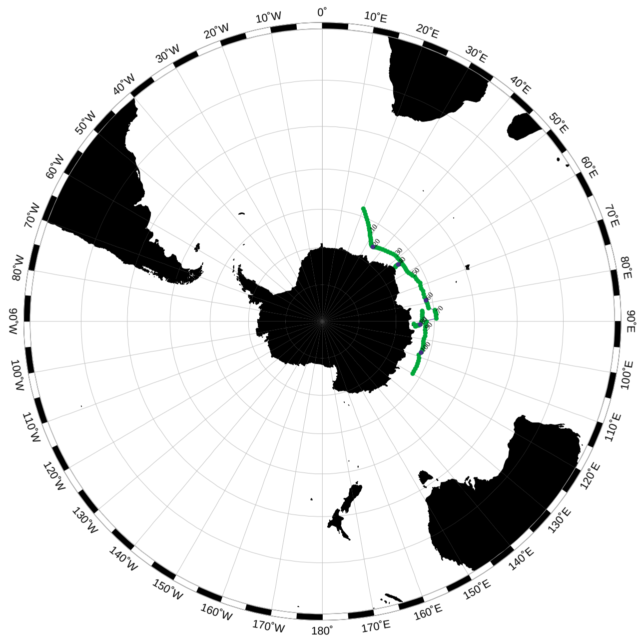
A. Cruise Report: S04I



A.1. Highlights

WHP Cruise Summary Information

WOCE line designation	**S04I**
Expedition designation (ExpoCode)	**320696_3**
Chief scientists and affiliation	**Thomas Whitworth III and James H. Swift***
Ship	RVIB NATHANIEL B. PALMER
Cruise dates	1996.MAY.03 - 1996.JUL.04
Ports of call	Cape Town, S. Africa - Hobart, Australia
Number of stations	108 full-depth CTD stations
Geographic boundaries	58° 0.23’ S 20° 0.34’ E 120° 0.08’ E 65° 41.97’ S
Floats and drifters deployed	17 ALACE floats
Moorings deployed or recovered	9 self-reporting current meter moorings

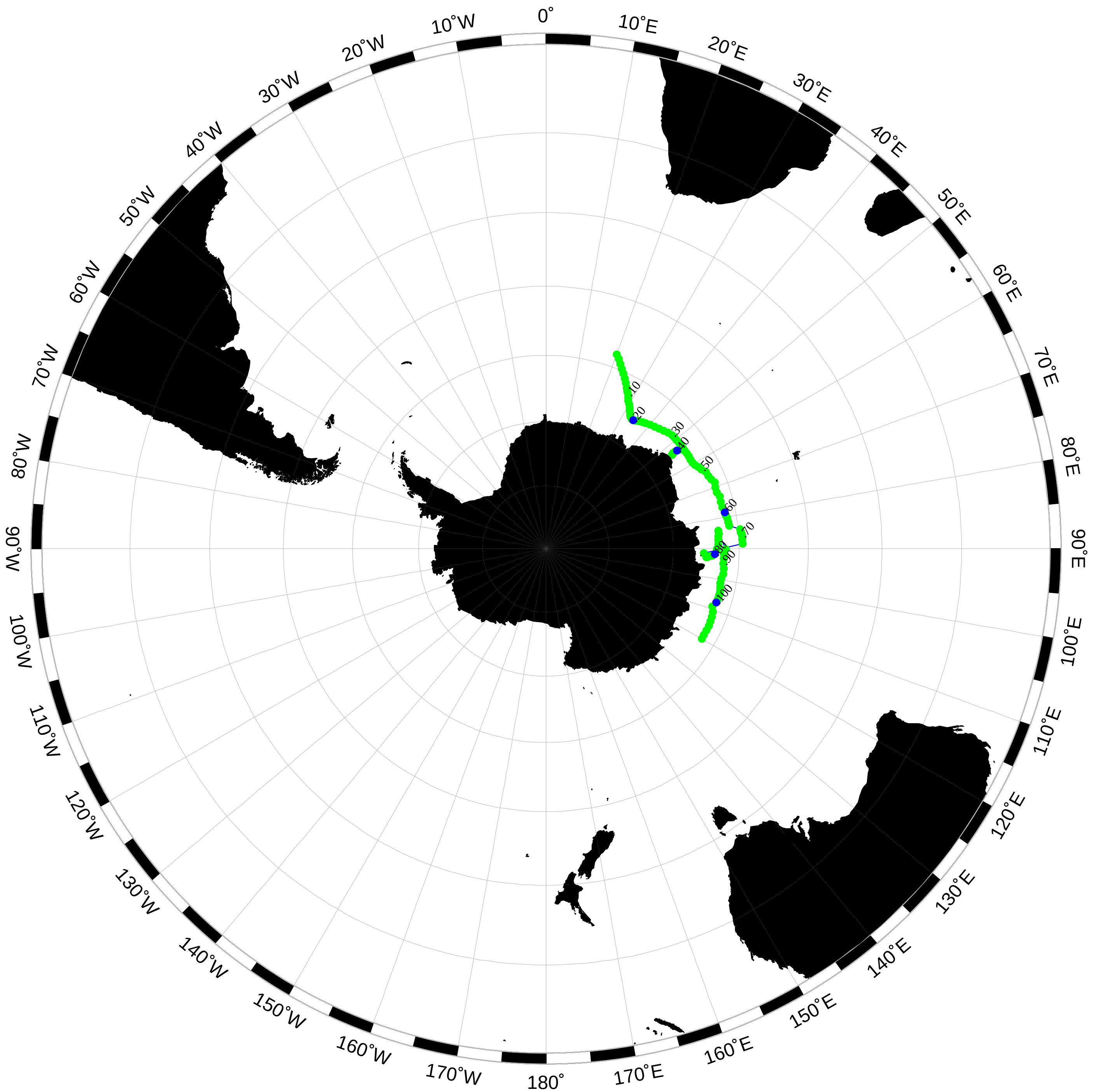
Thomas Whitworth III Department of Oceanography Texas A&M University College Station, TX, 77843 twhitworth@tamu.edu	James H. Swift Scripps Institution of Oceanography University of California, San Diego La Jolla, CA, 92093 jswift@ucsd.edu
Authors	S. Rutz, D. Chipman, M. Mensch, F. Delahoyd, D. Breger, R. Key, E. Peltola, T. Whitworth

WHP Cruise Data Locater

Instructions: Click on any item to locate primary reference(s) or use navigation tools above. Shaded items not available.

Cruise Summary Information	Bottle Data
Description of scientific program	Salinity
	Oxygen
Geographic boundaries of the survey	Nutrients
Cruise track PI SIO (figures)	CFCs
Description of stations	CO^2
Description of parameters sampled	Helium/Tritium/^{18}O
	Radiocarbon
Floats and drifters deployed	
Moorings deployed or recovered	
Principal Investigators for all measurements	
Cruise Participants	
Underway Data Information	**DQE Reports**
Navigation	CTD
Bathymetry	S/O_2/nutrients
Acoustic Doppler Current Profiler (ADCP)	CFCs
Thermosalinograph & related measurements	14C
Meteorological observations	
Atmospheric chemistry data	
Methodology and Calibrations	**References** **Acknowledgments**
CTD and hydrology measurements	HYD/BTL
CTD Instrumentation	AMS C14
CTD instrument calibrations	CTD
CTD and hydrology data collection techniques	
Water sampling methods	
Hydrology analytical methods	
	Data Processing Notes

Station locations for S04I: Whitworth/Swift: N.B. Palmer, 1996



Produced from .sum file by WHPO-SIO

WOCE Hydrographic Program Line S04I was conducted on the ***RVIB NATHANIEL B. PALMER*** on voyage S229 from 3 May to 4 July, 1996. The voyage began in Cape Town, Republic of South Africa, and ended in Hobart, Australia. Co-Chief Scientists for the cruise were Thomas Whitworth III/TAMU and James H. Swift/SIO.

WHP leg S04I was a cooperative effort among the PIs listed in Table 1. The members of the scientific party are listed in Table 2.

Table 1. Principal Investigators for WOCE S04I

Component	Principal Investigator	Institution
CTD/Hydrography	J. Swift	SIO
CFCs	W. Smethie/M. Warner	LDEO/UW
Tritium, ^{3}He, ^{18}O	P. Schlosser	LDEO
CO_2	T. Takahashi	LDEO
Alkalinity	F. Millero	Miami
^{14}C	R. Key	Princeton
current meters	W. Nowlin/T. Whitworth	TAMU
Transmissometer	W. Gardner	TAMU
LADCP	E. Firing/P. Hacker	UH
ALACE floats	R. Davis	SIO

Table 2. Participants on WOCE S04I

Participant	Affiliation	Responsibility
Isabelle Ansorge	UCT	CTD console, sampling, salinities
Dee Breger	LDEO	Tritium, ^{3}He, ^{18}O
Christie Campbell	ASA	deck ops, sampling, hazardous waste, salinities
Kent Chen	ASA	sampling, oxygen, NBP computer
David Chipman	LDEO	CO_2
Scott Colburn	ASA	PDR, sampling, NBP ET
Craig Hallman	ODF	deck ops, sampling, oxygen
Steve Covey	UW	CFCs
Frank Delahoyde	ODF	ODF systems, data q.c.
Bob Key	PU	^{14}C, gadfly
Leonard Lopez	ODF	deck ops, oxygen
Guy Mathieu	LDEO	CFCs
Carl Mattson	ODF	TIC, deck supv., ET
Rod McCabe	ASA	sampling, NBP computer
Manfred Mensch	LDEO	CFCs
Stacey Morgan	ODF	nutrients
Jim Noyes	SIO	CTD console, sampling

Participant	Affiliation	Responsibility
Alex Orsi	UW	CTD console, sampling, analysis
Ron Patrick	ODF	deck supv., bottle q.c.
Esa Peltola	UM	Alkalinity
Erik Quiroz	TAMU	nutrients
Blaine Reynolds	ASA	PDR, rosette prep., NBP ET
Stephany Rubin	LDEO	CO_2
Steve Rutz	TAMU	watch leader., CTD console, sampling, ADCP
Buzz Scott	ASA	deck ops., salinities, MT
Colm Sweeney	LDEO	CO_2
Jim Swift	SIO	watch leader., CTD console, sampling, analysis
Mark Talkovic	ASA	deck ops., salinities, MT
Tom Whitworth	TAMU	indirection, analysis
Kevin Wood	ASA	deck ops., sampling, MPC

ASA:	Antarctic Support Associates 61 Inverness Dr. East, Suite 300 Englewood, CO 80112	UM:	University of Miami (RSMAS) 4600 Rickenbacker Cswy. Miami, FL 33149
SIO:	Scripps Instit. of Oceanogr Univ. of Calif.-San Diego La Jolla, CA	LDEO:	Lamont-Doherty Earth Observatory Columbia University Palisades, NY 10964
TAMU:	Texas A&M University Dept. of Oceanography College Sta. TX 77843	UW:	University of Washington School of Oceanography Seattle, WA 98195
ODF:	Ocean Data Facility Scripps Instit. of Oceanog. 9500 Gilman Dr. La Jolla, CA 92093	UCT:	University of Cape Town Department of Ocenaography Rondebosch, Cape Town South Africa
PU:	Princeton University Dept. of Geosciences 207 Guyot Hall Princeton, N.J. 08544		

A2. Scientific Program Summary

Narrative

The cruise constituted the Indian Ocean portion of WOCE line S04, a meridional circumnavigation of Antarctica at a nominal latitude of 60° S. This segment covered the longitudes 20° E to 120° E.

After departure from Cape Town, a bottom-tracking course was set to provide about 8 hours of depths along the 200-m isobath to calculate the offset between the ship's gyro and the underway Acoustic Doppler Current Profiler (ADCP). Upon reaching deep water, the CTD wire was lowered to 5500 m wire out to tension the wire on the winch, and subsequently, two test CTD casts were made to choreograph the procedures for launching and recovering the package in the unfamiliar setting of the Palmer's Baltic Room.

At 0330 on 7 May, the Palmer turned back toward South Africa to seek medical attention for a crew member. The ship was diverted to the naval base at Simonstown where fuel was available, and the morning and afternoon of May 10 were spent getting the crewman treated and refueling. Bottom-tracking for the ADCP calibration was repeated into and out of Simonstown.

On Sunday, 12 May, a third CTD test cast was being recovered when a sudden wave lifted the rosette out of the water and then dropped it. The wire parted at the sheave, and the entire package was lost. The only piece of equipment without back-up was the lowered ADCP unit belonging to the University of Hawaii. Subsequent days were spent preparing a second rosette unit, considering alternative launch and recovery procedures and defining guidelines for the sea state in which CTD operations could be conducted on the Palmer. Because the Palmer reacted differently from UNOLS vessels we were accustomed to, the planned cruise track was modified to lie in, or closer to the ice where swell would be less of a problem.

Station 1 was occupied at 58° S, 20° E and the first station line was run southeast to Gunnerus Ridge, about 50 miles south of the ice edge. Station positions for the cruise are shown in Fig. 1. During the transit to station 1 and continuing to 58° S, 17 ALACE floats were launched. Details are provided in Table 3. Stations across the Enderby Abyssal Plain trended east-northeast from 66° S at 33° E, to 61° S at 83° E on the Kerguelen Plateau. A line of stations (35-42) was made north from the 500-m isobath on the continental slope at 53° E, and three self-reporting current meters were deployed along the slope. Details of the current meter deployments are given in Table 4. A line of stations (65-72) extending east from the crest of the Kerguelen Plateau was made at about 59° S, and three more current meters were placed in the boundary current on the eastern flank of the Plateau. On June 8, after station 72, science operations were suspended for seven days when the Palmer was diverted to Mirnyi Station in the Davis Sea to deliver emergency food supplies.

On June 14, the Palmer left Mirnyi and began a line of stations (73-86) from the shelf break of the Davis Sea to Kerguelen Plateau. One current meter was placed near the 3000-m isobath north of the Antarctic Continental Slope, and two were deployed at the southern end of Kerguelen Plateau. The zonal line of stations at a nominal latitude of 62°S was resumed at 90°E. Ice conditions, fuel and time considerations necessitated 45-mile station separation for most of the final 22 stations, which terminated with station 108 at 120° E.

Summary Information

108 full-depth CTD stations were made exclusive of test stations at the beginning of the cruise and a dedicated CFC archive-sample cast at the end of the cruise. Nine self-reporting current meters and 17 ALACE floats were deployed

Table 3. ALACE deployments on WOCE S04I

Ser#	Type	Lat	Long	Time/Date	Ser #	Type	Lat	Long	Time/Date
628	T	37-58.3 S	20-16.1 E	2056Z 5/4	641	Std	47-59.4 S	19-12.0 E	2221Z 5/13
346	Std	38-59.1 S	21-46.4 E	0610Z 5/5	642	Std	49-32.6 S	19-16.5 E	0700Z 5/14
629	T	39-59.1 S	21-46.1 E	1546Z 5/5	643	Std	50-59.8 S	19-20.7 E	1458Z 5/14
559	Std	40-59.4 S	21-42.2 E	2118Z 5/5	607	CTD	51-58.7 S	19-23.8 E	2045Z 5/14
634	Std	41-58.8 S	21-38.5 E	0228Z 5/6	644	Std	52-59.8 S	19-26.4 E	0224Z 5/15
566	Std	43-29.9 S	21-32.9 E	1040Z 5/6	608	CTD	54-30.0 S	19-31.7 E	1035Z 5/15
604	CTD	44-59.9 S	21-27.3 E	2042Z 5/6	645	Std	55-59.4 S	19-47.2 E	1855Z 5/15
640	Std	45-59.9 S	19-06.5 E	1118Z 5/13	609	CTD	57-30.0 S	19-58.6 E	0331Z 5/16
605	CTD	47-00.0 S	19-09.7 E	1651Z 5/13					

*T = temperature, Std = Standard, CTD = cond/temp/depth

Table 4. Self-reporting current meter deployments

CM§	serial #	time	date	latitude	longitude	depth	MAB*
A							
	26935	0732Z	28 May 96	65-22.8 S	53-14.2 E	1740 m	50
B							
	26939	1125Z	28 May 96	65-14.0 S	53-06.5 E	1900 m	50
C							
	26936	1904Z	28 May 96	65-07.0 S	52-59.6 E	2260 m	100
D							
	26937	1706Z	6 June 96	59-42.9 S	84049.9 E	2020 m	50
E							
	26941	2209Z	6 June 96	59-40.6 S	85-07.9 E	3080 m	50
F							
	26943	2231Z	6 June 96	59-40.3 S	85-10.9 E	4225 m	50
G							
	26944	1331Z	16 June	64-03.8 S	92-21.5 E	3275 m	100
H							
	26938	0614Z	19 June	63-00.0 S	85-00.0 E	3058 m	50
I							
	26940	1212Z	19 June	62-59.6 S	84-31.5 E	2740 m	50

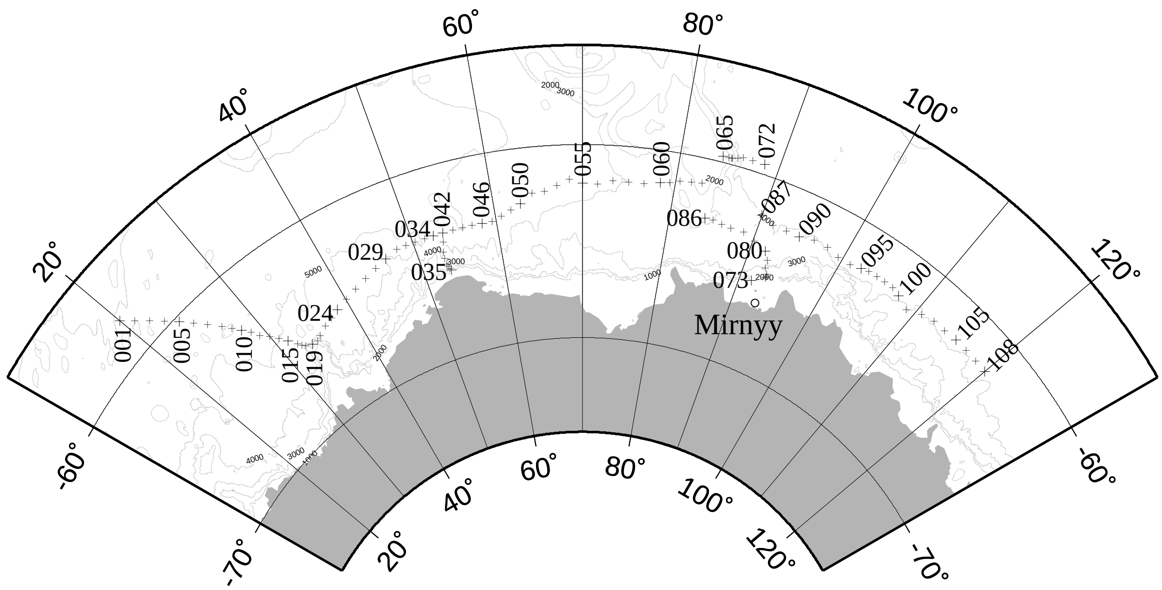
§ letters correspond to Fig. 1

* MAB = meters above bottom

World Ocean Circulation Experiment
Southern Indian Ocean S4I
R/V Nathaniel B. Palmer NBP96-3
3 May - 4 July 1996
Cape Town, South Africa - Hobart, Tasmania, Australia
Expocode: 320696_3

Co-Chief Scientists:

Dr. Thomas Whitworth (Texas A&M University)
Dr. James H. Swift (Scripps Institution of Oceanography)



S4I Cruise Track

Oceanographic Data Facility (ODF)
Final Cruise Report
1 August 2003

Data Submitted by:

Oceanographic Data Facility
Scripps Institution of Oceanography
La Jolla, CA 92093-0214
http://odf.ucsd.edu

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. 109 CTD/rosette casts were made at 108 stations, usually to within 5-15 meters of the bottom. Station 2 cast 1 was aborted at the surface because of signal failure at 322m on the down-cast; it is not otherwise mentioned in this release or documentation. Water was found inside the CTD case; after repairs, station 2 cast 2 was successfully accomplished.

17 ALACE floats were deployed during the transit from Cape Town to station 1. 9 expendable current meters were deployed following 8 stations along the cruise track.

The R/V Nathaniel B. Palmer departed from Cape Town, South Africa on May 3, 1996. One test cast was accomplished on May 6; on May 7, the ship turned back toward South Africa to seek medical attention for a crew member. The ship docked at the naval base at Simonstown on May 10, departing later the same day to resume the expedition. 2 more test casts were done during the transit. During the recovery of the second of these casts, a rogue wave lifted the rosette out of the water and then dropped it. The wire parted at the sheave, and the rosette package was lost. A backup rosette was prepared and used for the remainder of the cruise.

108 CTD/Rosette stations were occupied between May 16 and June 27 along the nominal S4I line (60°S), between 58-66 °S latitude and 20-120°E longitude. An additional line (stations 35-42) was made northward from the 500m isobath on the continental slope at 53°E back to the main track. There was a 6.5-day (June 8-14) diversion from the track after station 72 to deliver emergency food supplies to Mirnyy Station in the Davis Sea. After Mirnyy, an extra line (stations 73-86) was run northward, then westward, from the shelf break of the Davis Sea back toward the S4I line. The cruise ended in Hobart, Tasmania, Australia on July 4, 1996.

3655 bottles were tripped resulting in 3651 usable bottles. Any problems encountered during data acquisition or processing are described later in this document. The resulting data set met and in many cases exceeded WHP specifications. The distribution of samples is illustrated in Figures 1.0, 1.1 and 1.2.

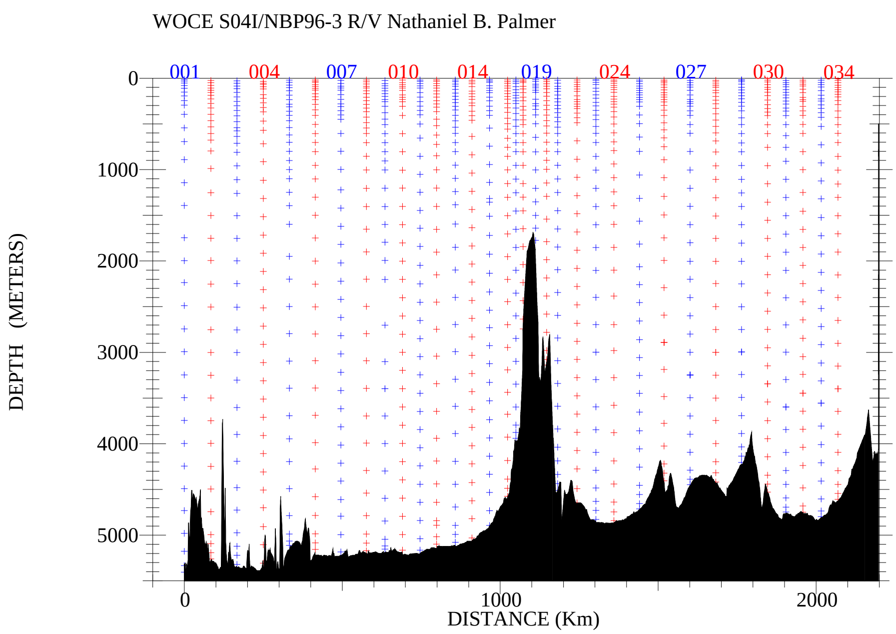


Figure 1.0 S4I sample distribution, stas 1-34.

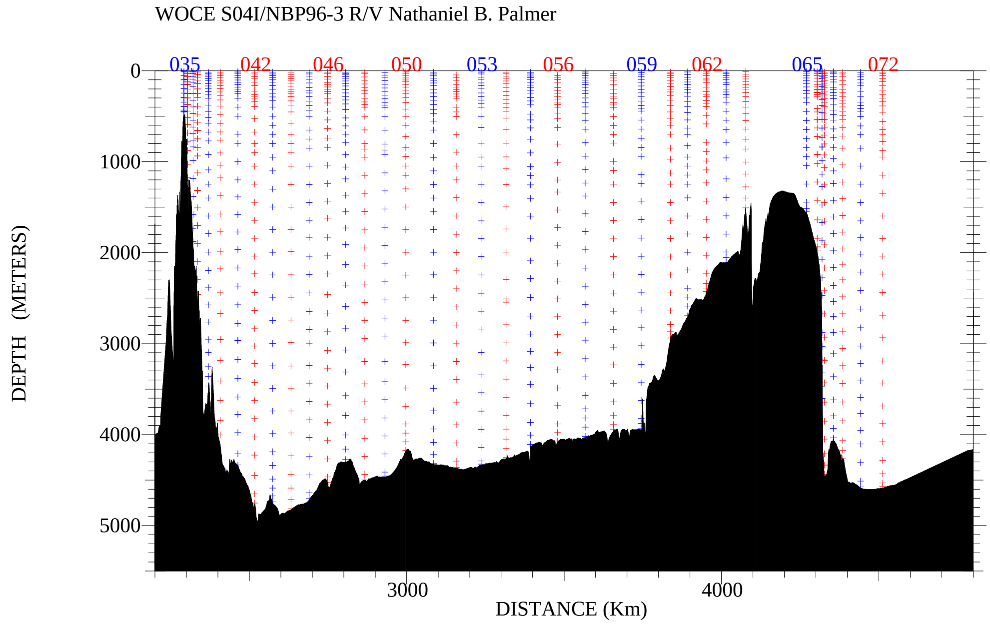


Figure 1.1 S4I sample distribution, stas 35-72.

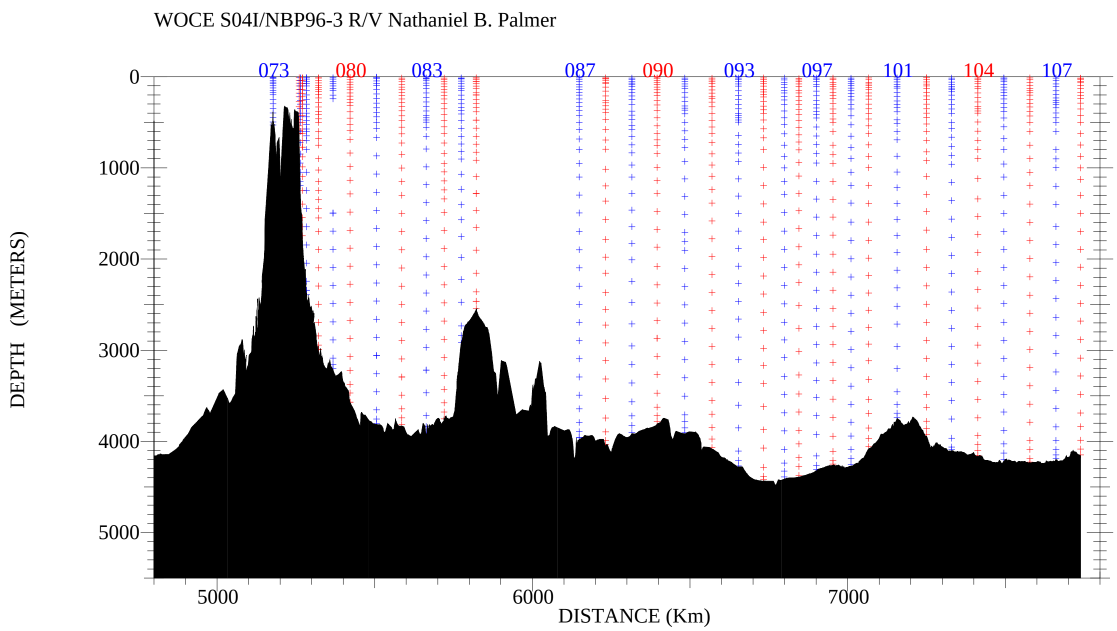


Figure 1.2 S4I sample distribution, stas 73-108.

