is 0.0078. Bottle salinity is acceptable. Large spikes in CTD data.
Station 086	
Cast 1	No comments on the Sample Log.
122-127	Footnote CTDO bad 0-288db.
119	Triplicate O2 drawn.
104	Delta-S at 2751db is 0.0025. PI: "Noisy CTD profile, so okay." Footnote CTD salinity despiked.
103	Delta-S at 2821db is 0.0057. PI: "Noisy CTD profile, so okay." Footnote CTD salinity despiked.
102	Delta-S at 2862db is 0.0044. PI: "Noisy CTD profile, so okay." Footnote CTD salinity despiked.
101	Delta-S at 2908db is -0.0073. PI: "Noisy CTD profile, so okay." Footnote CTD salinity despiked.
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.
125-127	Footnote CTDO bad 0-102db.
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.
101	Footnote CTDO questionable 2170-2182db.
Station 090	
Cast 1	No comments on the Sample Log.
118-123	Footnote CTDO bad 0-444db.
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	Footnote CTDO bad 1786-1798db.
Station 091	
Cast 1	No comments on the Sample Log.
Station 092	
Cast 1	No comments on the Sample Log.
118	Footnote CTDO questionable 0-34db.
Station 093	
Cast 1	No comments on the Sample Log.
101	Footnote CTDO questionable 506-516db.
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.
109-110	Footnote CTDO questionable 0-44db.
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. Footnote CTDO bad 0-18db.
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 O2 drawn. Footnote CTDO questionable 748-772db.

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. Footnote CTDO bad 0-40db.
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: "NO3 and PO4 are acceptable."
101	Footnote CTDO questionable 426-448db.

Station 098

Cast 1	No comments on the Sample Log.
108	Footnote CTDO questionable 0-12db.

Station 099

Cast 1	No comments on the Sample Log.
109-110	Footnote CTDO questionable 0-66db.

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

119-121	Footnote CTDO questionable 0-78db.
106	PO4 low, NO3 low vs other stations, but SiO3 is not. Nutrient analyst: "Yes, SiO3 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." Footnote CTDO questionable 0-40db.

Station 104

129	O2 appears high compared to adjoining stations, PO4 and NO3 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 O2 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 O2 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	O2 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. O2 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	NO3 low. Nutrient Analyst: "Reanalyzed data and made a correction to NO3. 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.
127-128	Footnote CTDO questionable 0-36db.

Station 107

126-128	Footnote CTDO questionable 0-68db.
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.
126-129	Footnote CTDO questionable 0-166db.
122	Triplicate O2 drawn.
111	Delta-S at 2119db is 0.0027. Autosal diagnostics do not indicate a problem. Gradient area. Salinity is acceptable.

110	Triplicate O2 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."
128-130	Footnote CTDO bad 0-62db.
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.
101-102	Footnote CTDO questionable 3010-3086db.
101	NO3 low. Nutrient Analyst: "Corrected data. NO3 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.
101	Footnote CTDO questionable 3188-3212db.
Station 111	
Cast 1	No comments on the Sample Log.
119	Oxygen appears high, CTDO indicates higher oxygen is acceptable. PO4, SiO3 and NO3 low verifying this as a real feature.
101-102	Footnote CTDO questionable 2608-2722db.
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.
101	Footnote CTDO questionable 2476-2508db.