2. Water Sampling Package

Hydrographic casts were performed with a rosette system consisting of a 36-bottle rosette frame (ODF), a General Oceanics (GO) 36-place pylon (Model 2216) and 36 10-liter PVC bottles (ODF). Underwater electronic components consisted of an ODF-modified NBIS Mark III CTD (ODF #3) and associated sensors, SeaTech transmissometer (TAMU) and Benthos pinger (Model 2216). The CTD was mounted horizontally along the bottom of the rosette frame, with the transmissometer, a SensorMedics dissolved oxygen sensor and an FSI secondary PRT sensor deployed next to the CTD. The pinger was monitored during a cast with a precision depth recorder (PDR) in the ship's laboratory. The rosette system was suspended from a three-conductor 0.322" electro-mechanical cable.

Power to the CTD and pylon was provided through the sea cable from the ship. Separate conductors were used for the CTD and pylon signals. The transmissometer, dissolved oxygen and secondary temperature were interfaced with the CTD, and their data were incorporated into the CTD data stream. Deep Sea Reversing Thermometers (DSRTs) were used occasionally on this leg to monitor for CTD pressure or temperature drift.

Three rosette test casts were performed prior to station 1: 998 (6 May), 997 (11 May) and 996 (12 May). During retrieval on the third test cast (996), a wave caught the rosette, and the wire jumped the sheave and broke. The rosette, bottles and all associated electronics were lost. The only instruments that did not have backup units were the UH LADCP and an ODF altimeter. A spare altimeter was used during stations 1-5 and 8-10, but was removed for the rest of the cruise; it never worked properly and was identified as the source of the degraded signal seen during the up-cast for station 5.

The deck watch prepared the rosette approximately 45 minutes prior to each cast. All valves, vents and lanyards were checked for proper orientation. The bottles were cocked and all hardware and connections rechecked. Time, position and bottom depth were logged by the console operator at arrival on station. The rosette system was deployed from the Palmer's main deck out of the starboard-side Baltic Room, a protected rosette room and winch shed with an external door and an extension boom. The deployment door to the Baltic Room was opened after the ship had finished positioning, which sometimes entailed clearing a hole in the ice. Deployment was assisted by tag lines threaded through rings on the rosette for stabilization.

Each rosette cast was lowered to within 5-15 meters of the bottom, unless the bottom return from the pinger was extremely poor. As noted already, no altimeter data were available to assist with bottom approaches after station 5.

Bottles on the rosette were each identified with a unique serial number. Usually these numbers corresponded to the pylon tripping sequence, 1-36, where the first (deepest) bottle tripped was bottle #1. Bottle #8 had repeated drain valve leakage problems and was replaced with bottle #37 (stations 13-25 and 35-47), Ocean Instrument Tech. (OIT) test bottle #61 (stations 26-34) and Antarctic Support Associates (ASA) test bottle #63 (stations 48-108). Bottle #4 was missing (apparently imploded) after station 77, and was replaced with bottle #39 for stations 78-108. GO test bottle #62 replaced bottles #10 (stations 26-28) and #6 (stations 82-83).

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.

Recovering the package at the end of deployment was essentially the reverse of the launching with the additional use of air-tuggers for added stabilization. The rosette was placed onto the Baltic Room deck, then the deployment door was closed prior to sampling. The bottles and rosette were examined before samples were taken, and any unusual situations or circumstances were noted on the sample log for the cast. Seawater froze on rosette bottles several times during recovery, but quickly thawed in the Baltic Room. There was never any evidence of water freezing in the bottles or spigots.

Routine CTD maintenance included soaking the conductivity and CTD O_2 sensors in distilled water between casts to maintain sensor stability. Beginning at station 20, the distilled water was replaced by salt water ~1 hour prior to deployment to reduce the possibility of sensors freezing before entering the water. This preventive measure was not totally successful, and freezing did occur during deployment on some casts. When freezing was detected by the console operator, the rosette was lowered to 30-80 meters to thaw the sensors, then raised back to the surface.

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

The transmissometer windows were cleaned prior to deployment approximately every 20 casts. The air readings were noted in the TAMU transmissometer log book after each cleaning. Transmissometer data were monitored for potential problems during every cast, but were not processed by ODF beyond initial block averaging.

The starboard-side Baltic Room Markey winch was used throughout the cruise. Only one sea cable retermination was necessary, prior to station 57.

3. Underwater Electronics Packages

CTD data were collected with a modified NBIS Mark III CTD (ODF #3). This instrument provided pressure, temperature, conductivity and dissolved O_2 channels, and additionally measured a second temperature with an FSI ocean temperature module (OTM) as a calibration check. An FSI ocean pressure module (OPM) was substituted in place of the secondary temperature OTM for four casts. Other data channels included elapsed-time, several power supply voltages and transmissometer. The instrument supplied a 15-byte NBIS-format data stream at a data rate of 25 Hz. Modifications to the instrument included revised pressure and dissolved O_2 sensor mountings; ODF-designed sensor interfaces for O_2, FSI-OTM PRT and 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.

Table 3.0 summarizes the serial numbers of instruments and sensors used during S4I.

<table>
<tr><th>Station(s)</th><th>ODF
CTD†
ID#</th><th>SensorMedics
Model 147737
Oxygen Sensor</th><th>SeaTech
Transmissometer
(TAMU)</th></tr>
<tr><td>1-31,39-61</td><td>3a</td><td rowspan="6">5-02-22</td><td rowspan="6">151D</td></tr>
<tr><td>32-38</td><td>3b</td></tr>
<tr><td>62-100</td><td>3c</td></tr>
<tr><td>101-102</td><td>3d</td></tr>
<tr><td>103-106</td><td>3e</td></tr>
<tr><td>107-108</td><td>3f</td></tr>
<tr><td colspan="4">† See table below for ODF CTD serial numbers</td></tr>
</table>

ODF CTD #3 sensor serial numbers:

<table>
<tr><th rowspan="2">NBIS
MKIIIB
CTD
(ODF-ID#)</th><th rowspan="2">Pressure
Paine Model
211-35-440-05
strain gage/0-8850psi</th><th colspan="2">Temperature</th><th rowspan="2">Conductivity

NBIS Model
09035-00151</th></tr>
<tr><th>PRT1
Rosemount
Model 171BJ</th><th>PRT2/(PRS2)
FSI
OTM/(OPM)</th></tr>
<tr><td>3a</td><td rowspan="6">77011</td><td rowspan="6">14373</td><td rowspan="2">OTM/1320T</td><td>E55</td></tr>
<tr><td>3b</td><td>P42</td></tr>
<tr><td>3c</td><td>OTM/1322T</td><td rowspan="4">O17</td></tr>
<tr><td>3d</td><td>OTM/1321T</td></tr>
<tr><td>3e</td><td>(OPM/1326P)</td></tr>
<tr><td>3f</td><td>OTM/1320T</td></tr>
</table>

Table 3.0 S4I Instrument/Sensor Serial Numbers

The CTD pressure sensor mounting had been modified to reduce the dynamic thermal effects on pressure. The sensor was attached to a section of coiled, oil-filled stainless-steel tubing that was connected to 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 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 using an off-the-shelf 12-bit A/D converter. The transmissometer interface was a similar design.

Although the secondary temperature sensor was located within 6 inches of the CTD conductivity sensor, it was not sufficiently close to calculate coherent salinities. It was used as a secondary temperature calibration reference rather than as a redundant sensor, with the intent of eliminating the need for mercury or electronic DSRTs as calibration checks. Three secondary temperature sensors were interchanged during S4I.

The General Oceanics (GO) 1016 36-place pylon was used in conjunction with an ODF-built deck unit and external power supply instead of a GO pylon deck unit. This combination provided generally reliable operation and positive confirmation. The pylon emitted a confirmation message containing its current notion of bottle trip position, which could be useful in sorting out mis-trips. The acquisition software averaged CTD data corresponding to the rosette trip as soon as the trip was initiated until the trip confirmed, typically 3.5±1 seconds on S4I.

There were 13 random bad trip confirmations during S4I; 12 of these were noticed in a timely manner by the console operator and re-tripped successfully. 3 odd trip confirmations resulted in open bottles at the surface. There were 255 other odd trip confirmations, most of which were duplicates of valid confirmations or in place of normal confirmations. 2 casts (stas 78 and 79) were re-started mid-up-cast because of pylon communication or confirmation problems. 2 casts (stas 40 and 79) had trip confirmations that were off by 1 level on many or all bottles. 2 other casts (stas 52 and 56) confirmed normally but returned to the surface with the first two bottles tripped at unknown depths, and the rest 2 trip levels deeper than expected. The bottles for these casts were matched up to the correct CTD trip depths after the casts, by comparison of CTD and bottle data water properties. Bad or odd confirmations that affected bottle trips are documented in Appendix D.

4. Navigation and Bathymetry Data Acquisition

Navigation data were acquired from the ship's Ashtech GPS receiver via the network, which reported full P-code position information. Data were logged automatically at one-minute intervals by one of the Sun SPARCstations. Underway bathymetry was logged manually from the 12 kHz Raytheon/EPC PDR at five-minute intervals (or when possible in the ice), then corrected according to Carter [Cart80] and 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 bathymetry on vertical sections.

5. CTD Data Acquisition, Processing and Control System

The CTD data acquisition, processing and control system consisted of a Sun SPARCstation LX computer workstation, ODF-built CTD and pylon deck units, CTD and pylon power supplies, and a VCR recorder for real-time analog backup recording of the sea cable signal. The Sun system consisted of a color display with trackball and keyboard (the CTD console), 18 RS-232 ports, 2.5 GB disk and 8mm cartridge tape. Two other Sun SPARCstation LX systems were networked to the data acquisition system, as well as to the rest of the networked computers aboard the Palmer. These systems were available for real-time CTD data display and provided for hydrographic data management and backup. Two HP 1200C color inkjet printers provided hardcopy capability from any of the workstations.

The CTD FSK signal 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 deck unit was connected to the Sun LX through a bi-directional 300 baud serial line, allowing bottle trips to be initiated and confirmed by the data acquisition software. A bitmapped color display provided interactive graphical display and control of the CTD rosette sampling system, including real-time raw and processed CTD data, navigation, winch and rosette trip displays.

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 and pylon power supplies, 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 were begun and a time and position were automatically logged for the beginning of the cast. A backup analog recording of the CTD signal on a VCR tape 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 pylon was initializing properly. Various plots and displays were initiated. When all was ready, the console operator informed the deck watch by radio.

Once the deck watch had deployed the rosette, it was immediately lowered without pausing at the sea surface. The deck watch informed the console operator that the rosette was on its way down (also confirmed by the computer displays). If the console operator noticed that sensors were frozen on entry, the package was stopped at 30-80 meters, then raised to just below the surface to allow the sensors to thaw. The console operator or deck watch leader then provided the winch operator with a target depth (wire-out) and maximum lowering rate, normally 60-70 meters/minute for this package. The package built up to the maximum rate during the first few hundred meters, then optimally continued 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 deck watch leader assisted the console operator by monitoring the rosette's distance to the bottom using the difference between the rosette's pinger signal and its bottom reflection displayed on the PDR. No altimeter was available to assist with bottom approaches. The winch speed was usually slowed to ~30 meters/minute during the final approach. The winch and PDR displays allowed the watch leader to refine the target depth relayed to the winch operator and safely approach to within 5-15 meters of the bottom.

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. A bad or suspicious confirmation signal typically resulted in the console operator repositioning the pylon trip arm via software, then re-tripping the bottle, until a good confirmation was received. All tripping attempts were noted on the console log. The console operator then instructed the winch operator to bring the rosette up to the next bottle depth. 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. It was sometimes necessary to close the surface bottles "on the fly" due to a risk of slack wire at higher sea states. 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. Usually the console operator also brought the sample log to the rosette room and served as the *sample cop*.

6. 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 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 25 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 25 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-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 CTD O_2 sensor was calibrated to check-sample data.

Two casts (stations 30 and 31) exhibited an unacceptable level of primary PRT temperature noise which was traced to a water leak in the sensor turret. The secondary PRT temperature was used in these cases. CTD salinity for these casts is noisier than usual because of the greater distance of the secondary PRT from the conductivity sensor, and because of potential noise induced on the conductivity sensor by the flooded turret.

There was a high level of conductivity drift during stations 32-38, which used a new and apparently defective conductivity sensor, and during stations 55-61, just before the original conductivity sensor was replaced with yet another new sensor. Since down- and up-cast conductivities were very different for these casts, it was necessary to use the up-casts for these stations, where bottle-CTD differences could be used to determine pressure-dependent conductivity corrections for each cast individually.

A few casts exhibited conductivity offsets due to biological or particulate artifacts. Some casts were subject to noise in the data stream caused by sea cable or slip-ring problems, or by moisture in the 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.

Pressure intervals with no time-series data can optionally be filled by double-quadratic interpolation/extrapolation. Most pressure intervals missing/filled during this leg were within the top 0-4 db, caused by chopping off going-in-water transition data during pressure-sequencing. However, there were a number of casts where temperature or conductivity sensors froze in transit from the deck into the water. Ideally, these were noticed by the console operator, and the casts were returned to near-surface water and restarted after thawing. However, a number of casts with freezing problems were not noticed. At the request of one of the co-chief scientists, down-cast data were extrapolated from the "thaw" point back to the surface whenever there was a clear, stable mixed layer. The resulting data were compared to original down-cast data from the un-frozen sensor, up-cast data from the same cast and density profiles.

When the down-cast CTD data have excessive noise, gaps or offsets, the up-cast data are used instead. This also applied to frozen-sensor casts where down-casts could not be extrapolated without distortion, or where sensors remained frozen below the mixed layer. 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.). The up-casts used for final S4I CTD data are indicated in Appendix C.

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 usually 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.

There were a number of casts colder than -1.5°C, where raw temperature values crossed the 0°C threshold. All transitions falling in lower-gradient areas were shallower than 480 db and showed no density inversions . All raw conductivity values were lower than 32768 and unaffected by this problem.

Appendix C contains a table of CTD casts requiring special attention. S4I CTD-related comments, problems and solutions are documented in detail.

7. CTD Laboratory Calibration Procedures

Pre-cruise laboratory calibrations of CTD pressure and temperature sensors were used to generate tables of corrections applied by the CTD data acquisition and processing software at sea. These laboratory calibrations were also performed post-cruise.

Pressure and temperature calibrations were performed on CTD #3 at the ODF Calibration Facility in La Jolla. Pre-cruise calibrations were done in March 1996, and post-cruise calibrations were done in July 1996.

The CTD pressure transducer was calibrated in a temperature-controlled water bath to a Ruska Model 2400 Piston Gage pressure reference. Calibration data were measured pre-/post-cruise at -1.89/-1.10°C to a maximum loading pressure of 6080 db, and 10.08/30.34°C to 1190 db. An additional pressure calibration was done post-cruise at 4.07°C to 6080 db. Figures 7.0 and 7.1 summarize the CTD #3 laboratory pressure calibrations performed in March and July 1996.

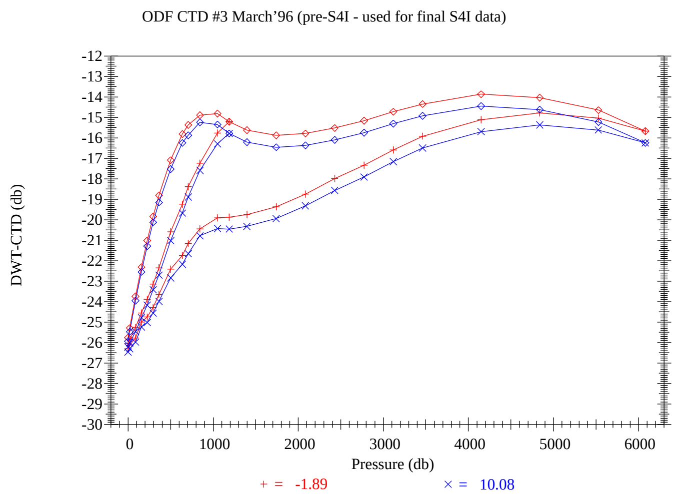


Figure 7.0 Pressure calibration for ODF CTD #3, March 1996.

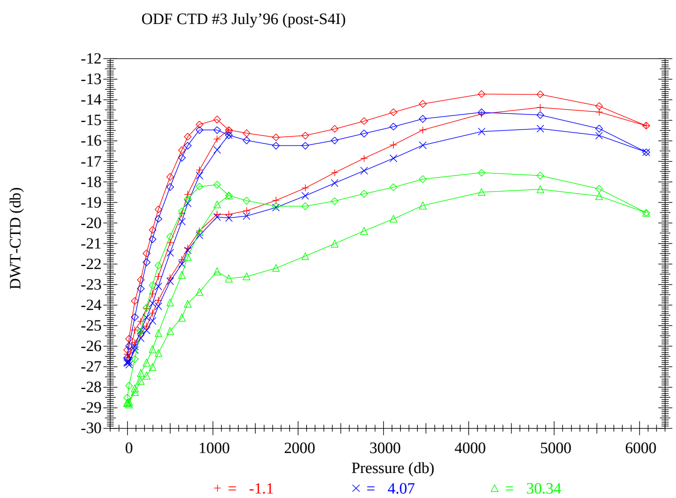


Figure 7.1 Pressure calibration for ODF CTD #3, July 1996.

Additionally, dynamic thermal-response step tests were conducted on the pressure transducer to calibrate dynamic thermal effects. These results were combined with the static temperature calibrations to optimally correct the CTD pressure.

CTD PRT temperatures were calibrated to an NBIS ATB-1250 resistance bridge and Rosemount standard PRT in a temperature-controlled bath. The primary and secondary CTD temperatures were offset by ~1.5 and ~2°C to avoid the 0-point discontinuity inherent in the internal digitizing circuitry. Standard and CTD temperatures were measured pre-cruise for the primary PRT at 7 different bath temperatures between -1.9 and 10.1°C. The primary and secondary PRT #FSI-1320T were both calibrated post-cruise at more than a dozen bath temperatures between -1.9 and 30.3°C. Figures 7.2 and 7.3 summarize the laboratory calibrations performed on the CTD #3 primary PRT during March and July 1996. Figure 7.4 shows the laboratory calibration performed on the CTD #3 secondary PRT (FSI-1320T only) during July 1996.

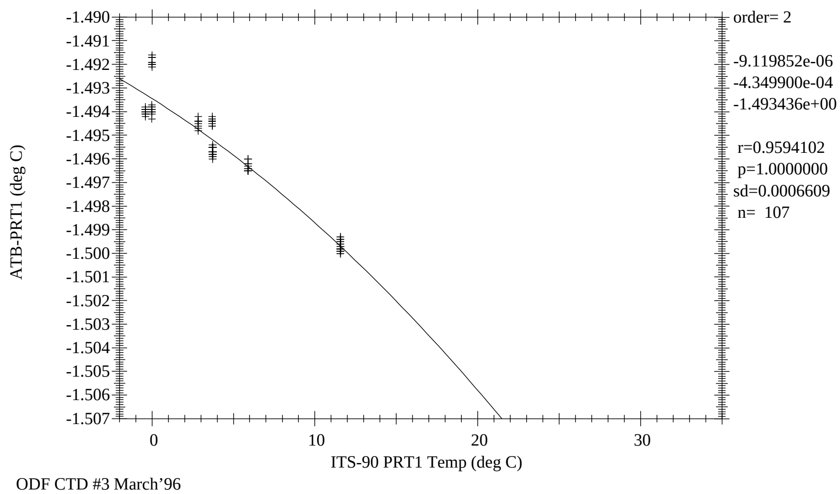


Figure 7.2 Primary PRT Temperature Calibration for ODF CTD #3, March 1996.

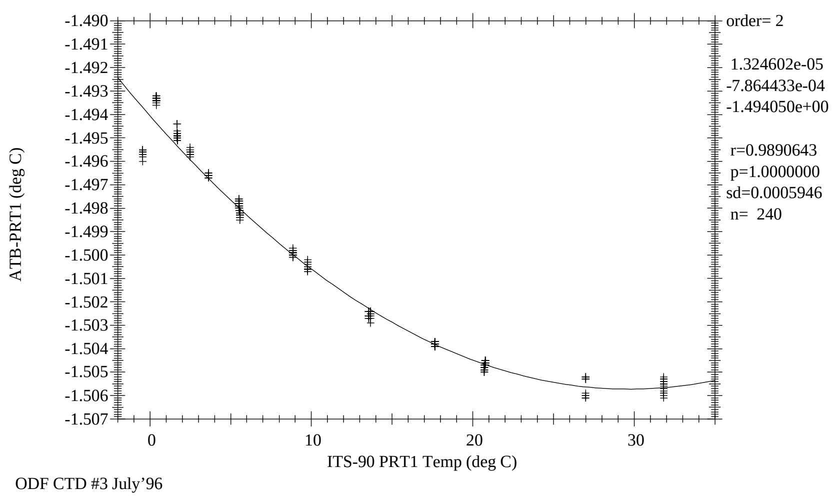


Figure 7.3 Primary PRT Temperature Calibration for ODF CTD #3, July 1996.

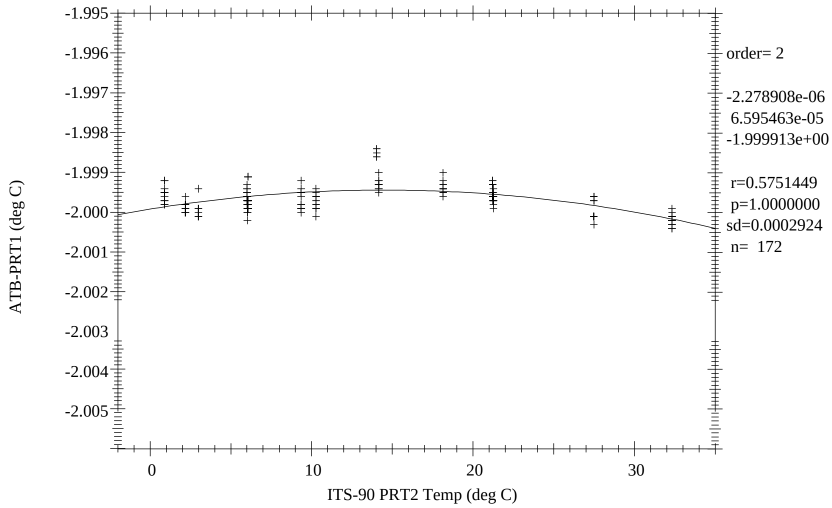


Figure 7.4 Secondary PRT (FSI-1320T) Temperature Calibration for ODF CTD #3, July'96

These laboratory temperature calibrations were referenced to an ITS-90 standard. Temperatures were converted to the IPTS-68 standard during processing in order to calculate other parameters, including salinity and density, which are currently defined in terms of that standard only. Final calibrated CTD temperatures are reported using the ITS-90 standard.

8. CTD Calibration Procedures

ODF CTD #3 had recently been acquired by ODF and did not have an extensive calibration history.

A redundant PRT sensor was used as a temperature calibration check while at sea. CTD conductivity and dissolved O_2 were calibrated to *in situ* check samples collected during each rosette cast.

Final pressure, temperature, conductivity and oxygen corrections were determined during post-cruise processing.

8.1. CTD #3 Pressure

There was a pre- to post-cruise shift in the loading curves (increasing pressure) of less than -0.5 db in the top 2000 db, gradually shifting to a maximum +0.5 db at the maximum pressure in the cold-bath laboratory calibrations for pressure. The unloading curves were similar in the top 1000 db, and shifted a fairly consistent +0.5 db in the post-cruise.

The intermediate-temperature (10/4°C pre-/post-cruise) pressure calibrations were less easily compared, since they differed by 6°C and were done to different maximum pressures. For easier comparison, the deep extrapolation of the pre-cruise 10°C calibration was used. The loading curves were within ±0.5 db of each other in the top 3500 db, with the post-cruise shifting by a maximum -0.5 db at 6080 db. The unloading curves crossed around 4500 db, with the post-cruise calibration showing a maximum +0.8 db at 1100 db, then closing in again to within ±0.2 db near the surface.

The 4°C calibration (post-cruise) would typically be twice as close as the 10°C calibration (pre-cruise) to the -1°C calibrations, if there were no shift in CTD pressure. However, the difference between the cold and intermediate calibrations at maximum pressure became twice as large instead (0.6 db in 12°C pre-cruise vs 1.3 db in 5°C post-cruise). The differences between the calibrations were still less than 1 db at any calibration temperature or pressure, a relatively insignificant amount. A test comparing the results of using one calibration or the other showed less than ±0.3 db differences in maximum pressures for each cast deeper than 1500 db, and 0.3 to 0.9 db differences in casts shallower than 1500 db. The pre-cruise calibration data, plus the dynamic thermal-response correction, were applied to S4I CTD #3 pressure data to generate final pressures.

Down-cast surface pressures were automatically adjusted to 0 db as the CTD entered the water; any difference between this value and the calibration value was automatically adjusted during the top 50 decibars. Residual pressure offsets at the end of each up-cast (the difference between the last corrected pressure in-water and 0 db) averaged 0.9 db, indicating no significant problems with the final pressure corrections.

The entire pre- to post-cruise laboratory calibration shift for the pressure sensor on CTD #3 was less than one-half the magnitude of the WOCE accuracy specification of 3 db. Final adjusted S4I CTD pressures should be well within the desired standards.

An FSI-OPM/pressure module (1326P) was substituted for the secondary PRT during stations 103 through 106 as a test of the OPM. These secondary pressure data were neither processed nor calibrated.

8.2. CTD #3 Temperature

Three different FSI-OTM/PRT sensors (S/N 1320T, 1322T, 1321T) were deployed as a second temperature channel (PRT2) and compared with the primary PRT channel (PRT1) on all casts except stations 103-106 to monitor for drift. The response times of the primary and secondary PRT sensors were matched, then preliminary corrected temperatures were compared for a series of standard depths from each CTD down-cast.

OTM-1320T was used for stations 1-61 and 107-108, OTM-1322T was used for stations 62-100, and OTM-1321T was used for stations 101-102 only. Since no OTM was attached during the pre-cruise calibration, a simple offset of -2.0 was used to correct PRT2 for comparison to PRT1 data, a correction within 0.0025°C of calibration checks of all 3 OTMs in November 1996. The differences between the CTD #3 primary PRT and all 3 OTM sensors remained a fairly stable ±0.0005°C for pressures deeper than 1500 db. A stable conductivity correction also indicated no shift in the primary PRT.

Figure 8.2.0 summarizes the comparison between the primary and secondary PRT temperatures.

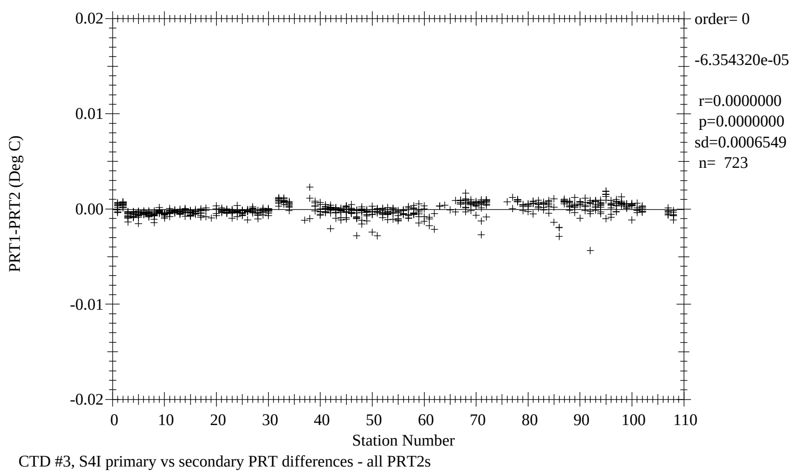


Figure 8.2.0 S4I comparison of CTD #3 primary vs. secondary PRT temperatures, pressure > 1500 db (no Sta.031).

The primary temperature sensor laboratory calibrations indicated a -0.0015°C shift at -1.5 to 6°C, with no slope change, from pre- to post-cruise. Figure 8.2.1 shows the pre-/post-cruise PRT1 calibrations plotted together, using only uncorrected PRT1 values above 0°C.

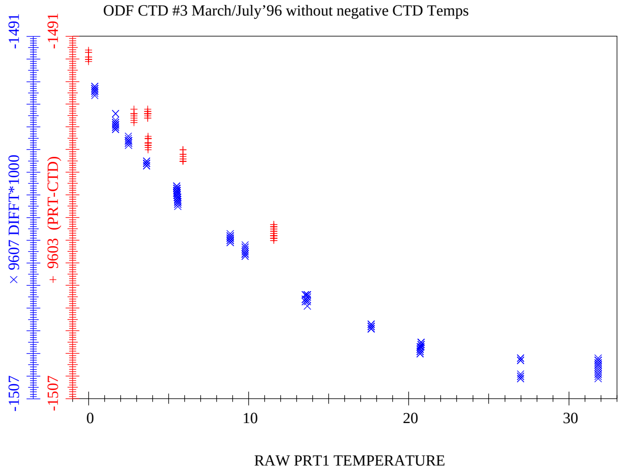


Figure 8.2.1 WOCE96-S4I Primary temperature (PRT1) correction for ODF CTD #3, March + July'96 calibs, rawPRT1 > 0 deg.C only.

The post-cruise PRT1 calibration measured more temperature points and was more consistent, so it was offset by +0.00075°C (half of the pre- to post-cruise change) and applied to S4I temperature data. Figure 8.2.2 shows the offset post-cruise temperature calibration used to correct CTD #3 PRT1 data.

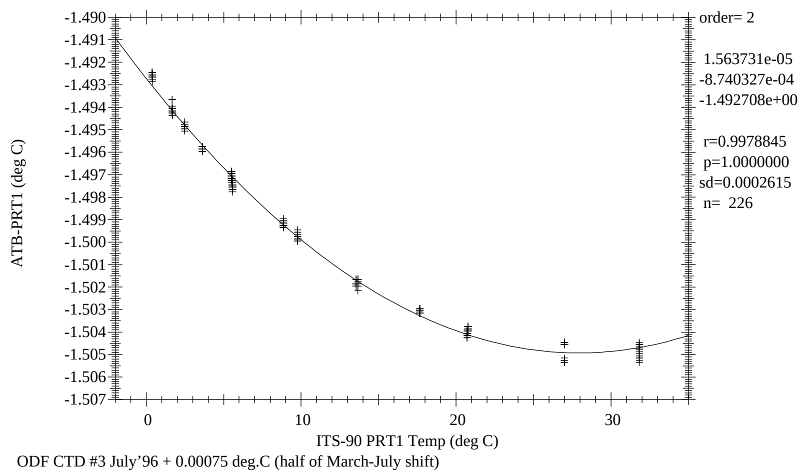


Figure 8.2.2 WOCE96-S4I Primary temperature (PRT1) correction for ODF CTD #3, July'96 calib. +0.00075°C.

Two casts (stations 30 and 31) had problems with PRT1 readings, caused by a flooded sensor turret; the problem was repaired before station 32. It was necessary to use PRT2 for the primary temperature data on these two casts, despite the expected noisier salinity caused by the distance between PRT2 and the conductivity sensor. The post-cruise secondary temperature sensor laboratory calibration showed a fairly constant -1.9997°C offset between -1.1 and 9°C, covering the full range of temperatures seen on these two casts. This offset was applied to correct the PRT2 temperature data for stations 30 and 31. Figure 8.2.3 shows the post-cruise temperature calibration data used to correct CTD #3 PRT2 data.

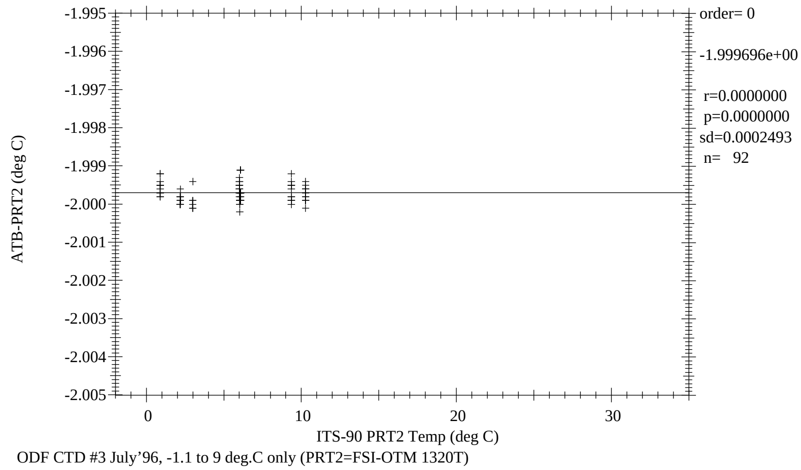


Figure 8.2.3 WOCE96-S4I Secondary temperature (PRT2) correction for ODF CTD #3, July'96 calib., rawPRT2 from 0.5 to 10.5°C only.

The pre- to post-cruise laboratory calibration shift for the primary temperature sensor on CTD #3 was less than the magnitude of the WOCE accuracy standard of 0.002°C for the temperature range of the S4I line. Since the difference between the two calibrations was essentially split and applied to the data, S4I CTD temperatures should be within the WOCE accuracy specifications. PRT2 data compared well to PRT1 data throughout the cruise, and should also be within the same accuracy range as PRT1.

The exception to these accuracy figures would be where uncorrected CTD temperatures cross between positive and negative values: the discontinuity described in the "CTD Data Processing" section may offset colder data. This error may be as much as +0.0025°C for corrected CTD temperatures below ~-1.49°C, an amount apparent in the figures for PRT1 Temperature Calibrations seen in the previous section. Fortunately, all such temperatures on S4I are shallower than 480 db and fall in areas where the temperature gradient is larger than the error, so it is not readily detectable.

8.3. CTD #3 Conductivity

The corrected CTD rosette trip pressure and temperature were used with the bottle salinity 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 3-cm conductivity cell used in the Mark III CTD, but CTD #3 sensors required pressure-dependent conductivity corrections as well.

Three different CTD conductivity sensors were used during S4I; all three sensors were essentially new at the start of S4I.

- #E55 was used on stations 1-31. It was replaced because the sensor turret leaked during stations 30-31.
- #P42 was used on stations 32-38. It was replaced because of nonlinear sensitivity and lack of stability.
- #E55 was again used on stations 39-61. This sensor became extremely noisy during stations 56-58. The sensor was cleaned with RBS prior to station 59, which caused a shift in the offset while significantly reducing the noise level. The sensor was replaced because of nonlinear sensitivity and lack of stability.
- #O17 was used on stations 62-108. It was fairly stable, with a small shift after the 6.5-day break in station work to deliver supplies to Mirnyy.

Conductivity differences above and below the thermocline were fit to CTD conductivity for each conductivity sensor to determine conductivity slopes. Stations 1-31, 39-55 and 56-61 were treated separately for sensor #E55, and stations 62-72 and 73-108 were grouped separately for sensor #O17. Figures 8.3.0.0-8.3.0.5 show the data used to determine preliminary conductivity slopes.

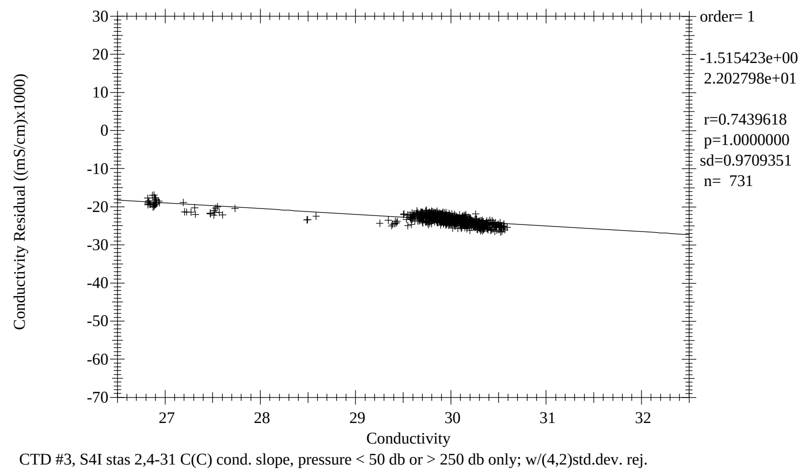


Figure 8.3.0.0 CTD #3 prelim. conductivity slopes for WOCE96-S4I, stations 1-31 (C-sensor #E55).

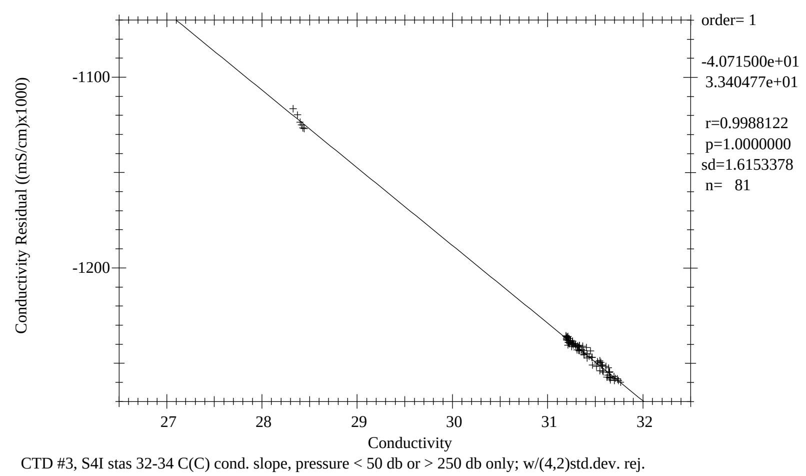


Figure 8.3.0.1 CTD #3 prelim. conductivity slopes for WOCE96-S4I, stations 32-38 (C-sensor #P42).

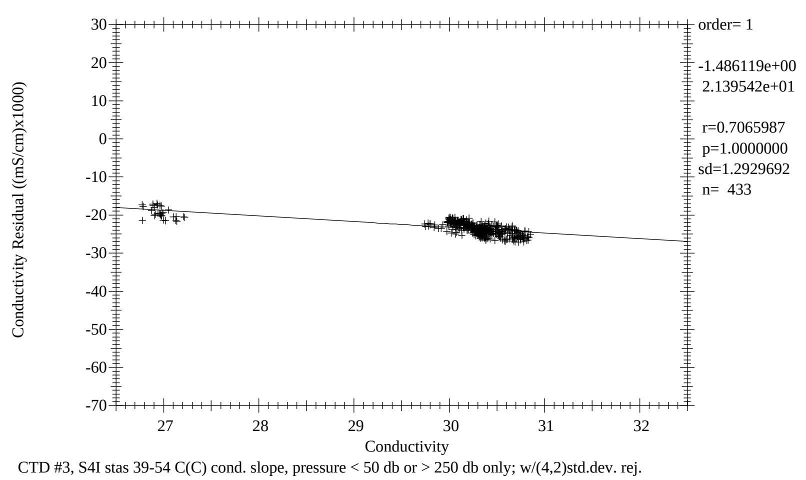


Figure 8.3.0.2 CTD #3 prelim. conductivity slopes for WOCE96-S4I, stations 39-55 (C-sensor #E55).

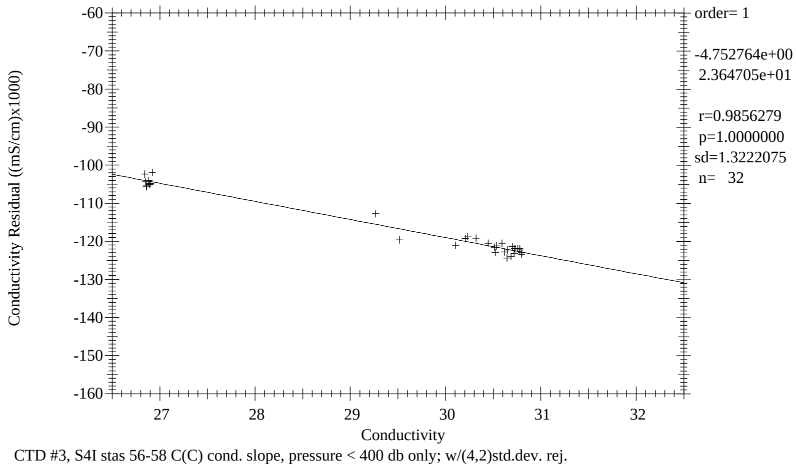


Figure 8.3.0.3 CTD #3 prelim. conductivity slopes for WOCE96-S4I, stations 56-61 (C-sensor #E55).

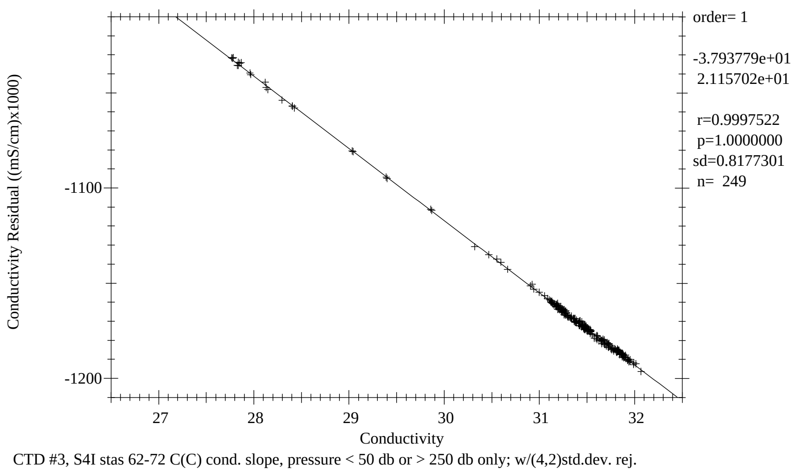


Figure 8.3.0.4 CTD #3 prelim. conductivity slopes for WOCE96-S4I, stations 62-72 (C-sensor #O17).

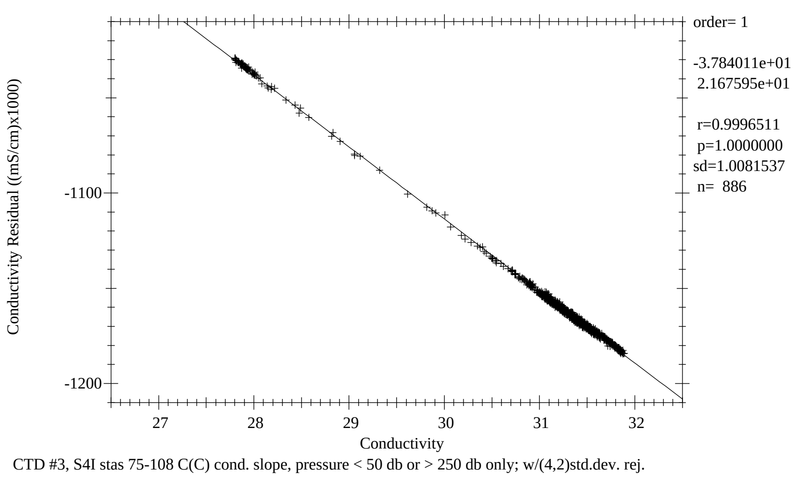


Figure 8.3.0.5 CTD #3 prelim. conductivity slopes for WOCE96-S4I, stations 73-108 (C-sensor #O17).

These preliminary conductivity differences were fit to conductivity, with outlying values (4,2 standard deviations) rejected. Shallower stations were omitted from all groups; only stations 56-58 were used to determine slopes for stations 56-61 because of the offset caused by cleaning the sensor prior to station 59. Conductivity slopes were calculated from the first-order fits. The slopes calculated for stations 1-31 and 39-55 were averaged, as were the slopes for stations 62-72 and 73-108. Preliminary slopes were then applied to each S4I cast.

Once the conductivity slopes were applied, residual CTD conductivity offset values were calculated for each cast using bottle conductivities deeper than 1400 db for stations 1-31, 39-55 and 62-108. More restricted pressure ranges were used to determine preliminary offsets for casts with unstable conductivity sensors, while pressure-dependent conductivity corrections were pending: only 0-70 db differences were used for stations 32-38, and 2300-2800 db for stations 56-61. Figure 8.3.1 illustrates the S4I preliminary conductivity offset residual values.

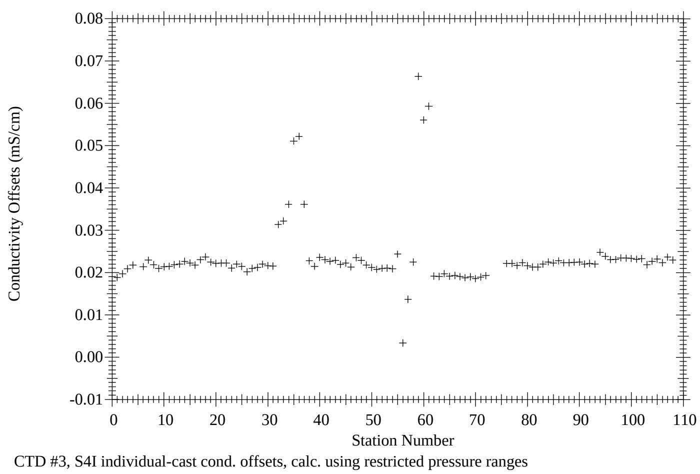


Figure 8.3.1 S4I CTD #3 preliminary conductivity offsets by station number.

Casts were grouped together based on drift and/or known CTD conductivity shifts or problems to determine average offsets. This also smoothed the effect of any cast-to-cast bottle salinity variation, typically on the order of ±0.001 PSU. Some casts were omitted from the fits because there were no bottle differences within the specified pressure ranges used, or because of known CTD shifts relative to nearby casts. Smoothed offsets were applied to each cast except stations 32-38 and 56-61, which had individual offsets applied because of sensor instabilities. Some offsets were then manually adjusted to account for discontinuous shifts in the conductivity transducer response or bottle salinities, or to maintain deep theta-salinity consistency from cast to cast.

After applying preliminary conductivity slopes and offsets to each cast, residual CTD conductivity differences above and below the thermocline were fit to CTD pressure for each sensor. Stations 1-31 + 39-55 conductivity differences varied ±0.002 mS/cm and warranted a second-order correction as a function of pressure. Stations 62-108 needed a linear correction as a function of pressure to pull in the 0.001 mS/cm differences at intermediate pressures. Stations 32-38 and 56-61 required individual second-order corrections (linear for shallow station 35) as a function of pressure to pull in much larger residual differences. Figures 8.3.2.0-8.3.2.3 show the residual conductivity differences used for determining these corrections.

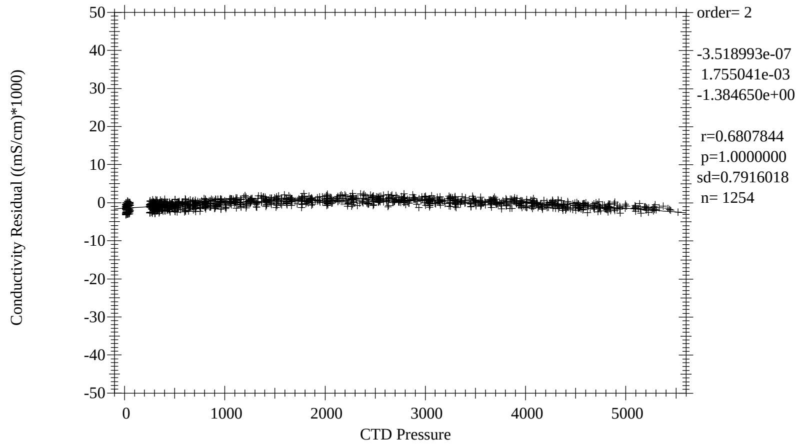


Figure 8.3.2.0 CTD #3 residual conductivity vs. pressure for WOCE96-S4I, stas 1-31 + 39-55 (C-sensor #E55).

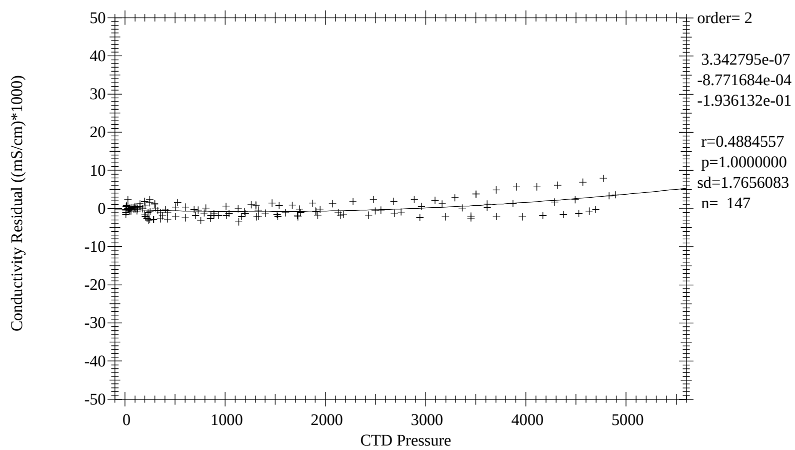


Figure 8.3.2.1 CTD #3 residual conductivity vs. pressure for WOCE96-S4I, stas 32-38 (C-sensor #P42).

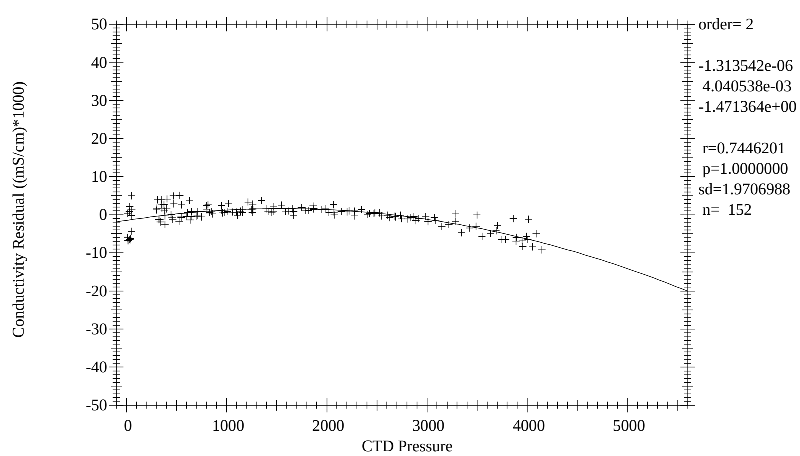


Figure 8.3.2.2 CTD #3 residual conductivity vs. pressure for WOCE96-S4I, stas 56-61 (C-sensor #E55).

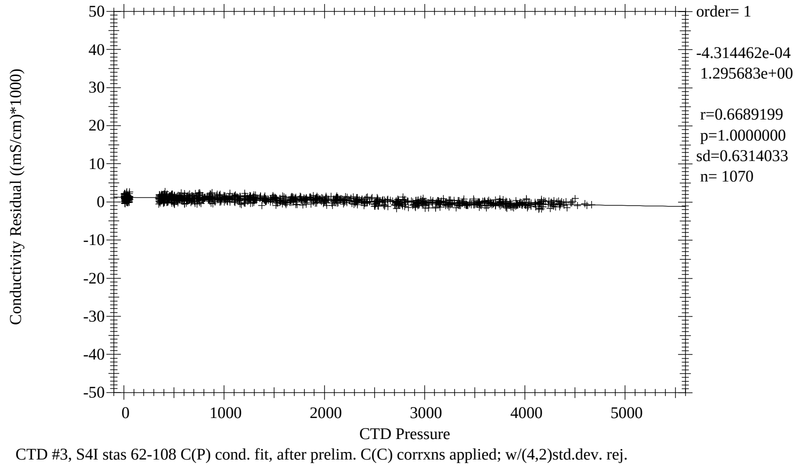


Figure8.3.2.3 CTD #3 residual conductivity vs. pressure for WOCE96-S4I, stas 62-108 (C-sensor #O17).

After applying the pressure-dependent corrections to conductivity, conductivity slopes were re-examined for any leftover dependence on conductivity. Two groups needed minor adjustments to conductivity slopes as a function of conductivity. Figures 8.3.3.0 and 8.3.3.1 show the residual corrections calculated for stations 55-61 and stations 62-108.

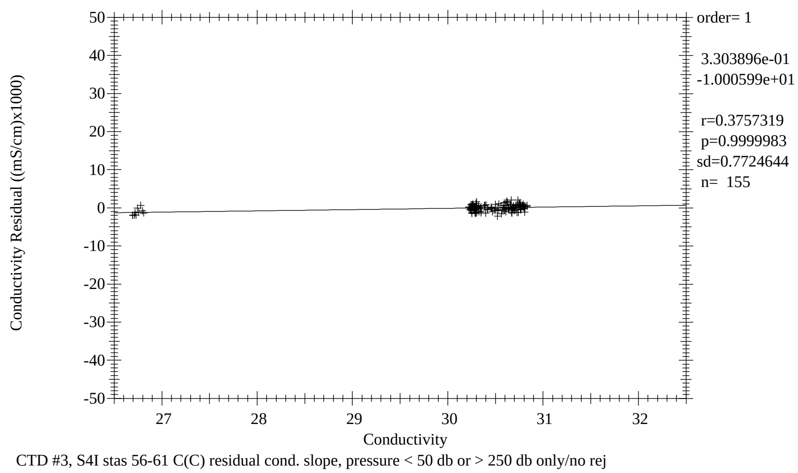
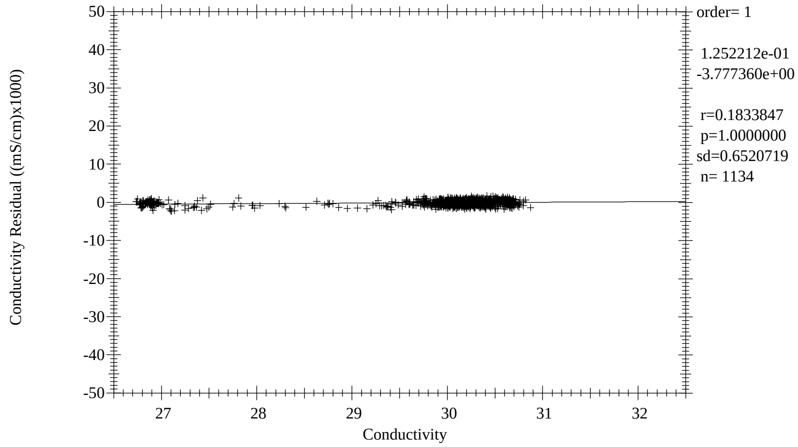


Figure 8.3.3.0 CTD #3 adjustments to conductivity slopes for WOCE96-S4I, stas 55-61 (C-sensor #E55).