Station 115	
Cast 1	No comments on the Sample Log.
101	Footnote CTDO questionable 1968-2010db.
Station 116	
Cast 1	No comments on the Sample Log.
122-123	Footnote CTDO bad 0-46db.
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	SiO3 low, and so is NO3. Data are acceptable.
109	Triplicate O2 drawn.
102	Triplicate O2 drawn.
Station 118	
Cast 1	No comments on the Sample Log.
101-102	Low SiO3, NO3 and PO4 also show this low feature and O2 a little higher than adjoining stations.
Station 119	
Cast 1	No comments on the Sample Log.
131	Footnote CTDO questionable 0-6db.
119	Low NO3 and PO4, but SiO3 does not show this low feature. Nutrient Analyst: "No analytical problems. NO3 and PO4 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. Footnote CTDO questionable 4332-4352db.
Station 120	
Cast 1	No comments on the Sample Log.
128	Triplicate O2 drawn.
126	Low nutrients, O2 slightly high. Data are acceptable.
Station 121	
Cast 1	No comments on the Sample Log.
128-129	Footnote CTDO questionable 0-54db.
124	Nuts appear high. CO2 reports bottle problem. O2 low but CTDO confirms O2 is acceptable. Salinity agrees with CTD. Data are acceptable.
101-103	SiO3 appears low. PO4 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 O2 drawn.
123	O2 low, nutrients high, salinity agrees with CTD. Data are acceptable.
118	Triplicate O2 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.
130-131	Footnote CTDO questionable 0-54db.
113	Oxygen high compared with adjoining stations. Nutrients are low. Data are acceptable. Footnote CTDO questionable 1924-1980db.
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.
101	Footnote CTDO questionable 4028-4056db.

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.
125-130	Footnote CTDO questionable 0-264db.
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 O2." O2 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	SiO3 appears low compared to adjoining stations, doesn't show in PO4 or NO3, but O2 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.
126-127	Footnote CTDO bad 0-36db.
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 O2 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." O2 does appear slightly high. Footnote O2 questionable.
127	Oxygen: "bad end point." O2 appears to be acceptable, agrees with CTDO and station profile.
122	Oxygen: "Overtitrated (No EP)." O2 appears a little low, but in gradient area. Oxygen is acceptable.
120	Oxygen: "Overtitrated (No EP)." O2 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)." O2 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)." O2 appears okay on station profile and agrees with CTDO. Oxygen is acceptable.
101	Footnote CTDO questionable 4018-4048db.

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 O2 drawn.
101-107	SiO3 may be high. Compared with adjoining stations and Station 034 and 031, it appears to be acceptable.
101-102	Footnote CTDO questionable 3496-3544db.
Station 133	
Cast 1	No comments on the Sample Log.
121	Oxygen appears high, nutrients low. O2 agrees with CTDO.
101	Footnote CTDO questionable 3180-3294db.
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 O2 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.
123-124	Footnote CTDO bad 0-50db.
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.
101	Footnote CTDO questionable 3040-3072db.
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.
101	Footnote CTDO questionable 2506-2560db.

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 O2 drawn.
101-102	Footnote CTDO questionable 2346-2444db.
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.
117-118	Footnote CTDO questionable 0-78db.
101	Footnote CTDO bad 1772-1786db.

Station 140

Cast 1	No comments on the Sample Log.
117-118	Footnote CTDO questionable 0-34db.
109	Delta-S at 656db is -0.014. No analytical problem noted. Gradient area, feature in the CTD trace. Data are acceptable.
101	Footnote CTDO bad 1726-1808db.

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.
101	Footnote CTDO questionable 1942-1968db.

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 O2 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.
120-121	Footnote CTDO questionable 0-40db.
114	Oxygen is high and nutrients are low. Data are acceptable.

Station 144

Cast 1	No comments on the Sample Log.

120-124	Footnote CTDO bad 0-192db.
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 O2 drawn.
102	Triplicate O2 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. Footnote CTDO questionable 2648-2688db.

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.
103	Footnote CTDO questionable 2610-2740db.
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.
121-124	Footnote CTDO bad 0-146db.
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. Footnote CTDO questionable 2602-2648db.

Station 148

Cast 1	No comments on the Sample Log.
118-120	Footnote CTDO questionable 0-84db.
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.
120-122	Footnote CTDO bad 0-100db.
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.
116-119	Footnote CTDO questionable 0-154db.
115	High O2. 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. Footnote CTDO questionable 1828-1836db.
101-102	Nutrients high, O2 low. Feature is real.

Station 151

Cast 1	No comments on the Sample Log.
115-117	Footnote CTDO questionable 0-112db.
102	Triplicate O2 drawn.

Station 152

Cast 1	No comments on the Sample Log.
115-117	Footnote CTDO bad 0-72db.
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.
101-103	No bottle oxygen data for fit, use corrections from nearby cast. Footnote CTDO questionable 0-1086db.
216	Sample Log: "Not enough water for salinity."
215-216	Footnote CTDO questionable 0-36db.
213	Oxygen: "Overtitrate, (No End Point)." Oxygen is acceptable.
211	O2 appears high on station profile, but CTDO also shows this high feature. Oxygen is acceptable.

APPENDIX E

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	
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	

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	
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 49
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	
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 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 Station 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	
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

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	
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	
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	

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	
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

WHPO Data Check

a24_ct1.zip
a24_hy1.csv

About the '_check.txt', '_sal.ps' and '_oxy.ps' files:

The WHP-Exchange format bottle and/or CTD data from this cruise have been examined by a computer application for contents and consistency. The parameters found for the files are listed, a check is made to see if all CTD files for this cruise contain the same CTD parameters, a check is made to see if there is a one-to-one correspondence between bottle station numbers and CTD station numbers, a check is made to see that pressures increase through each file for each station, and a check is made to locate multiple casts for the same station number in the bottle data. Results of those checks are reported in this '_check.txt' file.

When both bottle and CTD data are available, the CTD salinity data (and, if available, CTD oxygen data) reported in the bottle data file are subtracted from the corresponding bottle data and the differences are plotted for the entire cruise. Those plots are the' _sal.ps' and '_oxy.ps' files*.

Following parameters found for bottle file:

EXPOCODE	DEPTH	SILCAT	CFC-12_FLAG_W
SECT_ID	CTDPRS	SILCAT_FLAG_W	TCARBN
STNNBR	CTDTMP	NITRAT	TCARBN_FLAG_W
CASTNO	CTDSAL	NITRAT_FLAG_W	PCO2
SAMPNO	CTDSAL_FLAG_W	NITRIT	PCO2_FLAG_W
BTLNBR	SALNTY	NITRIT_FLAG_W	ALKALI
BTLNBR_FLAG_W	SALNTY_FLAG_W	PHSPHT	ALKALI_FLAG_W
DATE	CTDOXY	PHSPHT_FLAG_W	PH
TIME	CTDOXY_FLAG_W	CFC-11	PH_FLAG_W
LATITUDE	OXYGEN	CFC-11_FLAG_W	PCO2TMP
LONGITUDE	OXYGEN_FLAG_W	CFC-12	CTDRAW
THETA			