CTD #3, S4I stas 62-108 C(C) residual cond. slope, pressure < 50 db or > 250 db only; w/(4,2)std.dev. rej.

Figure8.3.3.1CTD #3 adjustments to conductivity slopes for WOCE96-S4I, stas 62-108 (C-sensor #O17).

The final S4I pressure-dependent coefficients and conductivity-dependent slopes are summarized in Figures 8.3.4 and 8.3.5. Figure 8.3.6 summarizes the final conductivity offsets (combined conductivity- and pressure-dependent corrections) by station number.

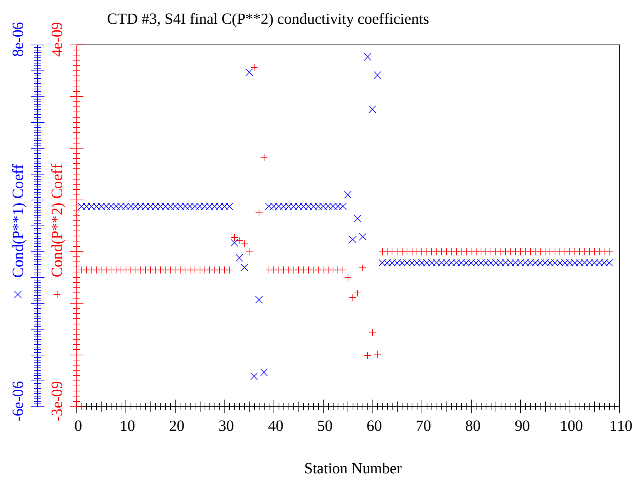


Figure 8.3.4 S4I CTD #3 pressure-dependent correction coefficients by station number.

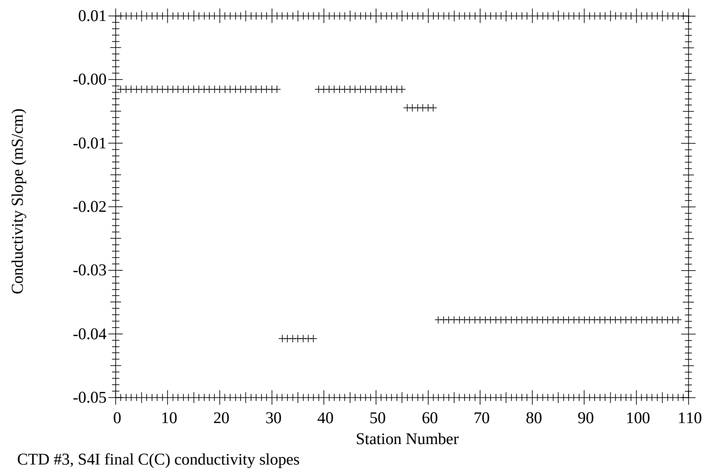


Figure 8.3.5 S4I CTD #3 conductivity-dependent slope corrections by station number.

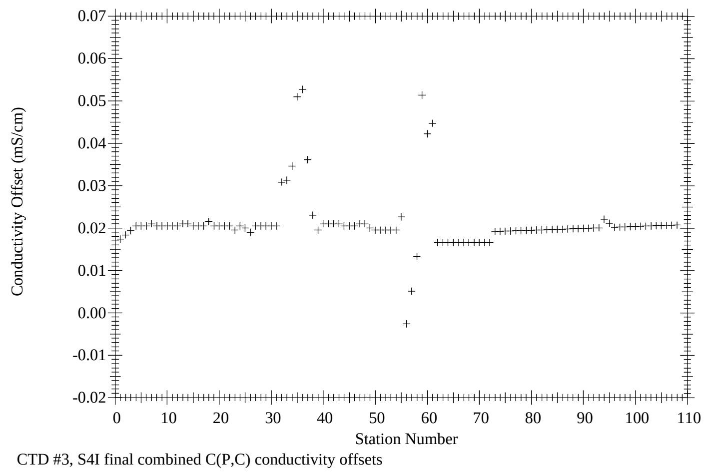


Figure 8.3.6 S4I CTD #3 combined conductivity offsets by station number.

S4I temperature and conductivity correction coefficients are also tabulated in Appendix A.

Summary of Residual Salinity Differences

Figures 8.3.7, 8.3.8, 8.3.9 and 8.3.10 summarize the S4I residual differences between bottle and CTD salinities after applying the conductivity corrections. Only CTD and bottle salinities with final quality code 2 (acceptable) were used to generate these figures and statistics. Residual differences exceeding ±0.025 PSU are included in the calculations for averages and standard deviations, even though they are not plotted.

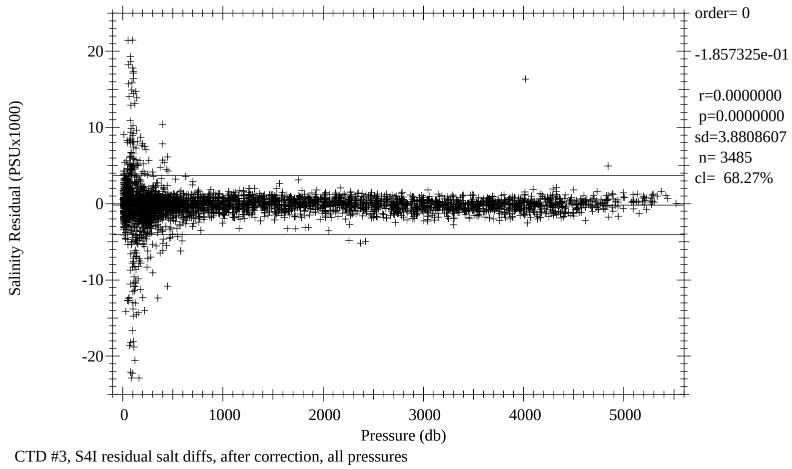


Figure 8.3.7 S4I Salinity residual differences vs pressure (after correction).

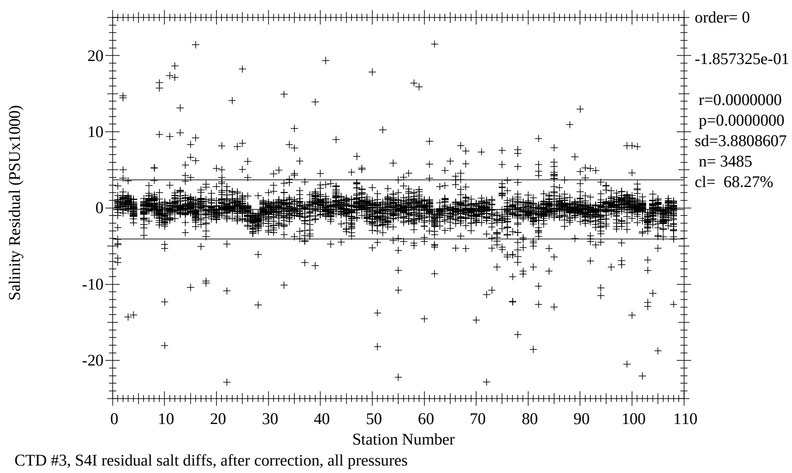


Figure 8.3.8 S4I Salinity residual differences vs station # (after correction).

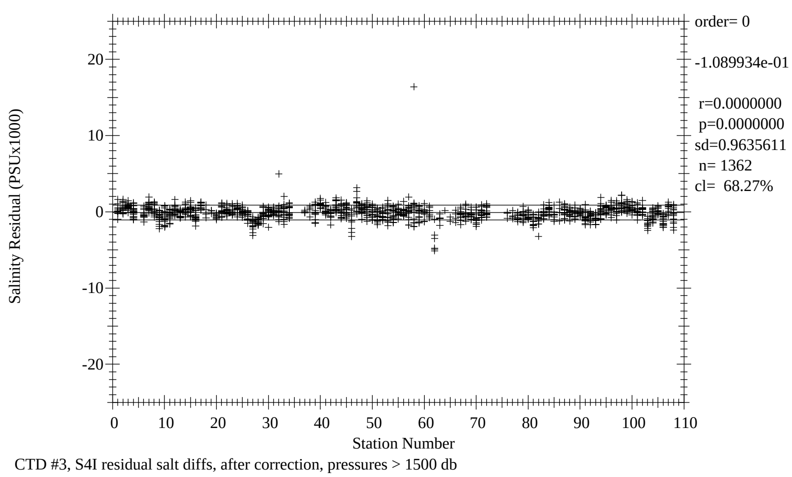


Figure 8.3.9 S4I Deep salinity residual differences vs station # (after correction).

The CTD conductivity calibration represents a best estimate of the conductivity field throughout the water column. 3σ from the mean residual in Figures 8.3.8 and 8.3.9, or ±0.0059 PSU for all salinities and ±0.0015 PSU for deep salinities, represents the limit of repeatability of the bottle salinities (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 and CTD salinities appears to be better than 0.001 PSU.

Final calibrated CTD data from WOCE96-S4I and various cruises were compared at their closest stations. Non-S4I WOCE data were extracted from http://whpo.ucsd.edu in March 2003. A table of the comparisons follows:

S4I/ Sta.No.	Crs.ID/ Sta.No.	Crs. Date	IAPSO SSW Batch No.	Distance Apart (nm)	Avg. Salinity Diffc. (Crs-S4I) (PSU at Deepest 1°C Theta)
S4I/1	WOCE-S4A/20 (06AQANTXIII_4)	Mar.96	P-127	68	0 to +0.001 (vs. S4A btls - CTD salinity quality-coded 4)
S4I/63,64 S4I/92	WOCE-I8S/76 WOCE-I9S/92 (316N145_5)	Dec.94 Jan.95	P-124 P-124	13,27 9	+0.001 +0.001
S4I/105 S4I/106 S4I/107 S4I/108 S4I/108	WOCE-S3+S4/17 WOCE-S3+S4/18 WOCE-S3+S4/3-4 WOCE-S3+S4/2 WOCE-S3+S4/19 (09AR9404_1)	Jan.95 Jan.95 Dec.94 Dec.94 Jan.95	P-123 P-123 P-123 P-123 P-123	9 12 14 0.5 0.1	+0.003 to +0.0035 +0.0005 to +0.002 +0.006 to +0.007 * +0.001 to +0.002 0 (0.5+°C Theta) to +0.004 (deep)
S4I/11 S4I/86	WOCE-S4/12345 WOCE-S4/12351 (74DI200_1)	Feb.93 Feb.93	P-120 P-120	46 21	-0.002 (below -0.04°C Theta) -0.0005 (-0.04 to 0.45°C Theta) -0.004 (S4I 300m shallower than S4)
S4I/48,49 S4I/85 S4I/88,89	GEOSECS/430 GEOSECS/431 GEOSECS/430	Feb.78 Feb.78 Feb.78	P-61 P-61 P-61	201,188 76 180,178	+0.004/+0.003 ±0.002 above 0.2°C Theta (incomparable deeper) +0.002
* these S3+S4 casts were +0.003 to +0.0045 PSU compared to nearby casts on the same cruise					

Table 8.3.10 S4I Compared To Historical Data

IAPSO Standard Seawater batch corrections are similar for S4I (P-125) and most of the standards used for the other cruises listed in the chart: at most, -0.0004 PSU in salinity. The P-123/P-125 batch difference may account for up to a +0.001 PSU difference between S3+S4/S4I salinity data [Culk98]. S4A stations 3-4 are probably not good for comparison, since they are offset from nearby casts on the same cruise. S4I stations 105-108 all agree within ±0.0005 PSU. IAPSO batch corrections would bring the GEOSECS data about 0.001 PSU closer to S4I [Mant87] [Culk98].

8.4. CTD Dissolved Oxygen

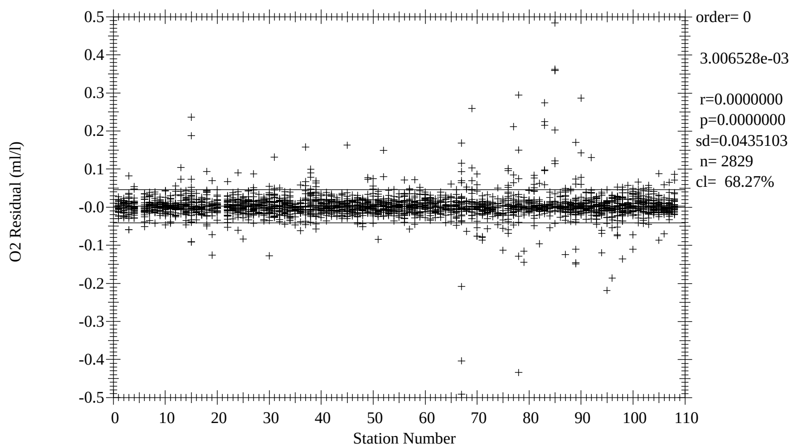
SensorMedics oxygen sensors have a finite shelf life, so new sensors are usually employed at the start of a cruise. A single, new O_2 sensor was used throughout S4I. The pressure-related response problems observed during WOCE95-I10 were not apparent during this leg. The oxygen sensor from this cruise was used again 8 months later, during WOCE97-ICM3 at 20S.

The extremely cold temperatures during S4I apparently caused problems with the CTD O_2 fits, since no fitting problems occurred for this same sensor on ICM3. Either the surface mixed layer fit the bottle oxygen data, causing a relatively shapeless deeper fit; or the deeper data fit the bottle-defined structure well at the expense of surface fits. Since freezing problems at the surface were observed with temperature and conductivity sensors, it is likely that the oxygen sensor was also affected. Most surface oxygen fits were sacrificed in order to define sub-thermocline CTD O_2 structure; these poorly fit areas are documented in Appendix C, and the data are quality-coded 3 or 4.

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, can cause shifts in the CTD O_2 profile as oxygen becomes depleted in water near the sensor. Such shifts could usually be corrected by offsetting the raw oxygen data from the stop or slow-down area until some time after the sensor has been moving again, occasionally until the bottom of the cast. All offset sections, winch stops or slow-downs that affected CTD oxygen data are documented in Appendix C.

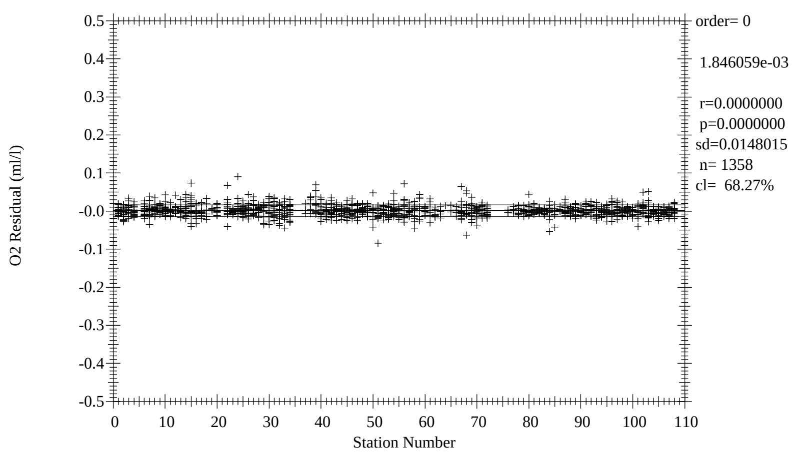
Because of these same stop/slow-down problems, up-cast CTD O_2 data cannot be optimally calibrated to O_2 check samples. Instead, down-cast CTD O_2 data are derived by matching the up-cast rosette trips along isopycnal surfaces. When down-casts were deemed to be unusable (see Appendix C), up-cast CTD O_2 data were processed despite the signal drop-offs typically seen at bottle stops. The differences between CTD O_2 data modeled from these derived values and check samples are then minimized using a non-linear least-squares fitting procedure.

Figures 8.4.0 and 8.4.1 show the residual differences between the corrected CTD O_2 and the bottle O_2 (ml/l) for each station. Only CTD and bottle oxygens with final quality code 2 (acceptable) were used to generate these figures and statistics. Residual differences exceeding ±0.5 ml/l are included in the calculations for averages and standard deviations, even though they are not plotted.



CTD #3, S4I residual o2 diffs, after correction, all pressures

Figure 8.4.0 S4I O_2 residual differences vs station # (after correction).



CTD #3, S4I residual o2 diffs, after correction, pressures > 1500 db

Figure 8.4.1 S4I Deep O_2 residual differences vs station # (after correction).

The standard deviations of 0.044 ml/l for all oxygens and 0.015 ml/l for deep oxygens are only intended as indicators of how well the up-cast bottle and pressure-series (mostly down-cast) CTD O_2 values match up. 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 O_c gradient, dO_c/dt, is approximated by low-pass filtering 1st-order O_c differences. This gradient 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:

$$O_{pp} = [c_1 O_c + c_2] \cdot f_{sat}(S,T,P) \cdot e^{(c_3 P_l + c_4 T_f + c_5 T_s + c_6 \frac{dO_c}{dt})} \tag{8.4.0}$$

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).

S4I CTD O_2 correction coefficients (c_1 through c_6) are tabulated in Appendix B.

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;
- AMS ^{14}C;
- Nutrients;
- Salinity;
- $^{18}O/^{16}O$;
- Tritium;
- Alkalinity.

Since some properties were not sampled on every cast, the actual sample-drawing sequence was modified as necessary.

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 the proper drawing order.

Normal sampling practice included opening the drain valve and then 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 respective laboratories for analysis. Oxygen, nutrients and salinity analyses were performed on computer-assisted (PC) analytical equipment networked to Sun SPARCstations for centralized data analysis. The analysts for each specific property were responsible for insuring that their results were updated into the cruise database.

10. Bottle Data Processing

Bottle data processing began with sample drawing, and continued until the data were considered to be final. One of the most important pieces of information, the sample log sheet, was filled out during the drawing of the many different samples. It was useful both as a sample inventory and as a guide for the technicians in carrying out their analyses. Any problems observed with the rosette before or during the sample drawing were noted on this form, including indications of bottle leaks, out-of-order drawing, etc. Oxygen draw temperatures recorded on this form were at times the first indicator of rosette bottle-tripping problems. Additional clues regarding bottle tripping or leak problems were found by individual analysts as the samples were analyzed and the resulting data were processed and checked.

The next stage of processing was accomplished after the individual parameter files were merged into a common station file, along with CTD-derived parameters (pressure, temperature, conductivity, etc.). The rosette cast and bottle numbers were the primary identification for all ODF-analyzed samples taken from the bottle, and were used to merge the analytical results with the CTD data associated with the bottle. At this stage, bottle tripping problems were usually resolved, sometimes resulting in changes to the pressure, temperature and other CTD properties associated with the bottle. All CTD information from each bottle trip (confirmed or not) was retained in a file, so resolving bottle tripping problems consisted of correlating CTD trip data with the rosette bottles.

Diagnostic comments from the sample log, and notes from analysts and/or bottle data processors were entered into a computer file associated with each station (the "quality" file) as part of the quality control procedure. Sample data from 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. Various property-property plots and vertical sections were examined for both consistency within a cast and consistency with adjacent stations by data processors, who advised analysts of possible errors or irregularities. The analysts reviewed and sometimes revised their data as additional calibration or diagnostic results became available.

Based on the outcome of investigations of the various comments in the quality files, WHP water sample codes were selected to indicate the reliability of the individual parameters affected by the comments. WHP bottle codes were assigned where evidence showed the entire bottle was affected, as in the case of a leak, or a bottle trip at other than the intended depth.

WHP water bottle quality codes were assigned as defined in the WOCE Operations Manual [Joyc94] with the following additional interpretations:

2	No problems noted.
3	Leaking. *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	Did not trip correctly. *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	Not reported. *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.*
9	The samples were not drawn from this bottle.

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

1	The sample for this measurement was drawn from the water 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 acceptable, but are open to interpretation.*
4	Bad measurement. *The data did 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 up-cast.*
4	Bad measurement. *The CTD up-cast data were determined to be unusable for calculating a salinity.*
7	Despiked. *The CTD data have been filtered to eliminate a spike or offset.*

WHP water sample quality flags were assigned to the CTDO (CTD O_2) parameter as follows:

1	Not calibrated. *Data are uncalibrated.*
2	Acceptable measurement.
3	Questionable 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, typically when CTD salinity is coded 3 or 4.*
7	Despiked. *The CTD data have been filtered to eliminate a spike or offset.*
9	Not sampled. *No operational CTD O_2 sensor was present on this cast.*

Note that CTDO values were derived from the down-cast pressure-series CTD data, except for 18 stations where up-casts were processed because of conductivity problems on the down-casts. CTD data were matched to the up-cast bottle data along isopycnal surfaces. If the CTD salinity is footnoted as bad or questionable, the CTD O_2 is not reported.

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 001-108								
	Reported	WHP Quality Codes						
	Levels	1	2	3	4	5	7	9
Bottle	3655	0	3542	1	108	0	0	4
CTD Salt	3655	0	3493	0	36	0	126	0
CTD Oxy	3619	0	2909	111	599	36	0	0
Salinity	3604	0	3521	24	59	9	0	42
Oxygen	3630	0	3568	33	29	7	0	18
Silicate	3640	0	3638	1	1	0	0	15
Nitrate	3640	0	3639	0	1	0	0	15
Nitrite	3640	0	3639	0	1	0	0	15
Phosphate	3640	0	3602	3	35	0	0	15

Table 10.0 Frequency of WHP quality flag assignments for S4I.

Additionally, all WHP water bottle/sample quality code comments are presented in Appendix D.

11. Pressure and Temperatures

All pressures and temperatures for the bottle data tabulations on the rosette casts were obtained by averaging CTD data for a brief interval at the time the bottle was closed on the rosette, then correcting the data based on CTD laboratory calibrations.

The temperatures are reported using the International Temperature Scale of 1990.

12. Salinity Analysis

Equipment and Techniques

Two Guildline Autosal Model 8400A salinometers were available for measuring salinities. The salinometers were modified by ODF and contained interfaces for computer-aided measurement. Autosal #57-396 was a backup unit but was not used on this expedition. Autosal #55-654 was used to measure salinity on all stations. Its water bath temperature was set and maintained at 24°C for all runs except stations 32-39, where the bath temperature was set at 21°C.

The salinity analyses were performed when samples had equilibrated to laboratory temperature, within 7-28 hours after collection. The salinometer was standardized for each group of analyses (typically one cast, usually 36 samples) using two fresh vials of standard seawater per group. A computer (PC) prompted the analyst for control functions such as changing sample, flushing, or switching to "read" mode. At the correct time, the computer acquired conductivity ratio measurements, and logged results. The sample conductivity was redetermined until readings met software criteria for consistency. Measurements were then averaged for a final result.

Unstable readings were encountered during analysis of the first 5 samples from station 42. The Autosal flow cell was cleaned, and sample analysis was resumed ~10 hours later without further problems.

Sampling and Data Processing

Salinity samples were drawn into 200 ml Kimax high-alumina borosilicate bottles, which were rinsed three times with sample prior to filling. The bottles were sealed with custom-made plastic insert thimbles and Nalgene screw caps. This assembly provides very low container dissolution and sample evaporation. Prior to collecting each sample, inserts were inspected for proper fit and loose inserts were replaced to insure an airtight seal. The draw time and equilibration time were logged for all casts. Laboratory temperatures were logged at the beginning and end of each run.

PSS-78 salinity [UNES81] was calculated for each sample from the measured conductivity ratios. The difference (if any) between the initial vial of standard water and one run at the end as an unknown was applied linearly to the data to account for any drift. The data were added to the cruise database. 3604 salinity measurements were made and 233 vials of standard water were used. The estimated accuracy of bottle salinities run at sea is usually better than 0.002 PSU relative to the particular standard seawater batch used.

Laboratory Temperature

The temperature stability in the salinometer laboratory was fair, ranging from 18.7 to 25.8°C and drifting an average of 0.5°C during a run of samples. The laboratory temperature was between -4 and +2°C of the Autosal bath temperature during all sample runs.

Standards

IAPSO Standard Seawater (SSW) Batch P-125 was used to standardize the salinometers.

13. Oxygen Analysis

Equipment and Techniques

Dissolved oxygen analyses were performed with an ODF-designed automated oxygen titrator using photometric end-point detection based on the absorption of 365nm wavelength ultra-violet light. The titration of the samples and the data logging were controlled by PC software. Thiosulfate was dispensed by a Dosimat 665 buret driver fitted with a 1.0 ml buret. ODF used 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). Carbon disulfide was added to the thiosulfate as a preservative. 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. Nine standards were made up during the cruise and compared to assure that the results were reproducible, and to preclude the possibility of a weighing or dilution error. Reagent/distilled water blanks were determined, to account for presence of oxidizing or reducing materials.

Sampling and Data Processing

Samples were collected for dissolved oxygen analyses soon after the rosette sampler was brought on board, and after samples for CFCs and helium were drawn. Using a Tygon drawing tube, nominal 125ml volume-calibrated iodine flasks were rinsed twice with minimal agitation, then filled and allowed to overflow for at least 3 flask volumes. The sample draw temperature was measured with a small platinum resistance thermometer embedded in the drawing tube. Reagents were added to fix the oxygen before stoppering. The flasks were shaken twice to assure thorough dispersion of the precipitate, once immediately after drawing, and then again after about 20 minutes. The samples were analyzed within 1-9 hours of collection (18 hours for station 1 only), and then the data were merged into the cruise database.

Thiosulfate normalities were calculated from each standardization and corrected to 20°C. The 20°C normalities and the blanks were plotted versus time and were reviewed for possible problems. New thiosulfate normalities were recalculated after the blanks had been smoothed as a function of time, if warranted. 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. Sample temperatures were measured at the time the samples were drawn from the rosette bottle. These temperatures were useful in indicating whether or not a bottle tripped properly.

3630 oxygen measurements were made, with no major problems encountered during the analyses.

Volumetric Calibration

Oxygen flask volumes were determined gravimetrically with degassed deionized water 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. The volumetric flasks used in preparing standards were volume-calibrated by the same method, as was the 10 ml Dosimat buret used to dispense standard iodate solution.

Standards

Potassium iodate standards, nominally 0.44 gram, were pre-weighed in ODF's chemistry laboratory to ±0.0001 grams. The exact normality was calculated at sea after the volumetric flask volume and dilution temperature were known. Potassium iodate was obtained from Johnson Matthey Chemical Co. and was reported by the supplier to be >99.4% pure. All other reagents were "reagent grade" and were tested for levels of oxidizing and reducing impurities prior to use.

14. Nutrient Analysis

Equipment and Techniques

Nutrient analyses (phosphate, silicate, nitrate and nitrite) were performed on an ODF-modified 4-channel Technicon AutoAnalyzer II, generally within a few hours after sample collection. Occasionally samples were refrigerated up to a maximum of 8 hours at 2-6°C. All samples were brought to room temperature prior to analysis.

The methods used are described by Gordon *et al.* [Gord93]. The analog outputs from each of the four channels were digitized and logged automatically by computer (PC) at 2-second intervals.

Silicate was analyzed using the technique of Armstrong *et al.* [Arms67]. An acidic solution of ammonium molybdate was added to a seawater sample to produce silicomolybdic acid which was then reduced to silicomolybdous acid (a blue compound) following the addition of stannous chloride. Tartaric acid was also added to impede PO_4 color development. The sample was passed through a 15mm flowcell and the absorbance measured at 660nm.