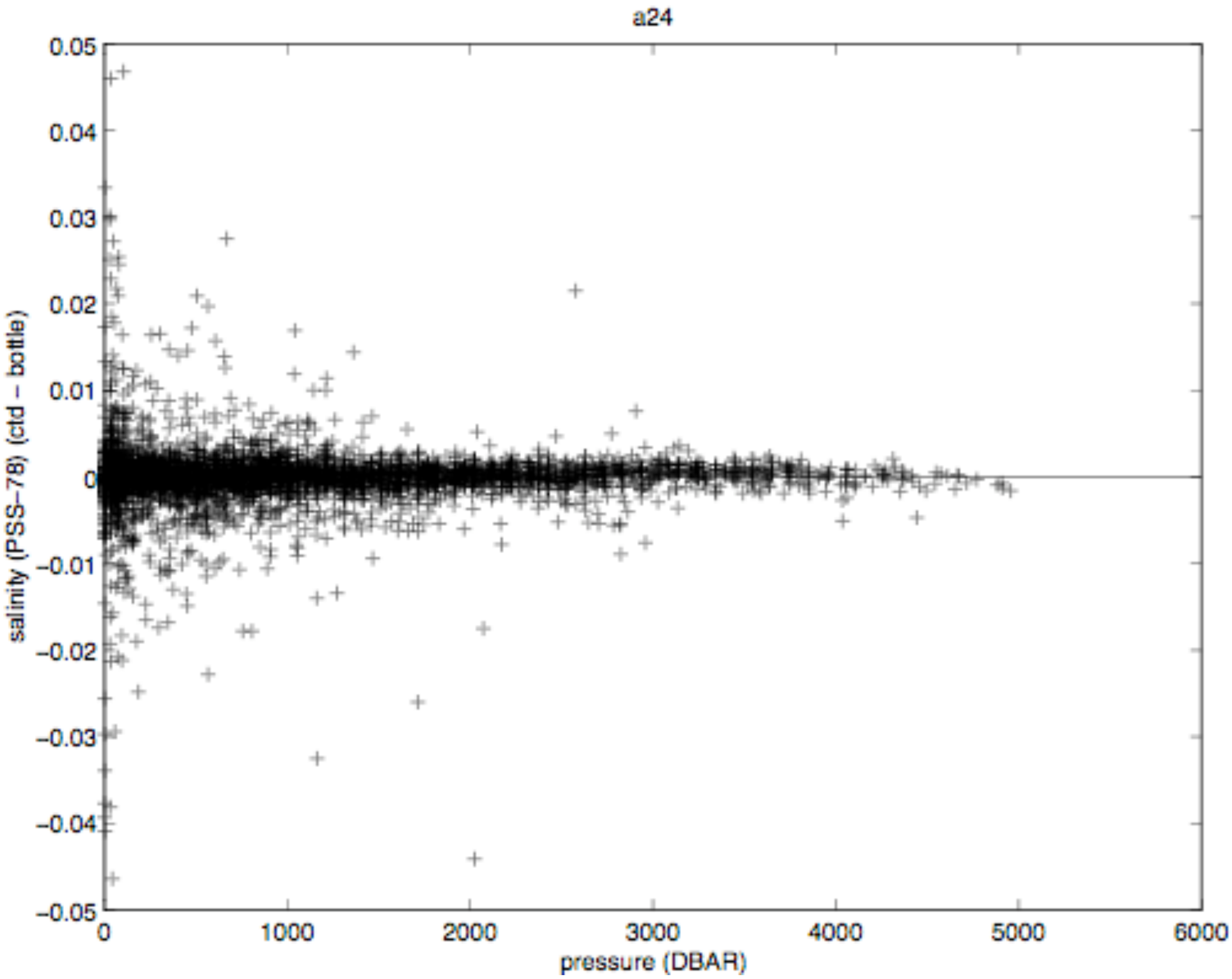
All ctd parameters match the parameters in the reference station.
All stations correspond among all given files.

No bottle pressure inversions found.
Bottle file pressures are increasing.

a24_hy1.csv -> contains stations with multiple casts:
station-> 153:
2 casts.

*_oxy.ps is not available

WHPO Data Check



CCHDO Data Processing Notes

Date	Contact	Data Type	Data Status Summary
03/18/98	Talley	Cruise Report	Submitted: Data Update
	I have revised the A24 doc file (a24do.txt). I have added cruise summary information to the front, very slightly reorderd the information in the narrative section, including the tables, and removed the page separators. I have placed the edited file in the imani ftp site. Please replace the version in the website table with this one.		
02/22/00	Diggs	CFCs	Submitted: by Weiss/Salameh
	To the best of my knowledge (and our database's) we did not receive any updated CFC values from you until today. We realize how important the CFC synthesis is, so I will put merging these data at the top of the list.		
02/22/00	Diggs	CFCs	Submitted; sent to D.Newton to merge
	In the list of things to do, there are new CFCs from Weiss/Salameh for A24 ready to be merged. They are in the following directory (I converted them already to WOCE format for your program and ran the file through WOCECVT)		
02/28/00	Huynh	Cruise Report	Website Updated: txt doc online
	pdf file is waiting for figures from Lynne Talley and the txt file is up.		
02/29/00	Newton	CFCs	Update needed: replicate values

	"I'm merging the updated WOCE A24 CFC data you sent Steve Diggs on Feb 22. I've encountered a small problem that you'll need to resolve.
	
	At the very end of file "woce-a24.cfc" you sent is this fragment:
	`153 2 14 64 1.463 2.769 22`
	`153 2 15 35 1.443 2.724 22`
	`153 2 16 2 1.404 2.627 22`
	`153 2 16 2 1.406 2.619 22`
	As you can see there are two station 153 cast 2 bottle 16 values. I can't merge them both.		

03/06/00	Huynh	Cruise Report	Website Updated: pdf & txt docs online
	Both txt and pdf doc versions are up		
03/13/00	Salameh	CFCs	Data Update: replicate value fixed
	Sorry it's taken me so long to get back to you on this! My software is supposed to take means of replicate samples before creating the file for WHPO, but obviously there is a bug when the replicate sample happens to be the last one in the list. I have now fixed the problem and attached a new version of the data file.		
03/13/00	Swift	CTD/BTL	Data are Public
	Please make the CTD and S/O2/nut data from the Talley A24 line public (and unencrypted), as per the message just received from Lynne. Thanks. Jim - funny you should ask minutes after Worth's note about making A24 public. I told him that A24 should be public now, so please have Steve make the necessary changes. I would be interested in seeing what you find for the EGS. Lynne		
03/14/00	Weiss	CFCs	Website Updated: Status changed to Public

CCHDO Data Processing Notes

Date	Contact	Data Type	Data Status Summary
03/14/00	Newton	CFCs	Website Updated: Data Online
	I received the correct a24 cfc file from Peter Salameh and have merged it. On whpo INCOMING please find: a24cfcmerg.tar.Z it contains the merged file, the corrected CFCs, and my notes. a24cfc_weiss_salameh_wocefmt.2000.02.24.txt on whpo in onetime/atlantic/a24/original/2000.02.23.A24.WEISS_SALAMEH.CFC is bogus (Quality codes not reordered with data). a24_cfc_salameh.2000.02.21.txt in that same directory contains an error at the last bottle (replicates not averaged) Those two files should be deleted/buried . -david Notes on merging CFC into A24 EXPOCODE 316N151/2 WHP-ID A24 merging went fine. no problems. D. Newton 13Mar2000		
03/22/00	Chapman	CTDO/NUTS/CFCs	Data are Public
	ar24: no tracers; a24: BTL data pubic. I asked Mke Mccartney what, if any data were taken on AR24 other than CTDO data. He said that no tracer data were collected on either of these repeat cruises, and that nutrients were collected only on the first of them. Thus, it seems as though the only tracer data collected in this region were on the A24 cruise when Lynne Talley was chief scientist. Her latest message, and one from Ray Weiss, state that the CTDO, nuts and CFC data should all be public now.		
03/24/00	Diggs	CTD/BTL	Website Updated: files online, public
03/24/00	Schlosser	He/Tr	Data are Public; NOT FINAL
	as mentioned in my recent message, we will release our data with a flag that indicates that they are not yet final. We started the process of transferring the data and we will continue with the transfer during the next weeks. I had listed the expected order of delivery in my last message.		
07/10/00	Huynh	Cruise Report	Website Updated:
	pdf, txt versions updated, online		
02/08/01	Kappa	Cruise Report	Update Needed
	Replace online ODF report w/ Orig. ODF report		
04/06/01	Uribe	CTD/BTL/SUM	Website Updated: expocodes corrected
	Expocodes for sum and bottle were modified. Expocodes in all ctd files have been editted to match the underscored expocode in the sum and bottle files New files were zipped and replaced existing ctd files online. Old files were moved to original directory.		
05/04/01	Kozyr	ALKALI/TCARBN	Final Data Submitted; also CO2/pH/PCO2
	I have put the final CO2-related data files for the N. Atlantic Ocean WOCE Sections A20, A22, and A24 to the WHPO ftp INCOMING area. There are 4 CO2 parameters: Total CO2, Total Alkalinity, pH, and pCO2 (with pCO2 temp) with quality flags. Note, that these data are different from those you have in your data base for these cruises on WHPO web site. Please confirm the data submissio		
06/20/01	Uribe	BTL	Website Updated: Exchange file online
	Bottle file in exchange format has been linked to website.		