A modification of the Armstrong *et al.* [Arms67] procedure was used for the analysis of nitrate and nitrite. For the nitrate analysis, the seawater sample was passed through a cadmium reduction column where nitrate was quantitatively reduced to nitrite. Sulfanilamide was introduced to the sample stream followed by N-(1-naphthyl)ethylenediamine dihydrochloride which coupled to form a red azo dye. The stream was then passed through a 15mm flowcell and the absorbance measured at 540nm. The same technique was employed for nitrite analysis, except the cadmium column was bypassed, and a 50mm flowcell was used for measurement.

Phosphate was analyzed using a modification of the Bernhardt and Wilhelms [Bern67] technique. An acidic solution of ammonium molybdate was 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 was heated to ~55°C to enhance color development, then passed through a 50mm flowcell and the absorbance measured at 820nm.

Sampling and Data Processing

Nutrient samples were drawn into 45 ml polypropylene, screw-capped "oak-ridge type" centrifuge tubes. The tubes were cleaned with 10% HCl and rinsed with sample twice before filling. Standardizations were performed at the beginning and end of each group of analyses (typically one cast, usually 36 samples) with an intermediate concentration mixed nutrient standard prepared prior to each run from a secondary standard in a low-nutrient seawater matrix. The secondary standards were prepared aboard ship by dilution from primary standard solutions. Dry standards were pre-weighed at the laboratory at ODF, and transported to the vessel for dilution to the primary standard. Sets of 6-7 different standard concentrations were analyzed periodically to determine any deviation from linearity as a function of concentration for each nutrient analysis. A correction for non-linearity was applied to the final nutrient concentrations when necessary.

After each group of samples was analyzed, the raw data file was processed to produce another file of response factors, baseline values, and absorbances. Computer-produced absorbance readings were checked for accuracy against values taken from a strip chart recording. The data were then added to the cruise database.

3640 nutrient samples were analyzed. No major problems were encountered with the measurements. The pump tubing was changed four times, and deep seawater was run as a substandard check. The temperature stability of the laboratory used for the analyses was good, ranging from 20 to 24°C.

Nutrients, reported in micromoles per kilogram, were converted from micromoles per liter by dividing by sample density calculated at 1 atm pressure (0 db), *in situ* salinity, and an assumed laboratory temperature of 25°C.

Standards

The silicate primary standard (Na_2SiF_6) was obtained from Aesar and was reported by the suppliers to be >98% pure. The nitrite ($NaNO_2$) primary standard was obtained from GFS and was reported by the suppliers to be >97% pure. Primary standards for nitrate (KNO_3) and phosphate (KH_2PO_4) were obtained from Johnson Matthey Chemical Co., and the supplier reported purities for each of 99.999%.

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B. Underway Measurements

B1. Navigation and Bathymetry

Navigation data were acquired from the ship's Ashtech GPS receiver via the network. They were logged automatically at one-minute intervals by one of the Sun Sparcstations. Underway bathymetry was logged manually from the ship's 12 kHz Raytheon/EPC PDR at five-minute intervals (or when possible in the ice), 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 (Carter, 1980). Depth data on the transit from Cape Town to station 1, and from station 108 to Hobart were not logged. Data on station were not logged.

B2. Meteorological Observations

Five-minute average meteorological data are routinely recorded by the Palmer. Data recorded consist of time, position, air temperature, relative humidity, wet-bulb temperature, PSR, PIR, barometric pressure, and wind speed and direction. Data were recorded continuously from Cape Town to Hobart. Significant data gaps (longer than 20 minutes, but less than 32 minutes in all cases) occurred on 19 and 27 May, and 1,2,4,7,20 and 24 June.

B3. Hull-mounted Acoustic Doppler Current Profiler

(S. Rutz)

Ocean velocity observations were taken using a hull-mounted Acoustic Doppler Current Profiler (ADCP) system and GPS navigation data. Data were recorded from May 3, 1995 to July 4, 1996 between Capetown, South Africa and Hobart, Australia, along the nominal latitude of 62° S from 20° E to 120° E with two transects across the Antarctic continental slope. The purpose of the observations was to document the upper ocean horizontal velocity structure along the cruise track. The observations provide absolute velocity estimates including the ageostrophic component of the flow. Fig. 2 shows the cruise track and the near-surface currents measured by the ADCP.

The hull-mounted ADCP is part of the ship's equipment aboard the Palmer. The ADCP is a 150 kHz unit manufactured by RD Instruments. The instrument pings about once per second, and for most of the cruise the data were stored as 100-second averages or ensembles. The user-exit program, ue4, receives and stores the ADCP data along with both the P-code navigation data from a Trimble receiver and the positions from an Ashtech gps receiver. The ship gyro provided heading information for vector averaging the ADCP data over the 100- second ensembles. The user-exit program calculates and stores the heading offset based on the difference between the heading determination from the Ashtech receiver and from the ship gyro. The ADCP transducer is mounted in a glycol bath at a depth of about 7 meters below the sea surface.

As setup parameters, a blanking interval of 16 meters, a vertical pulse length of 16 meters, a vertical bin size of 8 meters, and 60 bins were used. A 300- second sampling interval was used at the beginning of the cruise and the interval was decreased to 100-seconds shortly after entering pack ice to increase the amount of usable data (cruising through ice severely limited the percent of good return pings). 100-seconds was the sampling interval for the remainder of the cruise.

Bottom tracking was activated during the shallow water transits near South Africa, Antarctica, and Tasmania. For the processing of the ADCP data aboard ship, a rotation amplitude of 0.97, a rotation angle of -1.65 degrees (added to the gyro minus gps heading), and a time filter width of one hour were used. Final editing and calibration of the ADCP data has not yet been done. For example, some spikes due to pinging off the CTD wire or rosette on station are still present in the data.

A set of preliminary plots was generated during the cruise. The plots display velocity vectors averaged over several depth intervals, and over one hour in time. The velocity was measured from a depth of 23 meters to a depth of about 500 meters.

During the first few weeks of the cruise, the ADCP hung a half-dozen times for unknown reasons. Several measures were taken to prevent this (e.g., the keyboard was locked) or to minimize its effect (e.g., a "watch dog" program was installed that would reboot the PC if it hung for more than about five minutes). These measures were mostly successful though the ADCP did hang one more time for unexplained reasons late in the cruise.

A Trimble P-code receiver was used for navigation. The data from the receiver was stored once per second for the entire cruise. The Ashtech receiver uses a four antennae array to measure position and attitude. The heading estimate was used with the ship gyro to provide a heading correction for the ADCP ensembles. The Ashtech data was stored by the ADCP user-exit program along with the ADCP data.

The Ashtech receiver at times (especially after it had been reset) could not lock onto enough satellites to determine the ship's heading. This was remedied by temporarily disabling certain satellites that were low on the horizon so that the Ashtech would not waste its time in a futile attempt to lock onto them.

Also, the ship gyro input to the ADCP hung about two dozen times during the cruise for intervals ranging from several minutes to hours. The hangs were mostly due to the ship's data acquisition system (DAS) crashing. An attempt to feed the ship gyro directly to the ADCP, bypassing the DAS, was unsuccessful and had some unintended consequences (i.e., the auto-pilot went berserk).

B4. Atmospheric Chemistry
(D. Chipman and M. Mensch)

Air samples for analysis were drawn from a single inlet located just forward of the ship's bridge through a continuous run of 3/8 inch diameter Dekoron tubing. A KNF Neuberger pump with a teflon-covered rubber diaphragm was use to pressurize the air for distribution to the CO_2 analysis system in the Hydro Lab and the CFC analysis system in the Dry Lab.

A vent line with a needle valve from a tee fitting at the CFC system provided backpressure for the line while allowing it to be continuously flushed with fresh atmospheric air.

CO2 Analysis

The LDEO underway pCO_2 analysis system was used to determine the concentration of CO_2 in dried atmospheric air. At intervals of approximately one half hour, air from the atmospheric sampling line was allowed to flow through a countercurrent-flow permeation gas dryer and then through the cell of the Licor infrared gas analyzer for three minutes at a flow rate of 25-35 ml/min. The sample flow was stopped for 20 seconds prior to reading the analyzer output, to allow time for the pressure to vent to the atmospheric value and for the sample to come to cell temperature. Immediately following each atmospheric sample, the instrument was calibrated using a set of four compressed air-CO_2 mixtures (which have CO_2 concentrations traceable to the WMO scale of C.D. Keeling); a second-order polynomial response curve was fitted to the instrumental signals given by these gases and used to calculate the concentration of CO_2 in the sample.

Atmospheric measurements were made whenever the pCO_2 analysis system was operating, which was essentially continuously in open water and periodically (usually at stations only) when operating in the ice. Because of the problem of contamination with stack gas when the relative wind was from behind the ship, only those analyses made when the ship's meteorological monitoring system indicated relative winds from ahead were considered valid and retained.

CFC Analysis

Marine air samples for CFC analysis were taken from the bow air line immediately in front of the T-fitting leading to the vent line. The air was dried by flowing through magnesium perchlorate and then analyzed in exactly the same way standard gases were measured (Section C7). Marine air was analyzed whenever the necessary time was available and the relative wind direction was from the bow. The results will provide information about the current atmospheric CFC levels and will allow the calculation of the CFC saturation levels in the surface water.

B5. Thermosalinograph and underway pCO_2

(D. Chipman)

The Palmer is fitted with two separate uncontaminated seawater lines- a 1-inch line of stainless steel and PVC, which supplies the thermosalinograph and other instruments in the Hydro Lab, and a 2-inch stainless steel line which provides water to the Aquarium Lab.

Both have inlets located at a depth of approximately 6.7 meters, well aft of the bow to reduce the entrainment of air and ice during icebreaking operations. Due to a failure of the pump on the thermosalinograph line about one third of the way through the cruise, the thermosalinograph and underway pCO_2 equilibrator were replumbed to be supplied water from the larger seawater line. Both lines were plagued with blockages due to ice entrainment during operations in the heavy ice, especially when snow-covered, and in general uncontaminated seawater was only available when operating in open water or unconsolidated floes, or when on station within the ice.

The ship is fitted with a Seabird Model SBE-21 thermosalinograph, located in the Hydro Lab, operated and maintained by ASA personnel. The unit is provided with a remote temperature sensor located near the inlet of the smaller uncontaminated seawater line, to provide an approximate sea surface temperature. Data are logged continuously during operation by the ship's RTDAS. Due to the failure of the pump on the thermosalinograph line, the thermosalinograph received water from the other seawater line during most of the cruise, and the remote temperature was thus unavailable. A very approximate underway surface temperature during the later part of the cruise was calculated using an offset from the thermosalinograph temperature, calibrated against CTD mixed-layer temperatures during station work and against bucket thermometer temperatures during the transit from the last station to Hobart.

Although the seawater line in the Hydro Lab is provided with a vortex-type debubbler, it is plumbed in parallel with the thermosalinograph, and water for the latter instrument is not routinely debubbled. Near the beginning of the cruise it became obvious that the very high noise level on the thermosalinograph salinity channel was caused by entrained air in the seawater line and the unit was replumbed to receive water from the outlet of the debubbler, which reduced the noise appreciably.

Underway pCO$_2$

Underway measurements of the surface seawater pCO$_2$ were made using a shower-type seawater-air equilibrator similar to that originally designed by Takahashi (Broecker and Takahashi, 1966). Seawater from the same uncontaminated pumped water line which supplies the ship's thermosalinographwas used as a source for the CO_2 equilibrator. The equilibrator was located downstream of a vortex debubbler to remove air entrained with the water. Air was continuously recirculated through the headspace of the equilibrator by means of a small air pump, and aliquots of this air were removed for analysis using a Licor infrared analyzer built into a fully automated analysis system. Sample gases were dried by means of a countercurrent-flowpermeation gas dryer immediately prior to analysis. After eight samples of equilibrated air were analyzed, a single sample of atmospheric air pumped from a sampling point just ahead of the ship's bridge was similarly dried and analyzed. This was followed by calibration of the instrument using four air-CO_2 mixtures (150 to 450 ppm range) which are traceable to the WMO calibration scale of C. D. Keeling of SIO. Barometric pressure (essentially the same as the pressure of equilibration) was measured at the time of each analysis by means of an AIR electronic barometer, and the temperature of equilibration was measured at the same time by means of a platinum resistance thermometer within the equilibrator, calibratedagainst a NIST-traceablemercury thermometer. The entire cycle of eight equilibrated air samples, one atmospheric air sample, and four calibration gases required approximately one half hour, and was repeated continuously. Measurements were made whenever the ship was in open water outside the territorial waters of the Republic of South Africa or Australia, and to a limited extent while operating within the ice (due to the clogging of the seawater lines during ice operations).

C6. Nutrient Analysis

(F. Delahoyd)

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 also rinsed with 1.2N HCl after each use. Standardizations were performed at the beginning and end of each group of analyses (one cast, usually 36 samples) with a set of an intermediateconcentration 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 Auto-Analyzer II, generally within one hour of the cast. Occasionally some samples were refrigerated at 2° C to 6° C for a maximum of 4 hours. The methods used are described by Gordon et al. (1992). The colorimeter outputs from each of the four channels were digitized and logged automatically by computer (PC), then split into absorbence peaks. Each was manually verified.

Silicate is analyzed using the technique of Armstrong et al. (1967). 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 also added to impede PO4 color development (interference). The sample is passed through a 15 mm flowcell and the absorbence measured at 820nm. ODF's methodology is known to be non-linear at high silicate concentrations (>120 M); a correction for this nonlinearity is applied in ODF's software.

Modifications of the Armstrong et al. (1967) 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 flow-cell is used. Phosphate is analyzed using a modification of the Bernhardt and Wilhelms (1967) technique. 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 55° 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 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 obtained from Johnson Matthey Chemical Co. and the supplier reports purities of 99.999%, 97%, and 99.999%, respectively.

3854 nutrient analyses were performed. No major problems were encountered with the measurements. The pump tubing was changed four 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 99.6-100.0%. The temperature stability of the laboratory used for the analyses was good, ranging from 20.0 to 24.0°C.

C7. Chlorofluorocarbon Analysis

(M. Mensch)

The CFC analysis on board as well as the sampling in flame-sealed glass ampoules for subsequent on-shore analysis were performed by Guy Mathieu and Manfred Mensch (Lamont-Doherty Earth Observatory of Columbia University, New York, PI Bill Smethie) and by Steve Covey (University of Washington, Seattle, PI Mark Warner).

The CFC lab was set up in the aft dry lab (N.B. Palmer room # 905). This room was not optimal for the operation of the CFC measurement systems:

· There is no temperature control. This caused large long-term temperature drifts.
· Whenever the outside door of the Baltic Room was open, the only access to the Baltic Room was through the aft dry lab giving rise to considerable short-term temperature and pressure fluctuations.
· The "fresh" air supply to this lab consisted at least partly of recirculated air bearing the danger of serious contamination.

The equipment was provided by Lamont-Doherty Earth Observatory. Two gas chromatographic measurement systems, both designed and constructed at L-DEO, were used. Both systems use the same technique for gas and water sample preparation, purification and concentration prior to injection into the chromatographic separation columns.

The two systems were based on different chromatographic pre-columns and analytical columns for the separation of the CFCs from more slowly eluting compounds (pre-column) and from each other (analytical column). Both systems were configured to measure CFC11, CFC12, CFC113; system 1 also measured CCl_4.

On system 1, a capillary pre-column and analytical column (DB VRX, length 18 m and 57 m, respectively, film thickness 5 µm, I.D. 530 µm) were used. Both columns were held in the oven of an HP8950 GC at 90° C for the first 9.1 minutes of the run. After the complete elution of CCl_4, the temperature was ramped up to 110° C within 0.5 min to clean the columns. The detector was operated at a temperature of 280° C. To minimize analysis time, pressure ramping was also used. A relatively high pressure of 110 kPa during the first minute of each run rapidly transferred the CFCs from the trap to the pre-column. The pressure was lowered to 70 kPa during the next minute and held at that level for 4.5 minutes. Then it was raised back to 110 kPa within 2 minutes. The total length of the chromatographic run was 11 minutes. The analysis took about 15 minutes per sample.

System 2 used packed columns: a pre column of 80-100 mesh Porasil B packed in 40-inch stainless steel tubing with 0.085-inch I.D., and an analytical column of 60-80 mesh Carbograph 1AC packed in 5-ft stainless steel tubing with 0.085-inch I.D. Both were held at 80° C in the oven of a Shimadzu GC 8A, the detector temperature was 260° C. The analysis time per sample was about 11 min with 8 min being used for the chromatographic run.

To avoid interferenceof N_2O with CFC12, N_2O was suppressed on both systems by 80-100 mesh mol sieve 5A packed into 4 in of 0.085-inch I.D. stainless steel tubing. The mol sieve was operated at about 50°C. The mol sieve was placed between the analytical column and the detector. It was valved out of the gas stream before the elution of CFC11.

Based on the originally-proposed cruise track with 1 station every 30 nm it was planned to obtain 30 samples on every other station for analysis on system 2 and at least 18 samples out of the deep part of the water column on the stations in between for analysis on system 1. As the cruise progressed, this plan was adapted to the variable station spacing, bottom depth, weather and sea ice situation and other factors.

Sample collection

Water samples were drawn into 100-ml precision ground glass syringes directly from the 10-l Niskin-type bottles before any other samples. Close ended Luerlock fittings were used to seal filled syringes. The samples were kept under slightly positive pressure by applying a rubber band around the syringe barrel.

Because of the loss of the primary rosette during a test cast, the 10-l bottles on the back-up rosette could not be tested for their CFC blank levels. By the time the spare rosette was ready for deployment, the ship was already close to the first station and in an oceanic region where no CFC-free waters can be found at any depth. However, all O-rings of the Niskins were baked before use to remove CFCs; no suspicious variability in samples from the CFC minimum layer was detected.

To isolate the samples from lab air, filled syringes were stored in a deep sink that was continuously flushed with uncontaminatedsurface sea water from the ship's sea water line.

Unfortunately, whenever the ship was operating in ice covered waters the sea water pump had to be shut down. During these times the samples were still kept in the same sink filled with sea water.

Sample analysis

From the syringes, the water samples were injected through a three-way valve into a calibrated glass volume (approximately 35 cc, calibrated to better than 0.1%). The three-way valve and the calibrated volume were flushed with sample water. The water in the calibrated volume was subsequently transferred to a glass stripper chamber where the dissolved gases were purged with ultra high purity Nitrogen. The released CFCs were concentrated by adsorption on a Unibeads cold trap at -60° C. Subsequently the trap was isolated and heated. The desorped gases were backflushed into the chromatographic columns. On system 1, cooling was accomplished by immersing the trap into denatured alcohol cooled by a cryo cooler; heating to 100° C was achieved by immersion in boiling water. System 2 used an automated temperature control: Cooling was done by liquid CO_2, heating to 120° C was done electrically. Fig. 3 shows typical chromatograms for samples with intermediate and low concentrations as well as a stripper blank. These chromatograms were obtained from system 2.

On both systems, all chromatograms were acquired from the gas chromatograph by a Shimadzu Chromatopac CR601, which also controlled the valves, and on system 2, the automated trap.

Through an interface, the chromatograms were then transferred to a PC system where peak integration and data calculation were carried out.

Calibration
For both systems, the response of the electron capture detector to different amounts of CFCs was calibrated by filling 10 different volumes with standard gas out of an Acculife compressed gas cylinder. After relaxation to ambient temperature and pressure the standard gas was concentrated onto the cold trap and subsequently injected into the columns. One of the standard volumes was used frequently (at least every other hour) to check for drifts in the detector's response. The standard gas (CFCs in Nitrogen) was gravimetrically prepared at Brookhaven National Laboratories and calibrated at L-DEO relative to the SIO 1993 scale. It will be recalibrated as soon as possible after the cruise. Chromatograms from system 2 for different amounts of standard gas as well as a system blank are displayed in Fig. 4.

Preliminary results
Profiles of CFC11, CFC12 and CFC113 from station 67 are shown in Fig. 5. The intermediate CFC maximum at 250 m corresponds to a local minimum of the potential temperature and is associated with a maximum of the O_2 concentration.

Fig. 6 shows a vertical section of the CFC11 concentration along 59.6° S from the Kerguelen Plateau into the Australian Antarctic Basin. Surface concentrations are around 6.5 pM/kg along the entire section. In the eastern part of the section above the Kerguelen Plateau, CFC11 concentrations are less than 0.25 pM/kg below 500 m and drop below 0.1 pM/kg approximately 400 m off the bottom. West of station 66, the penetration depth of the CFCs is much larger. The effect is most pronounced at stations 67 to 70, where subpolar waters are encountered. Within the Australian Antarctic Basin, the lowest CFC11 concentrations are around 0.15 pM/kg.

Below 4000 m, CFC11 concentrations are higher than 1 pM/kg. The bottom values are around 1.3 pM/kg.

CFC intercomparison samples
On June 28, 1996, after all samples from the last WOCE station (# 108) were analyzed, a dedicated cast was made to collect water samples for an intercomparison of various European and U.S. CFC laboratories. The rosette was lowered to 1600 m depth where the CFC minimum was located on the previous WOCE stations, and 17 Niskins were closed before the rosette was brought up to the mixed layer. At 35 m depth the remaining 19 Niskins were closed.

Back on deck, five samples were drawn in succession from each of 16 deep Niskins. It took at most 15 minutes to draw all samples from each Niskin. The first and last sample were drawn into glass syringes as described above. The analysis results from the first syringe provide the initial CFC concentration of the sample; the measurements from the second syringe give information about possible atmospheric contamination during the sampling interval. A dedicated rig designed by the University of Bremen (PI Wolfgang Roether) and manufactured for L-DEO, was used to draw the other three samples into custom made glass ampoules which were flame-sealed within 15 min after sampling.

Four samples each were drawn from 16 of the shallow Niskins. Again, the first sample was drawn into a syringe to establish the CFC concentration of the sampled water mass. The remaining three samples were drawn and sealed into glass ampoules. (One of the deep, and three of the shallow Niskins were not accessible by the ampoule rigs and therefore not sampled at all.)

This special cast provided 48 samples each from two different depths sealed in glass ampoules. The initial CFC concentrations were determined from the syringe samples, which were analyzed within ten hours of the completion of the cast. To prevent hydrolysis of CCl_4, the ampoules were stored in one of the ships science coolers. They were air-freighted back to Lamont for distribution to the CFC laboratories participating in the intercomparison experiment.

C8. Helium, Tritium and ^{18}O Sampling

(D. Breger)

Helium, tritium and ^{18}O samples were drawn at a total of 606 levels distributed over 34 stations The samples were stored for shipment to Lamont-Doherty Earth Observatory for shore-based extraction and analysis.

Helium samples were drawn immediately after CFCs. The helium samplers consisted of one-meter long copper tubes (holding 200 ml of sample) housed in one-meter long aluminum channels, each marked with cruise name, station number, Niskin number, nominal depth, unique sample identification number, and station date. A seawater-cured tygon tube at the intake end delivered the sample from the Niskin bottle and a similar longer tygon tube at the outflow end ensured that no air would fall back into the copper tube during clamping, and directed the outflow away from neighboring samplers. After the intake tygon tube was cleared of air bubbles, the aluminum channel was struck several times while the copper tube was flushed with approximately 250-350 ml of water sample. The outflow end was then clamped with a ratchet wrench, after which the inflow end was clamped. The timing of sampling was logged at several points during the station. After the station, both ends of each channel were dipped in fresh water and towel dried. Fresh water was also sprayed into both ends of each copper tube and shaken out. The channels were immediately placed into their crates for storage and shipment.

Tritium samples were collected at the same stations and levels as helium, in one-liter amber glass bottles filled with argon. At the outset of the cruise, all personnel who expected to be in the sampling room during the cruise were warned against wearing tritium-dial watches, and replacement digital watches were issued to those who required them. All bottles were labeled with cruise name, station number, Niskin number, nominal depth, unique sample identification number, and station date. No delivery tube was used, and the bottle was not flushed prior to sample collection, although the caps were rinsed several times with the sample prior to closing. The seawater sample poured directly from the Niskin spigot into the bottle, which was held as upright as possible to avoid argon loss, and as close to the spigot as possible without touching it. The bottles were tightly capped and wiped dry. After each sample was drawn the bottle was returned to its storage/shipping crate. After completion of the station, the caps were sealed with electrical tape to avoid working loose during shipment and the crates sealed and stored for shipment.

Samples for ^{18}O analysis were collected at the same stations and levels as helium and tritium in 30 ml clear glass bottles. All bottles were labeled with cruise name, station number, Niskin number, nominal depth, unique sample identification number, and station date. No delivery tube was used. Both the bottles and caps were rinsed several times with the sample prior to collection, which was directly from the Niskin spigot, as close to it as possible without touching. After sampling each bottles was tightly capped and wiped dry and returned to its box. After completion of the station the caps were sealed by electrical tape to avoid working loose during shipment. When each box was full it was returned to its crate, which was sealed and stored for shipment.

C9. Radiocarbon Sampling

(R. Key)

Section S04I is the tenth and final sample collection leg for the WOCE radiocarbon program. Fig. 7 shows the sampling locations. Approximately 60% of the indicated stations were sampled only in the thermocline while the remainder were sampled throughout the water column. Normally 16 samples were collected for thermocline stations and 32 samples for full profiles. Approximately 4500 samples were collected in total. Throughout the Indian Ocean survey, only small volume (AMS) radiocarbon samples were collected. The sample collection procedures described in Joyce (1991) were used. The sample tracking, analysis and quality control procedures outlined in Key (1996) and Key et al. (1996) and described in detail in references cited there, will be used to complete the laboratory phase of this program.

Prior to WOCE section S04I, the only radiocarbon data in the Southern Ocean sector of the Indian Ocean were from three GEOSECS stations (430-432). The goals of this leg were to collect a sufficient data set to describe the major features of the area, to identify and characterize any "new" bottom waters and to define the characteristics of the deep and bottom waters which flow north into the deep Indian (and Pacific) Ocean. The extreme lack of data coupled with these goals resulted in a different sampling strategy than used for the rest of the Indian (and Pacific) Ocean. Rather than intersperse 1 full water column sampling with 1-2 thermocline profiles, all stations sampled for radiocarbon were sampled throughout the entire column. Station spacing was nominally 5 degrees of longitude (150nm) with somewhat closer spacing on the two north-south transects toward Antarctica.

Thirty-one stations (816 samples) were sampled along section S04I.

Upon return to the U.S., these samples will be placed in the analytical queue at NOSAMS (WHOI). Prior to the beginning of the Indian Ocean survey, the advisory group (Key, Quay, Toggweiler & Schlosser) which determines analytical priority decided that the Indian samples would be done on a first-in first-out basis. If this is followed, these samples will be measured in approximately 3-4 years. A second alternative is that these samples will be run along with the S04 Pacific samples. If this is the decision, the samples will be completed in less than 2 years.

C10. CO2 Sampling and Analysis

(D. Chipman)

Sampling

Samples for CO_2 and alkalinity analyses were drawn from the 10-liter Niskin bottles of the rosette sampler at selected stations

Samples for total CO_2 (TCO_2) analysis were collected in 250 ml glass reagent bottles with ground glass stoppers, sealed with silicone high-vacuum grease and were stored at room temperature prior to analysis.

Samples for pCO_2 analysis were collected in 500 ml volumetric flasks with plastic-lined screw caps and were stored in the dark at approximately 4^oC until analysis.