CCHDO Data Processing Notes

Date	Contact	Data Type	Data Status Summary
06/21/01	Uribe	CTD/BTL	Website Updated: New Exchange files online
	The exchange bottle file name in directory and index file was modified to lower case. CTD exchange files were put online.		
12/03/01	Muus	BTL/CO2	Website Updated: New CSV & BTL files
	Merged Carbon data received from A. Kozyr, May 2001, into bottle file and placed on web together with new exchange file. REVPRS and REVTMP columns deleted. Notes on A24 Carbon merging Dec 3, 2001. D. Muus 1. New TCARBN, ALKALI, PH, PCO2, and PCO2TMP from: /usr/export/html-public/data/onetime/atlantic/a24/original /2001.05.04_A20_A22_A24_CARBON_KOZYR/a24carb_wocefmt.txt Merged into SEA file from web Nov 30, 2001 (20010406WHPOSIOKJU) No QUALT2 words in SEA file or new data file so added QUALT2 identical to QUALT1 after merging. 2. REVPRS and REVTMP columns removed. No reversing thermometers used. 3. Exchange file checked using Java Ocean Atlas.		
12/17/01	Hajrasuliha	CTD/BTL	Internal DQE completed: summery of errors
	The following are results from the examminer.pl and plotter.pl code that were run on this cruise. Not all of the errors are reported but rather a summery of what was found. For more information you can go to the cruise directory, and look at the NEW file called CruiseLine_check.txt. Two plot files are also present. _oxy.ps and _sal.ps _oxy.ps and _sal.ps files are created for the cruise. No problems found in the BOTTLE and CTD file.		
12/20/01	Uribe	CTD	Website Updated: Exchange file online
	CTD has been converted to exchange using the new code and put online.		
04/10/02	Lebel	CFCs	Submitted Data ARE FINAL
	The data disposition is: Public The file format is: Plain Text (ASCII) The archive type is: NONE - Individual File The data type(s) is: Other: final CFC data The file contains these water sample identifiers: Cast Number (CASTNO) Station Number (STATNO) Bottle Number (BTLNBR) Sample Number (SAMPNO) LEBEL, DEBORAH would like the following action(s) taken on the data: Merge Data Place Data Online Update Parameters Any additional notes are: These are the final CFC data, including QUALT2 word. Scale is SIO98, units are pmol/kg. Data were recalibrated last fall, and these changes are incorporated as well.		
08/20/02	Diggs	TCARBN/CFCs	Website Updated: data are final
	Merged TCARBN (Kozyr: 20020820), and FINAL cfc-11 and cfc-12 values from D. Lebel (20020410). Made new bottle Exchange files and NetCDF, as well as inventory files.		
12/13/02	Kozyr	CFCs	Update Needed CFCs missing values
	I've noticed that CFCs missing values in the A24 bottle data file a24hy.txt are -9.074 (CFC11) and -9.048 (CFC12). Seems like it has happened when one added a constant correction for all cfc numbers. Same in the a24_hy.csv file.		
02/10/03	Diggs	He/Tr	Submitted Excel and CSV files
	Excel files and CSVs submitted and placed in home directory. Excel files (along w/ CSVs) were submitted to ODF email address and decoded and placed in home directory for A24 data files.		

CCHDO Data Processing Notes

Date	Contact	Data Type	Data Status Summary
02/12/03	Anderson	He/Tr/CFCs	Website Updated: Data Online

Merge Notes:

Alex Kozyr noted that the missing values for cfc11 was -9.074 and for cfc12 -9.048. These were the values in the file 20020410.123042_LEBEL_A24_a24.dat from Lebel found in original/20020410.123042_LEGEL_A24 that S. Diggs merged into the online file 20011130WHPOSIODM on Aug. 20, 2002.

I changed the missing values to -9.000 for cfc11 and cfc12.

Bottle: (cfc-11, cfc-12, tritum, helium, delhe3, triter, helier, delher, qualt1, qualt2)

Merged the HELIUM, HELIER, DELHE3, DELHER, TRITIUM, and TRITER sent to S. Diggs from B. Newton found in file.

A24_helium_tritium.csv found in original/20020522_A24_HE-TR_NEWTON into the online file 20011130WHPOSIODM (This is the file that S. Diggs merged the carbon and cfcs into, but he apparently didn't change the time stamp.

Sarilee Anderson

Date	Contact	Data Type	Data Status Summary
09/22/03	Kozyr	Cruise Report	CO2 report online @ CDIAC

The ORNL/CDIAC-143, NDP-082: "Carbon Dioxide, Hydrographic, and Chemical Data Obtained During the R/V Knorr Cruises in the North Atlantic Ocean on WOCE Sections AR24 (November 2 - December 5, 1996) and A24, A20, and A22 (May 30 - September 3, 1997)" is now available online through CDIAC web page:

http://cdiac.ornl.gov/oceans/doc.html

The hard copy is in production department and will be sent to you soon. Please let me know if you have any comments. Special thanks to Ken Johnson: even after retirement, he continues to supply CDIAC with all information needed for this and other NDPs.

Date	Contact	Data Type	Data Status Summary
10/18/06	Johnson	Cruise Report	Submitted Final cruise report

The documentation files have been updated with post-cruise info and final comments.

Date	Contact	Data Type	Data Status Summary
10/18/06	Johnson	CTD/BTL/SUM	Submitted; Data are Final

Final A24/ACCE data are now ready to go, with calibrations checked, CTDOXY data refit, and CTD data despiked as warranted. CTD data are coded for despiking and problems, and a few bottle quality codes were updated (codes for CTD data in the bottle files). Kristin gave us an updated bottle file with the final quality codes and CTD data, and an updated .sum file with theancillary codes added. The documentation files have been updated with post-cruise info and final comments.

These were older cruise data without the database, so we do NOT have exchange formats available. However, Steve Diggs said he could handle that for us.

Since all of the WOCE data have been declared public by the WHPO, the files are available for immediate access.

`CTDPRS CTDTMP CTDSAL CTDOXY THETA SALNTY OXYGEN SILCAT NITRAT NITRIT PHSPHT`

CCHDO Data Processing Notes

Date	Contact	Data Type	Data Status Summary
11/03/06	Johnson	Cruise Report	Submitted updated cruise report
	I caught a buglet in the documentation - Appendix A, the T(t**1) column was wrong and wasn't separated from the first column in the plain-text version. It's now fixed; the difference in the value is fairly negligible, but when I noticed the bug while doing something else, I thought I should correct it. I re-did the main ftp releases, but also made one with JUST the documentation files. You can find the doc-files at: ftp://odf.ucsd.edu/pub/HydroData/woce/a24.acce/ The files called a24final-doc.{zip,tar.gz} are the new doc. No data files have been altered, and only Appendix A in the doc has been updated.		
11/27/06	Kappa	Cruise Report	Website Updated: new cruise report
	New cruise report, pdf and ascii versions, include: * changes discussed in Mary Johnson's 11/03/06 email * CCHDO Data Processing Notes * Alex Kozyr's CO2 report * Hajrasuliha's CTD data check		