200 µl of 50%-saturated $HgCl_2$ solution was added to both types of CO_2 sample to prevent biological alteration of the CO_2

Total CO2 analysis

TCO_2 analyses were made coulometrically,using the LDEO-designextraction system. This system provides for automated calibration of the coulometer by means of injections of known quantities of pure CO_2, whereas sample injection is manual, using glass syringes fitted with special adapters to provide constant sample volumes. A jacketed electrochemical cell with constant-temperature circulator is used to insure the cell solutions are at constant temperature, in order to provide a consistent endpoint pH. The anode and cathode compartments are separated by means of an agar plug in addition to the usual glass frit. Glass wool and a 0.2µ teflon filter are used to prevent aerosols from being carried to the electrochemical cell from the extraction tube, but no chemical clean-up or drying of the carrier gas is used between extraction and analysis. The carrier gas is CO_2 -free air, provided by means of a chromatographic-type pure-air generator and Mallcosorb CO_2 scrubber.

The instrument is calibrated at the beginning and end of the use of a given set of cell solutions, and after every 10-12 sample analyses, using 99.999% CO_2. Since this type of calibration verifies the instrumental calibration but does not check the accuracy of the volume of seawater sample being injected, samples of calibrated reference material (CRM) provided by A. Dickson of SIO were run as unknowns at the beginning and end of the use of a given set of cell solutions (immediately after the initial and prior to or after the final instrumental calibration). Each CRM was analyzed using each of the three syringes which were being used for sample injection, so that any change in the volume injected could be detected (none was ever noted). Each set of cell solutions was retired after the instrumental calibration was observed to have changed by 0.10 to 0.15% from the startup value.

pCO_2 analysis

The partial pressure of CO_2 at a constant temperature of 4^o C was determined using the LDEO gas chromatograph-based analysis system (Chipman et al., 1993). Prior to analysis, samples (525 ml) are brought to temperature in a thermostatted bath and a headspace of approximately 38 ml is created by forcing this much water from the flask with air of known CO_2 concentration. The headspace air is recirculated through a gas disperser a few cm below the surface of the water, by means of a small air pump with teflon-covered rubber diaphragm. After approximately 20 minutes of equilibration, a 1 ml aliquot of the equilibrated air is injected into the carrier gas stream of a Shimadzu Mini-2 gas chromatograph by means of a fixed-volume loop on a sampling valve. The hydrogen carrier gas carries the air sample through a chromatographicpre-column and column packed with Chromosorb 102 (0.2 and 2 m), where the various components of the air are separated, and then through a ruthenium catalyst, where the CO_2 reacts with the carrier to form methane and water. The methane so produced in quantified by means of a flame ionization detector and a computing integrator to determine the peak areas. Each sample is re-equilibated and analyzed a second time before a second sample is connected and analyzed. After four analyses (two separate samples), the gas chromatogaph is calibrated by means of injection of three air-CO_2 mixtures (using the same loop on the injection valve) which are traceable to the WMO calibration scale of C. D. Keeling. All samples are analyzed without the removal of water vapor, and correctionsare applied for the perturbation of the TCO_2 of the sample due to the equilibration process. The pressure of equilibration is measured just prior to injection by means of a Setra (Model 270) electronic pressure transducer, the output of which is read (as a voltage) by the integrator. The response of the FID is calculated as a second-order polynomial using the values for the calibration gases run immediately before and after each set of unknowns, corrected for drift as a function of time between the calibration periods.

C11. Total Alkalinity

(E. Peltola)

Samples for alkalinity analysis were collected in 500 cm^3 glass reagent bottles. Total alkalinity (TA) was determined using a titration system similar to the one used in earlier studies (Millero et al., 1993) and to that developed by Bradshaw and Brewer (1988). The titration system consisted of a Metrohm 665 Dosimat titrator and an Orion 720A pH meter that is controlled by a personal computer. Both the acid titrant in a water-jacketed burette and the seawater sample in a water-jacketed cell were maintained at a constant temperature of 25±0.1°C with a Neslab constant temperature bath. The plexiglas water-jacketed cells used were similar to those used by Bradshaw et al. (1988), but a larger volume (about 200 cm^3) was used to increase the precision. This cell had a fill-and-drain valve which increased the reproducibility of the cell volume. A LabWindows C program was used to run the titration, record the volume of the added acid and the emf of the electrodes using RS232 interfaces. The output of the computer program yields values of TA, total CO_2 (TCO_2), pH, the standard emf (E°) and the pK_1 for the dissociation of carbonic acid. The titration is made by adding HCl to seawater past the carbonic acid end-point. A typical titration records the emf reading after it become stable (0.05 mV) and adds enough acid to change the voltage by a pre-assigned increment (10 mV). In contrast to the delivery of a fixed volume increment of acid, this method gives data points in the range of a rapid increase in the emf near the endpoint. A full titration (25 points) takes about 20 minutes. Using two systems a 36-bottle station cast can be completed in 9 hours. The electrodes used to measure the emf of the sample during a titration consisted of a ROSS glass pH electrode and an Orion double junction Ag, AgCl reference electrode.

The HCl acid solutions (20 L) used throughout the cruise were made, standardized, and stored in 500 cm^3 glass bottles in the laboratory for use at sea. The 0.24790 M HCl solutions were made from 1 M Mallinckrodt standard solutions in 0.45 M NaCl to yield an ionic strength equivalent to that of average seawater (0.7 M). The acid was standardized by Dr. Millero's laboratory using a potentiometric technique and by Dr. Dickson's laboratory by using a coulometric technique (Taylor and Smith, 1959).

The volumes of the cells used at sea were determined in the laboratory by weighing the cells filled with degassed Millipore Super Q water. The density of water at the temperature of the measurements (25°C) was calculated from the international equation of state of seawater (Millero and Poisson, 1981). The nominal volumes of all the cells were about 200 cm^3 and the values were determined to 0.03 cm^3.

The volume of HCl delivered to the cell is traditionally assumed to have small uncertainties and equated to the digital output of the titrator. Calibrations of the burettes of the Dosimats with water at 25°C indicate that the systems deliver 3.000 cm^3 (the value for a titration of seawater) to a precision of 0.0004 cm^3. This uncertainty results in an error of 0.4 $\mu mol\ kg^{-1}$ in TA and TCO_2.

A number of titrations were made on TCO_2 Certified Reference Material (Batch # 31) before, during and after the cruise. Duplicate samples were taken from some Niskin bottles from the surface and from 800 meters for same-cell and between-cell reproducibility at sea. Internal consistency of the cells was checked every day by titrating Certified Reference Material and surface seawater.

D. Current meter deployments

(T. Whitworth)

Nine self-reporting current meters were deployed as part of S04I. The instruments were model 9407 vector-averaging current meters manufactured by Alpha Omega Computer Systems, Inc. of Corvallis, Oregon. The current meter consists of a computer/controller and Argos transmitter in a 17" glass ball enclosed by a plastic hardhat, a rotor and vane assembly, a timed release and anchor, all assembled and packed in a single shipping crate. The meters were preprogrammed at Oregon State University to control data collection, storage, transmission and the releases were preprogrammed to activate on March 15, 1997, the approximate date of the local ice minimum period in the Indian Ocean sector of the Southern Ocean. The only action required for deployment is to confirm that the instrument is operating, that the release is properly programmed, and to select the length of mooring line between the anchor and the current meter. The meters were launched by hand by three people with the assistance of a small crane to lift the anchor over the rail to the water's edge.

The current meters were programmed to burst sample in a 10-minute window every hour and to average 24 bursts to provide daily averages of current speed, direction, temperature and pressure. The releases consist of a monofilamentline passing through two redundant heating elements that melt the monofilament at the time programmed on the on-board computer. When the current meter surfaces, it reports its data via Argos satellite, repeating the message until the transmitter batteries expire.

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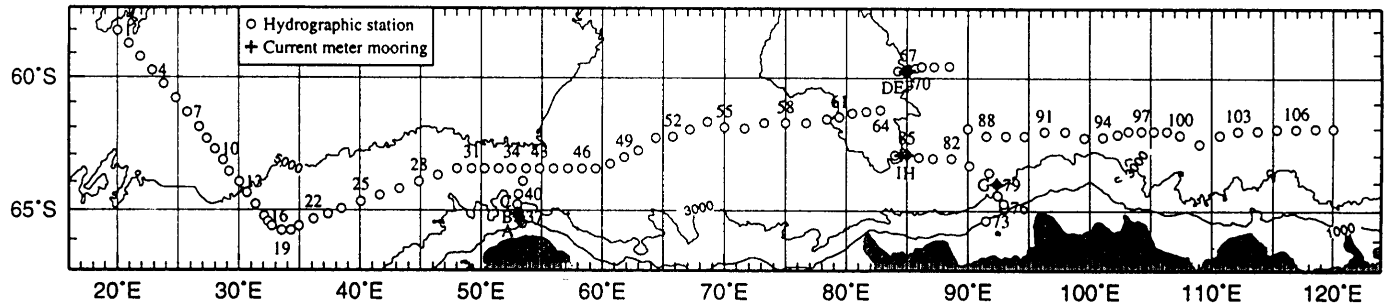

Figure 1: Locations of hydrographic stations and current meters for WOCE cruise S404I.

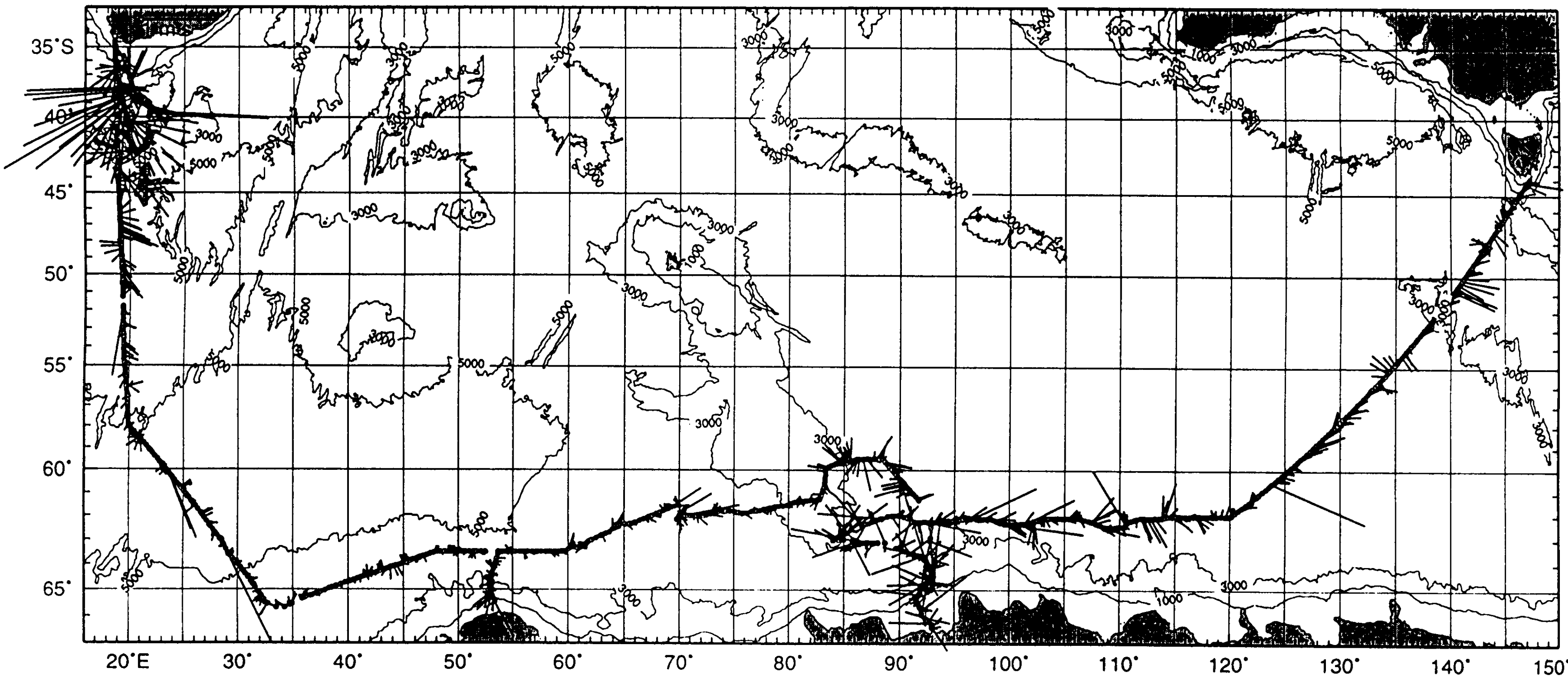

Figure 2: Underway ADCP current vectors in the layer between 75-125 m.

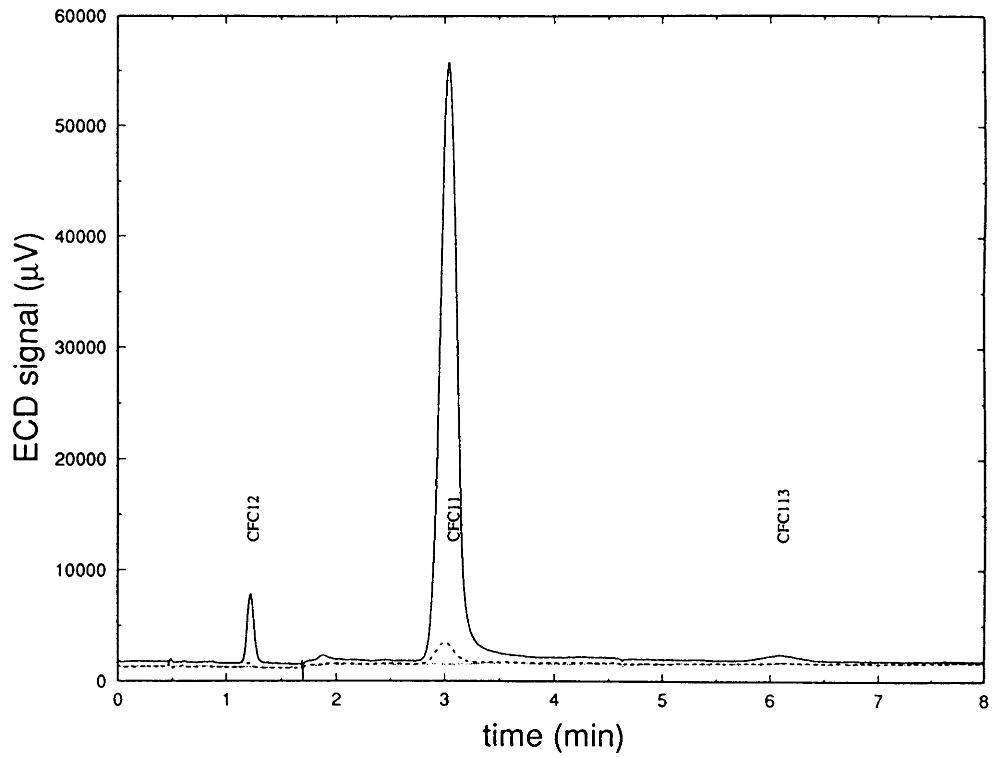

Figure 3: Typical chromatograms from the packed column system for different amounts of standard gas injected into the chromatographic columns. Solid line: 4.64 cc (reference volume), dashed line: 0.26 cc (smallest available volume); dotted line: system blank.

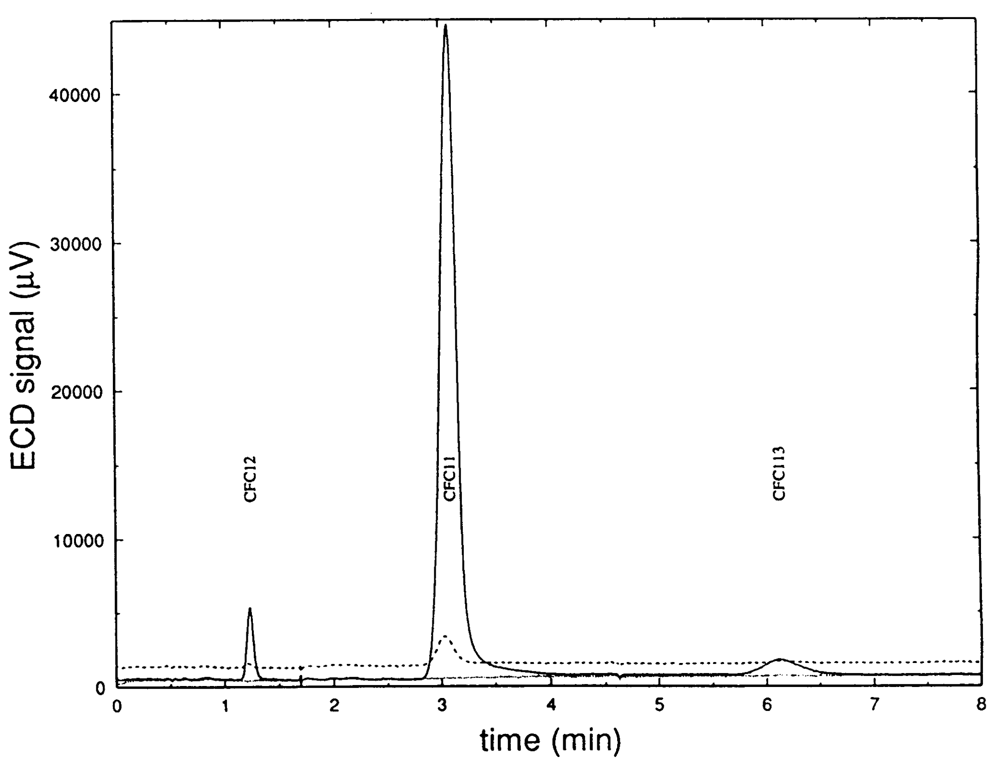

Figure 4: Typical chromatograms from the packed column system for water samples. Solid line: intermediate concentration (sample depth 120 m); dashed line: low concentration (depth 1100 m); dotted line: stripper blank.

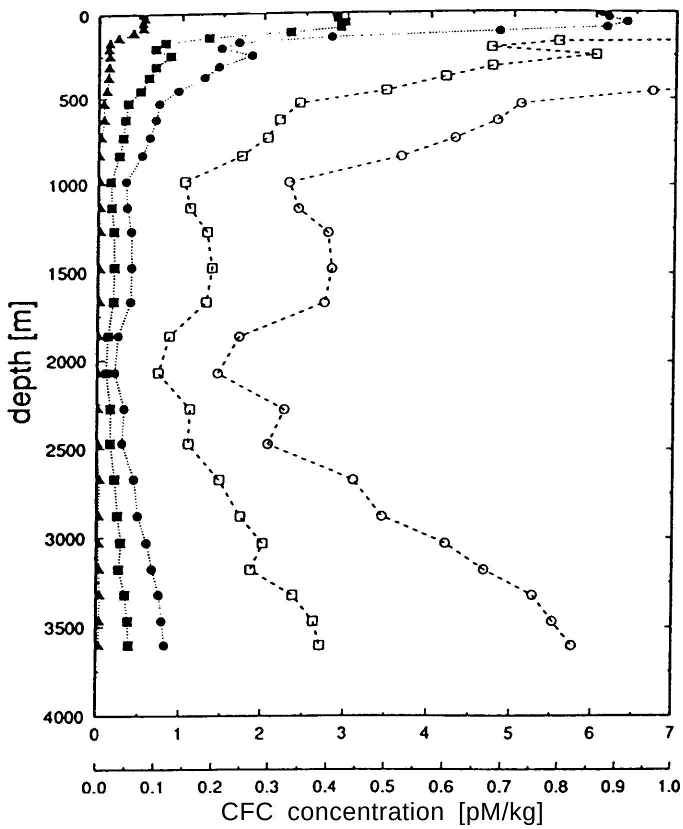

Figure 5: Profiles for CFC 11 (circles), CFC 12 (squares) and CFC 113 (triangles) from station 67. The filled symbols apply to the full scale (0-7 pM/kg) and the open symbols (not available for CFC 113) apply to the expanded scale (0- 1 pM/kg).

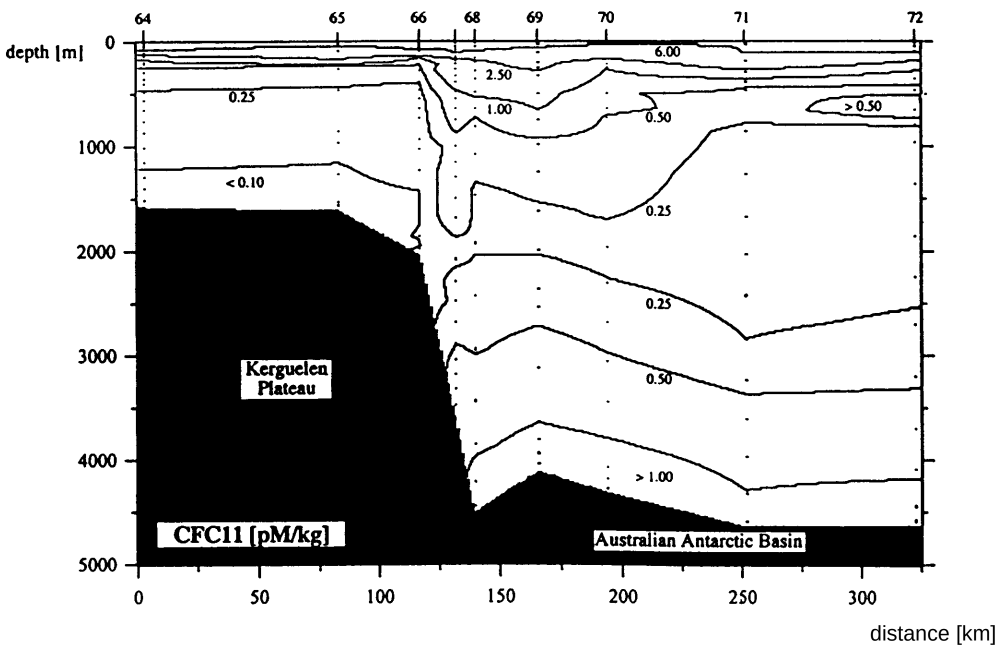

Figure 6: CFC 11 section along 5 9.6 ° S from the Kerguelen Plateau into the Australian-Antarctic Basin. Station 64 at 61.3°S has been projected onto the 59.6°S parallel.

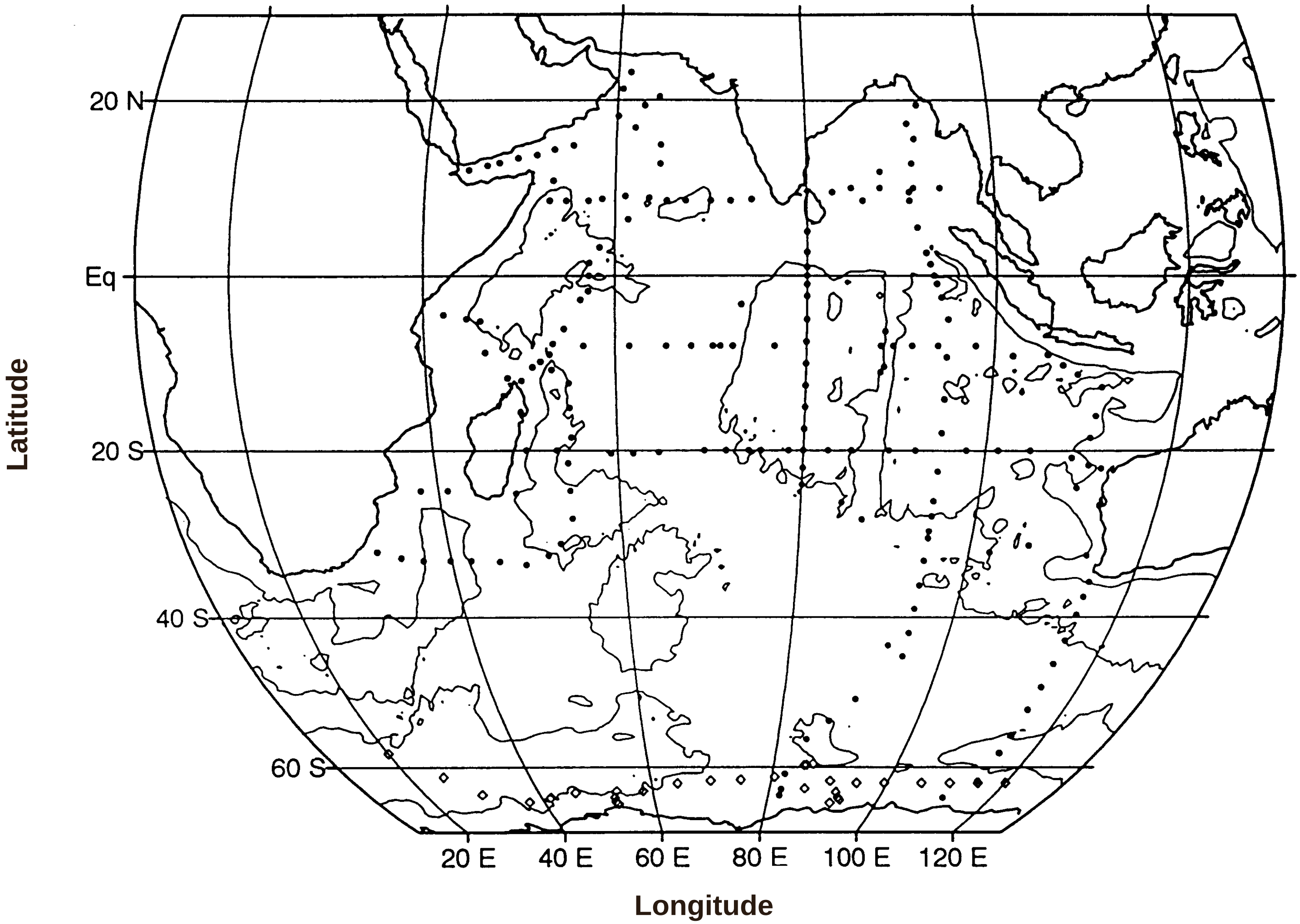

Figure 7: WOCE Indian Ocean Radiocarbon sampling locations.

Final Report for S04I AMS ^{14}C Samples

(Robert M. Key)

April 19, 1999

1.0 General Information

WOCE cruise S4I was carried out aboard the R/V N.B. Palmer in the southern Indian Ocean. The WHPO designation for this cruise was 320696/3. Thomas Whitworth III (TAMU) and James H. Swift (SIO) were the co-chief scientists. The cruise constituted the Indian Ocean portion of WOCE line S4, a meridional circumnavigation of Antarctica at a nominal latitude of 60S. This segment covered the longitudes 20°E to 120°E. A total of 108 full depth CTD/Rosette stations were carried out. The cruise departed Cape Town, South Africa on May 3 and ended at Hobart Tasmania on July 4, 1996. On June 8, science operations were suspended for seven days when the Palmer was diverted to Mirnyy Station in the Davis Sea to deliver emergency food supplies. The reader is referred to cruise documentation provided by the chief scientists as the primary source for cruise information. This report covers details of the small volume radiocarbon samples. The AMS station locations are shown in Figure 1 and summarized in Table 1. A total of 816 $\Delta^{14}C$ samples were collected at 31 stations

TABLE 1. S4I $\Delta^{14}C$ station locations.

Station	Month	Latitude	Longitude	Bottom Depth (m)
1	5/16/96	-58.008	20.006	5412
7	5/18/96	-61.399	25.749	5243
13	5/20/96	-64.000	30.017	5135
23	5/22/96	-65.134	37.349	4874
26	5/24/96	-64.465	41.619	4435
29	5/25/96	-63.736	46.408	4270
35	5/28/96	-65.456	53.363	501
36	5/28/96	-65.371	53.264	1303
38	5/28/96	-65.104	53.018	2468
40	5/29/96	-64.435	53.072	4200
42	5/29/96	-63.498	53.682	4790
46	5/30/96	-63.501	58.335	4566
51	6/1/96	-62.361	64.406	4365
55	6/3/96	-61.962	70.017	4165
58	6/4/96	-61.806	74.982	4000
62	6/5/96	-61.417	80.489	2480
66	6/6/96	-59.696	84.850	2024
68	6/7/96	-59.660	85.248	4494
70	6/7/96	-59.520	86.221	4304

TABLE 1. S4I $\Delta^{14}C$ station locations.

Station	Month	Latitude	Longitude	Bottom Depth (m)
73	6/14/96	-65.330	91.475	553
76	6/15/96	-64.859	93.004	1808
78	6/16/96	-64.464	92.481	3060
80	6/16/96	-63.653	91.737	3629
84	6/18/96	-63.092	86.007	3809
87	6/20/96	-62.001	90.001	4020
90	6/22/96	-62.286	94.670	3848
93	6/23/96	-62.335	99.558	4316
98	6/24/96	-62.104	105.269	4297
102	6/26/96	-62.244	110.607	3986
105	6/26/96	-62.002	115.331	4255
108	6/27/96	-62.000	120.000	4194

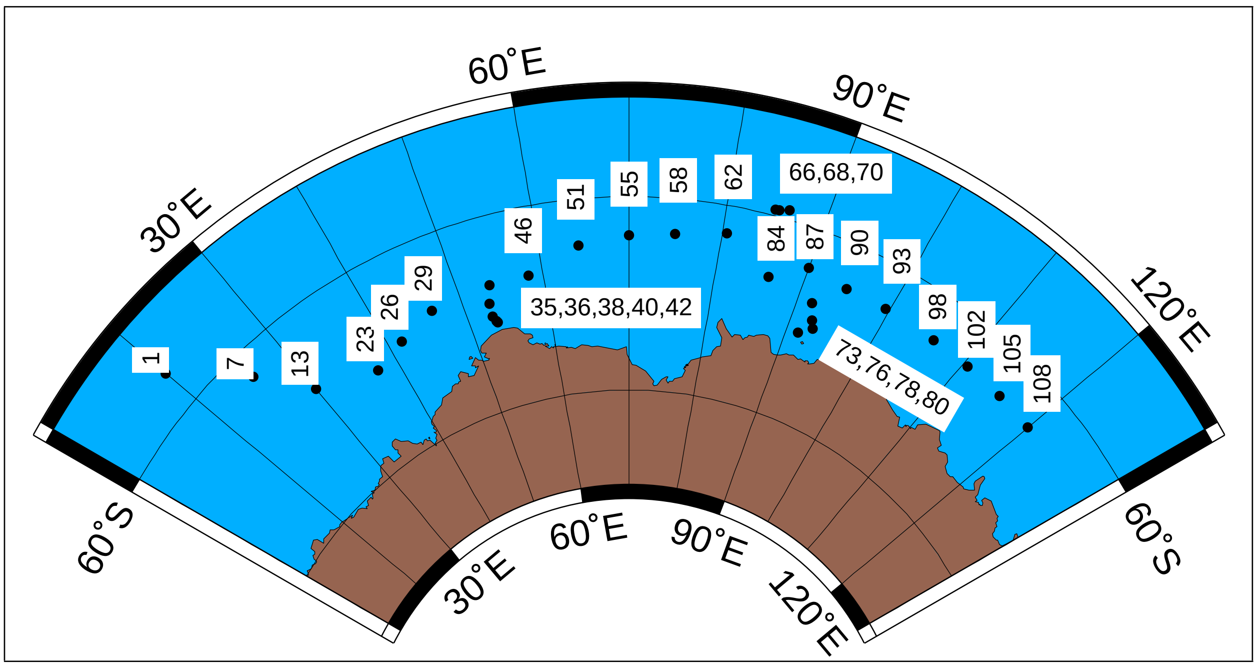

Figure 1: AMS ^{14}C station map for WOCE S4I.

2.0 Personnel

^{14}C sampling for this cruise was carried out by Robert M. Key (Princeton University). ^{14}C (and accompanying ^{13}C) analyses were performed at the National Ocean Sciences AMS Facility (NOSAMS) at Woods Hole Oceanographic Institution. R. Key collected the data from the originators, merged the files, assigned quality control flags to the ^{14}C and submitted the data files to the WOCE office (4/99). R. Key is P.I. for the ^{14}C data and NOSAMS for the ^{13}C data.

3.0 Results

This ^{14}C data set and any changes or additions supersedes any prior release.

3.1 Hydrography

Hydrography from this leg has been submitted to the WOCE office by the chief scientist and described in the hydrographic report.

3.2 ^{14}C

The $\Delta^{14}C$ values reported here were originally distributed in a NOSAMS data report (NOSAMS, 1999), February 16, 1999. That reports included results which had not been through the WOCE quality control procedures. This report supersedes that data distribution.

All of the AMS samples from this cruise have been measured. Replicate measurements were made on 4 water samples. These replicate analyses are tabulated in Table 2. The table shows

Table 2: Summary of Replicate Analyses

Sta-Cast-Bottle	$\Delta^{14}C$	Err	E.W.Mean[a]	Uncertainty[b]
51-1-9	-161.31	2.92	-167.40	2.62
	-176.84	2.91		
51-1-10	-167.33	3.26	-167.40	2.59
	-167.51	4.29		
58-1-26	-151.72	5.74	-155.78	3.49
	-156.65	2.67		
70-1-5	-176.29	4.42	-176.06	3.46
	-175.69	5.55		

a. Error weighted mean reported with data set

b. Larger of the standard deviation and the error weighted standard deviation of the mean.

the error weighted mean and uncertainty for each set of replicates. Uncertainty is defined here as the larger of the standard deviation and the error weighted standard deviation of the mean. For these replicates, the simple average of the normal standard deviations for the replicates is 1.0‰. This precision estimate is lower than the average error for the time frame over which these samples were measured (Jul. 1996 - Dec. 1998) and lower than the overall mean error for Pacific WOCE samples (Elder, *et. al*., 1998). Note that the errors given for individual measurements in the final data report (with the exception of the replicates) include only counting errors, and errors due to blanks and backgrounds. The uncertainty obtained for replicate analyses is generally a better estimate of the true error since it includes errors due to sample collection, sample degassing, *etc*. Close examination of the data along 67°S in the deep water indicates that 4‰ is a more realistic of the true error associated with this data set.

4.0 Quality Control Flag Assignment

Quality flag values were assigned to all $\Delta^{14}C$ measurements using the code defined in

Table 0.2 of WHP Office Report WHPO 91-1 Rev. 2 section 4.5.2. (Joyce, *et al.*, 1994). Measurement flags values of 2, 3, and 6 have been assigned. The choice between values 2 (good) and 3 (questionable) involves some interpretation. There is little overlap between this data set and any existing ^{14}C data, so that type of comparison was difficult. In general the lack of other data for comparison led to a more lenient grading on the ^{14}C data.

When using this data set for scientific application, any ^{14}C datum which is flagged with a "3" should be carefully considered. When flagging ^{14}C data, the measurement error was taken into consideration. That is, approximately one-third of the ^{14}C measurements are expected to deviate from the true value by more than the measurement precision. No measured values have been removed from this data set. Table 3 summarizes the quality control flags assigned to this data set. For a detailed description of the flagging procedure see Key, *et al*. (1996).

Table 3: Summary of Assigned Quality Control Flags

Flag	Number
2	803
3	6
4	0
5	4
6	3[a]

a. Some replicates flagged 3 or 4

5.0 Data Summary

Figures 2-6 summarize the $\Delta^{14}C$ data collected on this leg. Only $\Delta^{14}C$ measurements with a quality flag value of 2 ("good") or 6 ("replicate") are included in each figure. Figure 2 shows the $\Delta^{14}C$ values with 2σ error bars plotted as a function of pressure. The mid depth $\Delta^{14}C$ minimum which normally occurs around 2500 meters in most of the Pacific is absent in this section. In fact, there is very little variation in the deep and bottom water. All of the samples for the entire cruise collected at a depth greater than 1000 meters have a mean $\Delta^{14}C$ = -153.8±7.2‰ with a substantial fraction of this variance due to the samples collected very near the Antarctic slope. This result compares remarkably well with the mean of -156.0±8.5‰ calculated for the WOCE Pacific Antarctic section (S4P). Figure 3 shows the $\Delta^{14}C$ values plotted against silicate.The straight line shown in the figure is the least squares regression relationship derived by Broecker *et al.* (1995) based on the GEOSECS global data set. According to their analysis, this line ($\Delta^{14}C$ = -70 - Si) represents the relationship between naturally occurring radiocarbon and silicate for most of the ocean. They interpret deviations in $\Delta^{14}C$ above this line to be due to input of bomb-produced radiocarbon, however, they note that the technique can not be applied at high latitudes as confirmed by this data set. With the exception of the very near surface waters, this region of the Pacific shows no change since GEOSECS which strongly implies that the data in Figure 3 indicates a failure of the technique in this area rather than bomb-produced contamination throughout the water column.

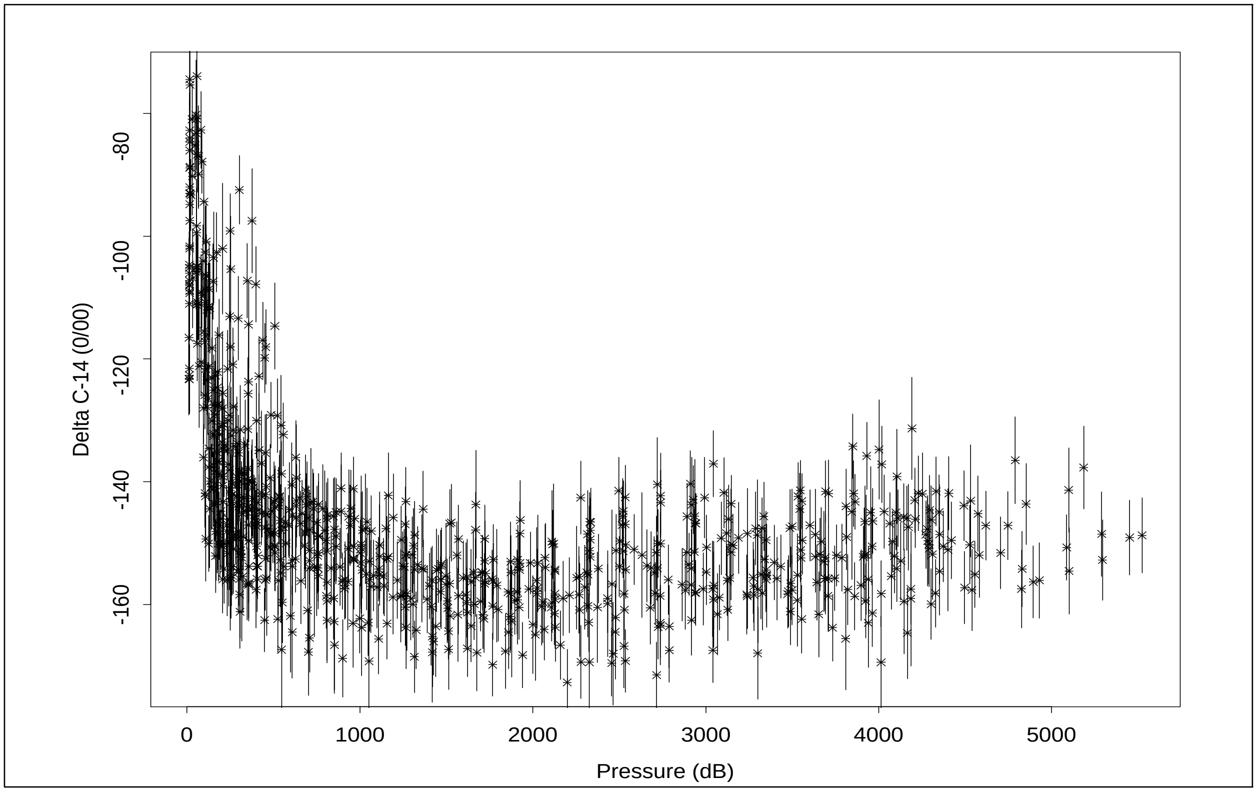

Figure 2: $\Delta^{14}C$ results for S4I stations shown with 2σ error bars.Only those measurements having a quality control flag value of 2 or 6 are plotted.

Figure 4 shows all of the S4I radiocarbon values plotted against potential alkalinity normalized to a salinity of 35 (defined as [alkalinity + nitrate]*35/salinity). The straight line is the regression fit (^{14}C = -68 -(PALK_35 - 2320) derived by S. Rubin (LDEO) to all of the GEOSECS results for waters which were assumed to have no bomb-produced ^{14}C (depths greater than 1000 meters, but including high latitude samples). Preliminary investigation indicates that this new method for separating bomb-produced and natural ^{14}C works in high latitude waters. For this data set it appears that the regression intercept derived from the GEOSECS data may be a bit too low. Regardless, if the function is valid, then for these data, waters which have alkalinity values less than ~2400 μmole/kg have a significant amount of bomb-produced radiocarbon. If this is true, and if the values have changed little since GEOSECS, then most of the bomb contamination had to have been distributed throughout most of the water column even as early as the mid 1970's.

Figures 5-7 show gridded sections of the $\Delta^{14}C$ data. The data were gridded using the "loess" methods described in Chambers *et al.* (1983), Chambers and Hastie (1991), Cleveland (1979) and Cleveland and Devlin (1988).

Figure 5 shows the main zonal cruise section along ~62°S. The colors in the image indicate $\Delta^{14}C$ while the contours are CFC-11 concentration (pmol/kg; preliminary data from Bill Smethie (LDEO) and Mark Warner (UW)). Significant resolution is lost in the deep water $\Delta^{14}C$ since most of the variability is near the surface. Nevertheless, a strong correlation in the two distributions is immediately apparent. The bottom waters both east and west of the Kerguelen Ridge (~80°E) have appreciable chlorofluorocarbon concentrations and are most likely contaminated with bomb-produced radiocarbon. The highest near bottom (pressure >3750dB) $\Delta^{14}C$ values

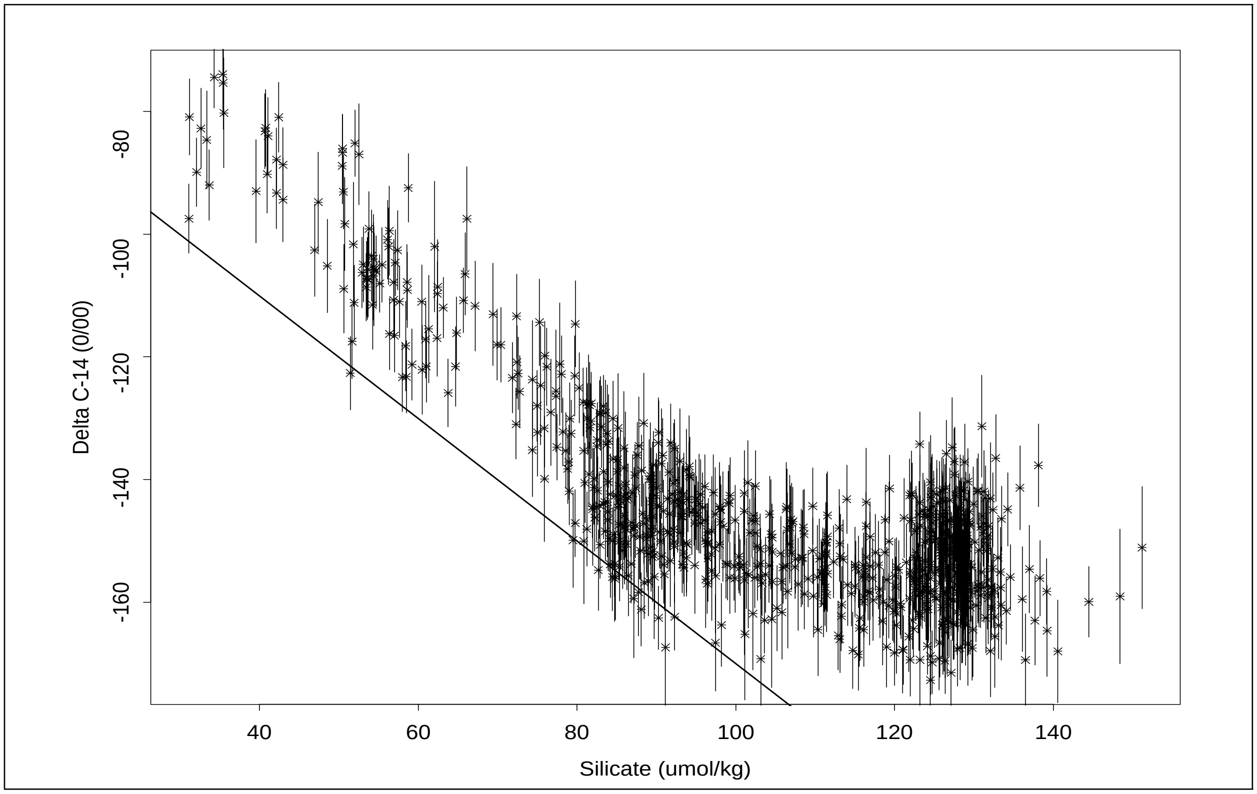

Figure 3: $\Delta^{14}C$ as a function of silicate for S4I AMS samples. The straight line shows the relationship proposed by Broecker, *et al.*, 1995 ($\Delta^{14}C$ = -70 - Si with radiocarbon in ‰ and silicate in μmol/kg). Two-sigma error bars are given for the $\Delta^{14}C$ measurements.

along this section range between -140‰ and -130‰ and are comparable to near bottom waters at similar latitudes in the Pacific (Key and Schlosser, 1999). Figure 6 and Figure 7 show contoured sections of the $\Delta^{14}C$ distribution along 65°E and 90°E respectively. Note that the contour interval used in the two figures is different. The 65°E and 90°E sections clearly show penetration of bomb radiocarbon along the Antarctic continental slope.

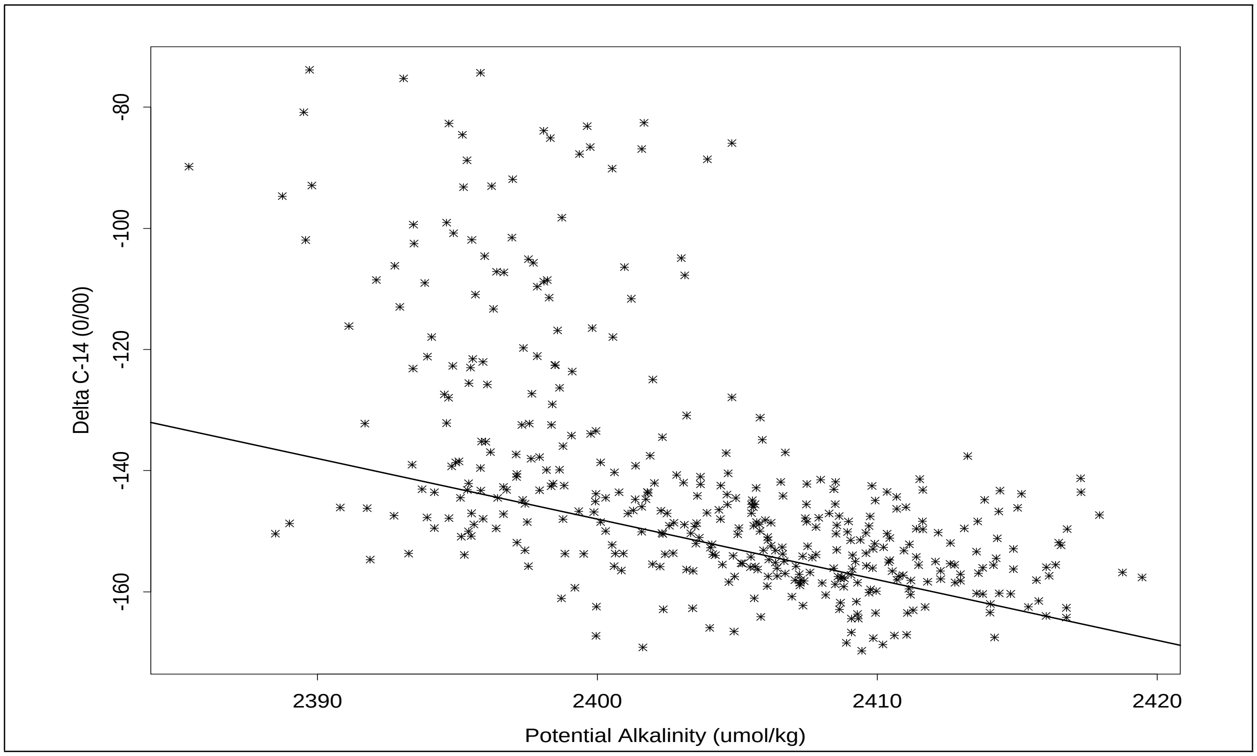

Figure 4: Based on the new method devised by S. Rubin, the samples which plot above the line and have potential alkalinity values less than about 2400 μmole/kg are contaminated with bomb-produced ^{14}C..

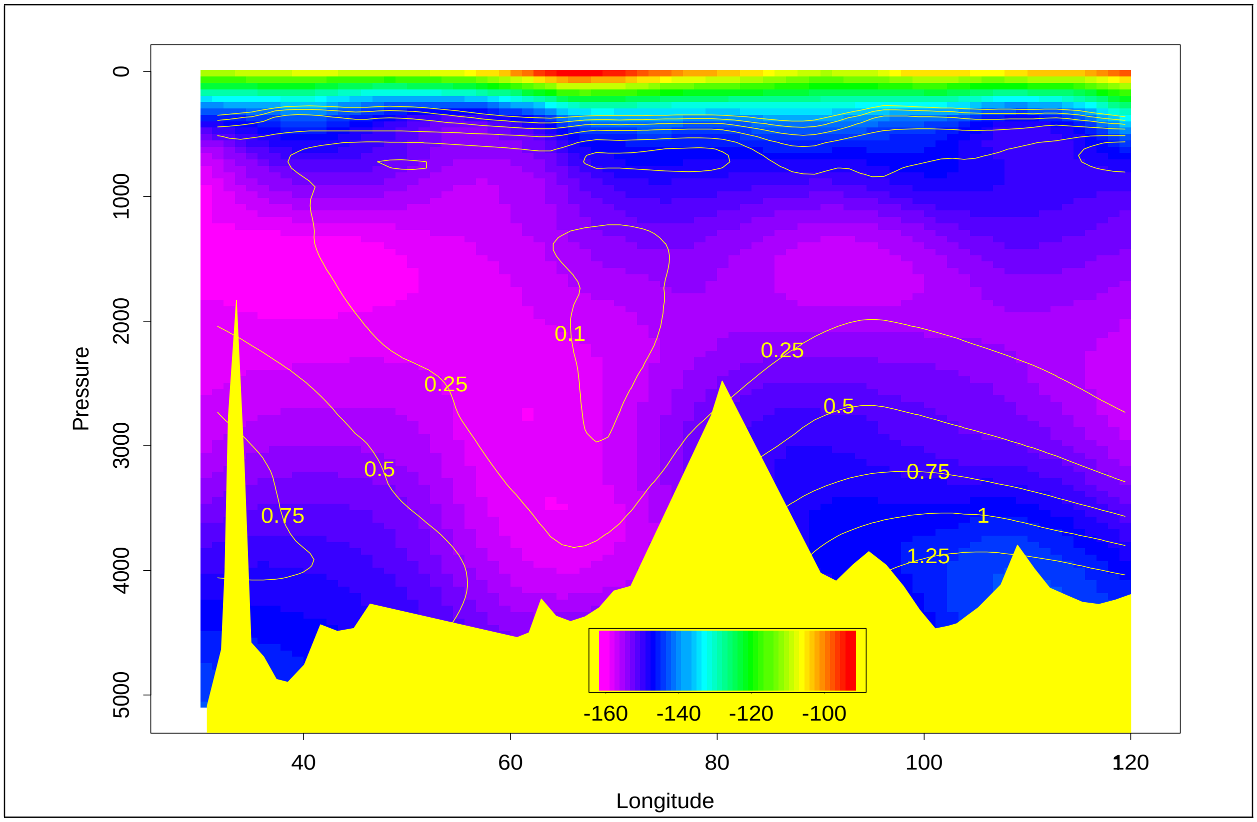

Figure 5: Δ^{14}C concentrations, along main east-west section of S4I at approximately 62°S, are indicated by color. Contour lines are preliminary CFC-11 concentrations (pmol/kg).

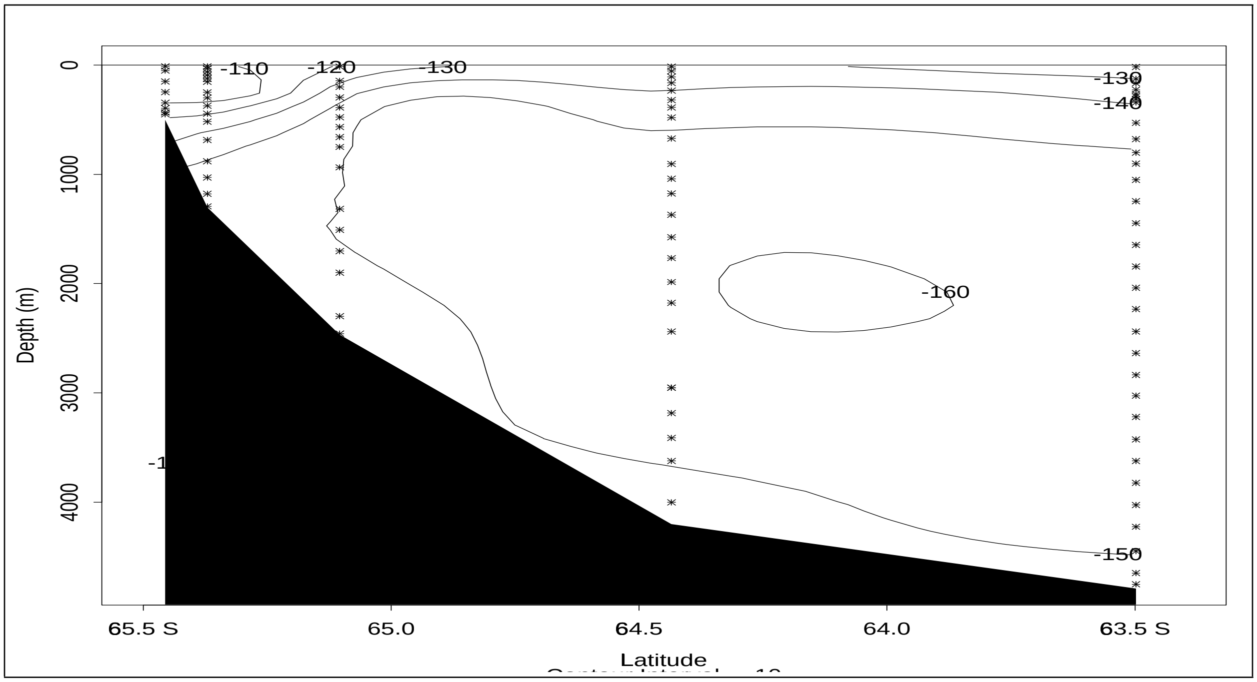

Figure 6: $\Delta^{14}C$ along ~65°E near the Antarctic slope. The near bottom values along the lower slope indicate entrainment of "new" bottom water.

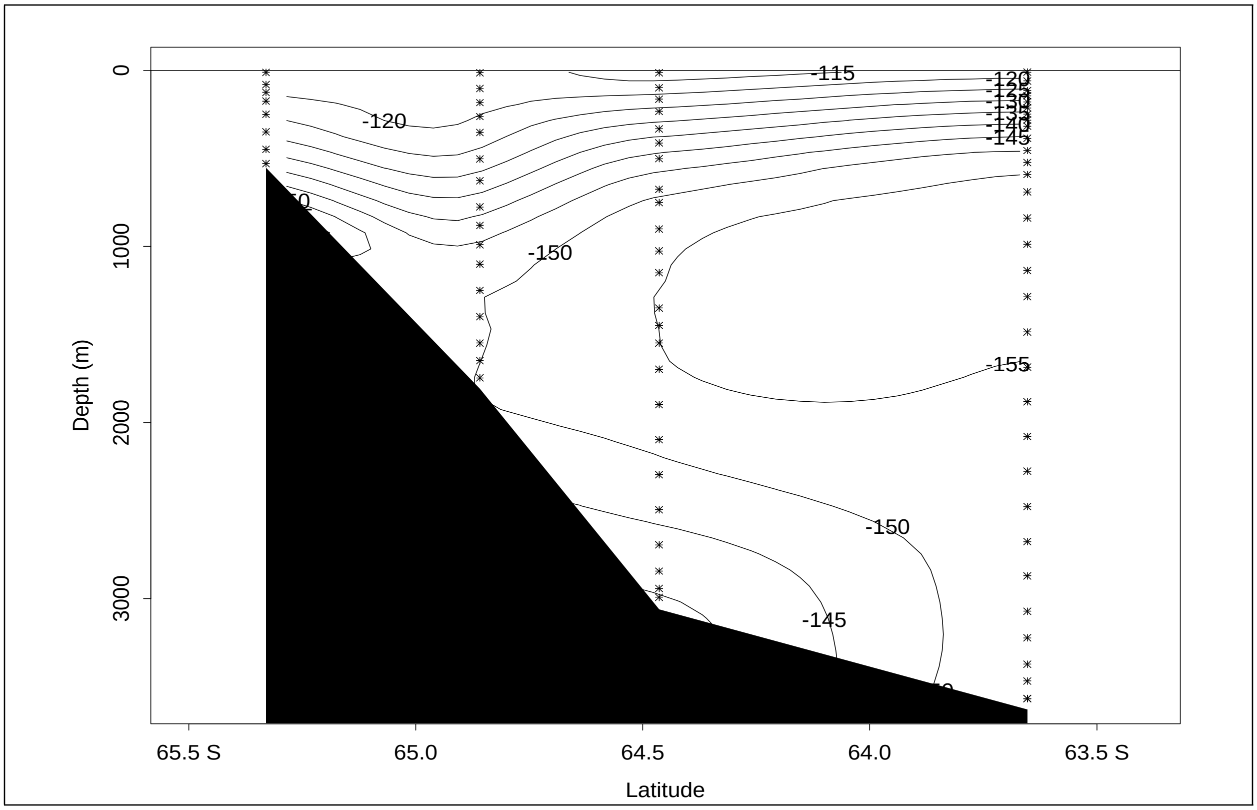

Figure 7: .$\Delta^{14}C$ along ~90°E near the Antarctic slope. The near bottom values along the lower slope indicate entrainment of "new" bottom water.

6.0 References and Supporting Documentation

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Appendix A

WOCE96-S4I: CTD Temperature and Conductivity Corrections Summary

Sta/ Cast	PRT Response Time(secs)	ITS-90 Temperature Coefficients $corT = t2*T^2 + t1*T + t0$ t2	t1	t0	Conductivity Coefficients $corC = cp2*corP^2 + cp1*corP + c1*C + c0$ cp2	cp1	c1	c0
001/01	.20	1.5637e-05	-8.7403e-04	-1.4927	-3.51900e-10	1.75504e-06	-1.50077e-03	0.01745
002/02	.20	1.5637e-05	-8.7403e-04	-1.4927	-3.51900e-10	1.75504e-06	-1.50077e-03	0.01844
003/01	.20	1.5637e-05	-8.7403e-04	-1.4927	-3.51900e-10	1.75504e-06	-1.50077e-03	0.01943
004/01	.20	1.5637e-05	-8.7403e-04	-1.4927	-3.51900e-10	1.75504e-06	-1.50077e-03	0.02054
005/01	.20	1.5637e-05	-8.7403e-04	-1.4927	-3.51900e-10	1.75504e-06	-1.50077e-03	0.02054
006/01	.20	1.5637e-05	-8.7403e-04	-1.4927	-3.51900e-10	1.75504e-06	-1.50077e-03	0.02054
007/01	.20	1.5637e-05	-8.7403e-04	-1.4927	-3.51900e-10	1.75504e-06	-1.50077e-03	0.02104
008/01	.20	1.5637e-05	-8.7403e-04	-1.4927	-3.51900e-10	1.75504e-06	-1.50077e-03	0.02054
009/01	.20	1.5637e-05	-8.7403e-04	-1.4927	-3.51900e-10	1.75504e-06	-1.50077e-03	0.02054
010/01	.20	1.5637e-05	-8.7403e-04	-1.4927	-3.51900e-10	1.75504e-06	-1.50077e-03	0.02054
011/01	.20	1.5637e-05	-8.7403e-04	-1.4927	-3.51900e-10	1.75504e-06	-1.50077e-03	0.02054
012/01	.20	1.5637e-05	-8.7403e-04	-1.4927	-3.51900e-10	1.75504e-06	-1.50077e-03	0.02054
013/01	.20	1.5637e-05	-8.7403e-04	-1.4927	-3.51900e-10	1.75504e-06	-1.50077e-03	0.02104
014/01	.20	1.5637e-05	-8.7403e-04	-1.4927	-3.51900e-10	1.75504e-06	-1.50077e-03	0.02104
015/01	.20	1.5637e-05	-8.7403e-04	-1.4927	-3.51900e-10	1.75504e-06	-1.50077e-03	0.02054
016/01	.20	1.5637e-05	-8.7403e-04	-1.4927	-3.51900e-10	1.75504e-06	-1.50077e-03	0.02054
017/01	.20	1.5637e-05	-8.7403e-04	-1.4927	-3.51900e-10	1.75504e-06	-1.50077e-03	0.02054
018/01	.20	1.5637e-05	-8.7403e-04	-1.4927	-3.51900e-10	1.75504e-06	-1.50077e-03	0.02154
019/01	.20	1.5637e-05	-8.7403e-04	-1.4927	-3.51900e-10	1.75504e-06	-1.50077e-03	0.02054
020/01	.20	1.5637e-05	-8.7403e-04	-1.4927	-3.51900e-10	1.75504e-06	-1.50077e-03	0.02054
021/01	.20	1.5637e-05	-8.7403e-04	-1.4927	-3.51900e-10	1.75504e-06	-1.50077e-03	0.02054
022/01	.20	1.5637e-05	-8.7403e-04	-1.4927	-3.51900e-10	1.75504e-06	-1.50077e-03	0.02054
023/01	.20	1.5637e-05	-8.7403e-04	-1.4927	-3.51900e-10	1.75504e-06	-1.50077e-03	0.01954
024/01	.20	1.5637e-05	-8.7403e-04	-1.4927	-3.51900e-10	1.75504e-06	-1.50077e-03	0.02054
025/01	.20	1.5637e-05	-8.7403e-04	-1.4927	-3.51900e-10	1.75504e-06	-1.50077e-03	0.02004
026/01	.20	1.5637e-05	-8.7403e-04	-1.4927	-3.51900e-10	1.75504e-06	-1.50077e-03	0.01904
027/01	.20	1.5637e-05	-8.7403e-04	-1.4927	-3.51900e-10	1.75504e-06	-1.50077e-03	0.02054
028/01	.20	1.5637e-05	-8.7403e-04	-1.4927	-3.51900e-10	1.75504e-06	-1.50077e-03	0.02054
029/01	.20	1.5637e-05	-8.7403e-04	-1.4927	-3.51900e-10	1.75504e-06	-1.50077e-03	0.02054
030/01	.60	0.0000e+00	0.0000e+00	-1.9997	-3.51900e-10	1.75504e-06	-1.50077e-03	0.02054
031/01	.60	0.0000e+00	0.0000e+00	-1.9997	-3.51900e-10	1.75504e-06	-1.50077e-03	0.02054
032/01	.20	1.5637e-05	-8.7403e-04	-1.4927	2.78520e-10	3.42393e-07	-4.07150e-02	0.03089
033/01	.20	1.5637e-05	-8.7403e-04	-1.4927	2.16360e-10	-2.39730e-07	-4.07150e-02	0.03135
034/01	.20	1.5637e-05	-8.7403e-04	-1.4927	1.52300e-10	-6.07742e-07	-4.07150e-02	0.03464
035/01	.20	1.5637e-05	-8.7403e-04	-1.4927	0.00000e+00	6.94653e-06	-4.07150e-02	0.05101
036/01	.20	1.5637e-05	-8.7403e-04	-1.4927	3.56882e-09	-4.82532e-06	-4.07150e-02	0.05274
037/01	.20	1.5637e-05	-8.7403e-04	-1.4927	7.61630e-10	-1.85630e-06	-4.07150e-02	0.03617
038/01	.20	1.5637e-05	-8.7403e-04	-1.4927	1.81994e-09	-4.67152e-06	-4.07150e-02	0.02307
039/01	.20	1.5637e-05	-8.7403e-04	-1.4927	-3.51900e-10	1.75504e-06	-1.50077e-03	0.01954
040/01	.20	1.5637e-05	-8.7403e-04	-1.4927	-3.51900e-10	1.75504e-06	-1.50077e-03	0.02104

Sta/ Cast	PRT Response Time(secs)	ITS-90 Temperature Coefficients $corT = t2*T^2 + t1*T + t0$ t2	t1	t0	Conductivity Coefficients $corC = cp2*corP^2 + cp1*corP + c1*C + c0$ cp2	cp1	c1	c0
041/01	.20	1.5637e-05	-8.7403e-04	-1.4927	-3.51900e-10	1.75504e-06	-1.50077e-03	0.02104
042/01	.20	1.5637e-05	-8.7403e-04	-1.4927	-3.51900e-10	1.75504e-06	-1.50077e-03	0.02104
043/01	.20	1.5637e-05	-8.7403e-04	-1.4927	-3.51900e-10	1.75504e-06	-1.50077e-03	0.02104
044/01	.20	1.5637e-05	-8.7403e-04	-1.4927	-3.51900e-10	1.75504e-06	-1.50077e-03	0.02054
045/01	.20	1.5637e-05	-8.7403e-04	-1.4927	-3.51900e-10	1.75504e-06	-1.50077e-03	0.02054
046/01	.20	1.5637e-05	-8.7403e-04	-1.4927	-3.51900e-10	1.75504e-06	-1.50077e-03	0.02054
047/01	.20	1.5637e-05	-8.7403e-04	-1.4927	-3.51900e-10	1.75504e-06	-1.50077e-03	0.02104
048/01	.20	1.5637e-05	-8.7403e-04	-1.4927	-3.51900e-10	1.75504e-06	-1.50077e-03	0.02104
049/01	.20	1.5637e-05	-8.7403e-04	-1.4927	-3.51900e-10	1.75504e-06	-1.50077e-03	0.02004
050/01	.20	1.5637e-05	-8.7403e-04	-1.4927	-3.51900e-10	1.75504e-06	-1.50077e-03	0.01954
051/01	.20	1.5637e-05	-8.7403e-04	-1.4927	-3.51900e-10	1.75504e-06	-1.50077e-03	0.01954
052/01	.20	1.5637e-05	-8.7403e-04	-1.4927	-3.51900e-10	1.75504e-06	-1.50077e-03	0.01954
053/01	.20	1.5637e-05	-8.7403e-04	-1.4927	-3.51900e-10	1.75504e-06	-1.50077e-03	0.01954
054/01	.20	1.5637e-05	-8.7403e-04	-1.4927	-3.51900e-10	1.75504e-06	-1.50077e-03	0.01954
055/01	.20	1.5637e-05	-8.7403e-04	-1.4927	-5.00590e-10	2.20650e-06	-1.50077e-03	0.02269
056/01	.20	1.5637e-05	-8.7403e-04	-1.4927	-8.85520e-10	4.74834e-07	-4.42237e-03	-0.00257
057/01	.20	1.5637e-05	-8.7403e-04	-1.4927	-8.00570e-10	1.28872e-06	-4.42237e-03	0.00514
058/01	.20	1.5637e-05	-8.7403e-04	-1.4927	-3.12620e-10	5.80077e-07	-4.42237e-03	0.01334
059/01	.20	1.5637e-05	-8.7403e-04	-1.4927	-2.00923e-09	7.53662e-06	-4.42237e-03	0.05142
060/01	.20	1.5637e-05	-8.7403e-04	-1.4927	-1.56768e-09	5.51326e-06	-4.42237e-03	0.04231
061/01	.20	1.5637e-05	-8.7403e-04	-1.4927	-1.98246e-09	6.83533e-06	-4.42237e-03	0.04479
062/01	.20	1.5637e-05	-8.7403e-04	-1.4927	0.00000e+00	-4.31446e-07	-3.77637e-02	0.01665
063/01	.20	1.5637e-05	-8.7403e-04	-1.4927	0.00000e+00	-4.31446e-07	-3.77637e-02	0.01665
064/01	.20	1.5637e-05	-8.7403e-04	-1.4927	0.00000e+00	-4.31446e-07	-3.77637e-02	0.01665
065/01	.20	1.5637e-05	-8.7403e-04	-1.4927	0.00000e+00	-4.31446e-07	-3.77637e-02	0.01665
066/01	.20	1.5637e-05	-8.7403e-04	-1.4927	0.00000e+00	-4.31446e-07	-3.77637e-02	0.01665
067/01	.20	1.5637e-05	-8.7403e-04	-1.4927	0.00000e+00	-4.31446e-07	-3.77637e-02	0.01665
068/01	.20	1.5637e-05	-8.7403e-04	-1.4927	0.00000e+00	-4.31446e-07	-3.77637e-02	0.01665
069/01	.20	1.5637e-05	-8.7403e-04	-1.4927	0.00000e+00	-4.31446e-07	-3.77637e-02	0.01665
070/01	.20	1.5637e-05	-8.7403e-04	-1.4927	0.00000e+00	-4.31446e-07	-3.77637e-02	0.01665
071/01	.20	1.5637e-05	-8.7403e-04	-1.4927	0.00000e+00	-4.31446e-07	-3.77637e-02	0.01665
072/01	.20	1.5637e-05	-8.7403e-04	-1.4927	0.00000e+00	-4.31446e-07	-3.77637e-02	0.01665
073/01	.20	1.5637e-05	-8.7403e-04	-1.4927	0.00000e+00	-4.31446e-07	-3.77637e-02	0.01921
074/01	.20	1.5637e-05	-8.7403e-04	-1.4927	0.00000e+00	-4.31446e-07	-3.77637e-02	0.01926
075/01	.20	1.5637e-05	-8.7403e-04	-1.4927	0.00000e+00	-4.31446e-07	-3.77637e-02	0.01930
076/01	.20	1.5637e-05	-8.7403e-04	-1.4927	0.00000e+00	-4.31446e-07	-3.77637e-02	0.01935
077/01	.20	1.5637e-05	-8.7403e-04	-1.4927	0.00000e+00	-4.31446e-07	-3.77637e-02	0.01939
078/01	.20	1.5637e-05	-8.7403e-04	-1.4927	0.00000e+00	-4.31446e-07	-3.77637e-02	0.01943
079/01	.20	1.5637e-05	-8.7403e-04	-1.4927	0.00000e+00	-4.31446e-07	-3.77637e-02	0.01948
080/01	.20	1.5637e-05	-8.7403e-04	-1.4927	0.00000e+00	-4.31446e-07	-3.77637e-02	0.01952

Sta/ Cast	PRT Response Time(secs)	ITS-90 Temperature Coefficients corT = t2∗T^2 + t1∗T + t0 t2	t1	t0	Conductivity Coefficients corC = cp2∗corP^2 + cp1∗corP + c1∗C + c0 cp2	cp1	c1	c0
081/01	.20	1.5637e-05	-8.7403e-04	-1.4927	0.00000e+00	-4.31446e-07	-3.77637e-02	0.01957
082/01	.20	1.5637e-05	-8.7403e-04	-1.4927	0.00000e+00	-4.31446e-07	-3.77637e-02	0.01961
083/01	.20	1.5637e-05	-8.7403e-04	-1.4927	0.00000e+00	-4.31446e-07	-3.77637e-02	0.01965
084/01	.20	1.5637e-05	-8.7403e-04	-1.4927	0.00000e+00	-4.31446e-07	-3.77637e-02	0.01970
085/01	.20	1.5637e-05	-8.7403e-04	-1.4927	0.00000e+00	-4.31446e-07	-3.77637e-02	0.01974
086/01	.20	1.5637e-05	-8.7403e-04	-1.4927	0.00000e+00	-4.31446e-07	-3.77637e-02	0.01979
087/01	.20	1.5637e-05	-8.7403e-04	-1.4927	0.00000e+00	-4.31446e-07	-3.77637e-02	0.01983
088/01	.20	1.5637e-05	-8.7403e-04	-1.4927	0.00000e+00	-4.31446e-07	-3.77637e-02	0.01988
089/01	.20	1.5637e-05	-8.7403e-04	-1.4927	0.00000e+00	-4.31446e-07	-3.77637e-02	0.01992
090/01	.20	1.5637e-05	-8.7403e-04	-1.4927	0.00000e+00	-4.31446e-07	-3.77637e-02	0.01996
091/01	.20	1.5637e-05	-8.7403e-04	-1.4927	0.00000e+00	-4.31446e-07	-3.77637e-02	0.02001
092/01	.20	1.5637e-05	-8.7403e-04	-1.4927	0.00000e+00	-4.31446e-07	-3.77637e-02	0.02005
093/01	.20	1.5637e-05	-8.7403e-04	-1.4927	0.00000e+00	-4.31446e-07	-3.77637e-02	0.02010
094/01	.20	1.5637e-05	-8.7403e-04	-1.4927	0.00000e+00	-4.31446e-07	-3.77637e-02	0.02214
095/01	.20	1.5637e-05	-8.7403e-04	-1.4927	0.00000e+00	-4.31446e-07	-3.77637e-02	0.02118
096/01	.20	1.5637e-05	-8.7403e-04	-1.4927	0.00000e+00	-4.31446e-07	-3.77637e-02	0.02023
097/01	.20	1.5637e-05	-8.7403e-04	-1.4927	0.00000e+00	-4.31446e-07	-3.77637e-02	0.02027
098/01	.20	1.5637e-05	-8.7403e-04	-1.4927	0.00000e+00	-4.31446e-07	-3.77637e-02	0.02032
099/01	.20	1.5637e-05	-8.7403e-04	-1.4927	0.00000e+00	-4.31446e-07	-3.77637e-02	0.02036
100/01	.20	1.5637e-05	-8.7403e-04	-1.4927	0.00000e+00	-4.31446e-07	-3.77637e-02	0.02040
101/01	.20	1.5637e-05	-8.7403e-04	-1.4927	0.00000e+00	-4.31446e-07	-3.77637e-02	0.02045
102/01	.20	1.5637e-05	-8.7403e-04	-1.4927	0.00000e+00	-4.31446e-07	-3.77637e-02	0.02049
103/01	.20	1.5637e-05	-8.7403e-04	-1.4927	0.00000e+00	-4.31446e-07	-3.77637e-02	0.02054
104/01	.20	1.5637e-05	-8.7403e-04	-1.4927	0.00000e+00	-4.31446e-07	-3.77637e-02	0.02058
105/01	.20	1.5637e-05	-8.7403e-04	-1.4927	0.00000e+00	-4.31446e-07	-3.77637e-02	0.02062
106/01	.20	1.5637e-05	-8.7403e-04	-1.4927	0.00000e+00	-4.31446e-07	-3.77637e-02	0.02067
107/01	.20	1.5637e-05	-8.7403e-04	-1.4927	0.00000e+00	-4.31446e-07	-3.77637e-02	0.02071
108/01	.20	1.5637e-05	-8.7403e-04	-1.4927	0.00000e+00	-4.31446e-07	-3.77637e-02	0.02076

Appendix B

Summary of WOCE96-S4I CTD Oxygen Time Constants

(time constants in seconds)

Temperature		Pressure	O_2 Gradient
Fast(τ_{Tf})	Slow(τ_{Ts})	(τ_p)	(τ_{og})
10.0	400.0	16.0	16.0

WOCE96-S4I: Conversion Equation Coefficients for CTD Oxygen

(refer to Equation 8.4.0)

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)
001/01	6.64222e-05	3.69988e-01	5.27460e-05	-1.60964e-01	-1.07497e-02	-3.65946e-06
002/02	1.60064e-04	4.72569e-02	1.13520e-04	-1.68735e-01	-2.38912e-02	3.57998e-06
003/01	8.92432e-05	2.95656e-01	6.76237e-05	-8.83472e-02	-3.84316e-02	-2.52195e-06
004/01	1.01429e-04	2.46574e-01	7.62818e-05	-1.14233e-01	-4.03175e-02	-5.96727e-06
005/01	1.21052e-04	1.72426e-01	9.78343e-05	-6.79666e-02	-2.23190e-02	8.71185e-04
006/01	1.75804e-04	-8.14364e-02	1.85816e-04	-5.86033e-02	3.10723e-02	-2.82704e-04
007/01	1.67620e-04	-4.55276e-02	1.71252e-04	-9.39250e-02	4.57988e-02	-5.20961e-05
008/01	1.66325e-04	-2.85025e-02	1.61039e-04	-5.53008e-02	-3.79618e-03	-4.14391e-05
009/01	1.70643e-04	-4.68586e-02	1.67534e-04	-5.20969e-02	-1.25383e-03	-4.07629e-05
010/01	1.73540e-04	-6.56200e-02	1.77527e-04	-4.97766e-02	1.19130e-02	-4.55851e-05
011/01	1.72403e-04	-5.00361e-02	1.67712e-04	-5.09542e-02	-4.18908e-03	-3.83772e-05
012/01	1.71900e-04	-4.92350e-02	1.69273e-04	-3.97714e-02	2.36830e-04	-3.15800e-05
013/01	1.78000e-04	-9.00978e-02	1.90210e-04	-4.88200e-02	2.58634e-02	-5.11015e-05
014/01	1.77069e-04	-7.31275e-02	1.78150e-04	-2.49933e-02	-1.60592e-02	-1.87121e-05
015/01	1.59613e-04	1.16227e-02	1.44177e-04	-5.31770e-02	-9.14318e-03	-3.63113e-05
016/01	1.57341e-04	2.02208e-02	1.43189e-04	-3.52929e-02	-2.97283e-02	-2.20004e-05
017/01	1.56583e-04	7.01699e-03	1.54378e-04	-4.75374e-02	2.30226e-03	-3.99093e-05
018/01	1.63593e-04	-5.03368e-02	1.92880e-04	-5.72196e-03	-3.59595e-03	-3.35300e-05
019/01	6.11726e-05	3.81783e-01	6.86468e-05	-4.26830e-02	-3.90103e-03	8.65146e-07
020/01	1.90291e-04	-1.41595e-01	2.06383e-04	-2.13872e-02	2.46375e-04	2.99994e-03
021/01	2.36786e-04	-2.67405e-01	2.26985e-04	-5.79502e-02	-6.45128e-03	-1.11680e-03
022/01	2.01954e-04	-8.12027e-02	1.44691e-04	-8.20009e-02	-1.25784e-02	1.99728e-04
023/01	1.82316e-04	-1.05753e-01	1.91276e-04	-4.12774e-02	1.00084e-02	6.28652e-04
024/01	1.82856e-04	-1.07923e-01	1.92579e-04	-4.98937e-02	1.78914e-02	-5.04070e-05
025/01	1.60390e-04	-4.47050e-03	1.52677e-04	-6.99194e-02	1.88180e-02	1.53118e-03
026/01	1.57341e-04	2.50596e-03	1.52465e-04	-7.51499e-02	2.44353e-02	-1.02095e-03
027/01	1.87486e-04	-1.24597e-01	1.95597e-04	-4.20899e-02	9.08619e-03	-5.30758e-05
028/01	1.60117e-04	-8.22508e-03	1.53600e-04	-1.08556e-01	4.39258e-02	-6.89579e-04
029/01	9.26089e-05	2.28398e-01	1.11365e-04	-3.80661e-02	2.43638e-02	-2.91259e-06
030/01	1.87398e-04	-9.33588e-02	1.69993e-04	-5.38509e-02	-1.88677e-02	-5.24901e-05
031/01	1.35498e-04	8.60360e-02	1.31241e-04	-4.61573e-02	8.05983e-03	-1.49800e-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)
032/01	1.65367e-04	4.33789e-02	1.18786e-04	-9.00930e-02	5.11988e-03	-6.53573e-04
033/01	1.17182e-04	1.93940e-01	9.67868e-05	-6.35173e-02	1.04704e-02	-5.41701e-04
034/01	2.06678e-04	-9.70171e-02	1.48263e-04	-8.49894e-02	-8.37841e-03	-2.30906e-04
035/01	2.62326e-05	5.27992e-01	2.16841e-05	-1.38104e-01	-2.84938e-02	1.18910e-04
036/01	8.73771e-05	3.37968e-01	2.41086e-05	-6.79387e-02	4.01084e-03	7.54130e-05
037/01	1.38279e-04	1.11314e-01	1.03332e-04	-3.76023e-02	7.70197e-03	6.65158e-05
038/01	1.14596e-04	1.94668e-01	9.86980e-05	-4.62619e-02	-1.95564e-03	-3.47209e-04
039/01	1.70956e-04	-7.05612e-02	1.83839e-04	-4.75151e-02	1.96858e-02	-1.59216e-03
040/01	9.72632e-05	2.10154e-01	1.14223e-04	-2.32618e-02	7.48909e-03	-1.63830e-06
041/01	1.09514e-04	1.66175e-01	1.22432e-04	-2.49055e-02	6.29424e-03	-2.11951e-06
042/01	1.80085e-04	-8.03887e-02	1.74160e-04	-9.05823e-02	2.55015e-02	-4.37275e-05
043/01	1.70308e-04	-4.26982e-02	1.64338e-04	-5.32510e-02	1.14311e-03	-5.76926e-05
044/01	1.48613e-04	4.60874e-02	1.38334e-04	-5.16137e-02	8.95181e-04	1.09674e-03
045/01	1.12517e-04	1.68541e-01	1.14058e-04	-3.60248e-02	9.04835e-03	-3.31312e-06
046/01	1.44264e-04	4.69187e-02	1.43808e-04	-7.20736e-02	3.33922e-02	-3.59809e-05
047/01	1.27785e-04	9.60933e-02	1.39427e-04	-1.91795e-02	2.81743e-03	-5.02140e-06
048/01	1.86990e-04	-1.02427e-01	1.81959e-04	-3.10524e-02	-1.97950e-02	-4.16601e-05
049/01	1.25237e-04	1.15910e-01	1.27915e-04	-3.40142e-02	7.25798e-03	-5.66089e-06
050/01	1.01787e-04	1.73378e-01	1.26750e-04	-3.09797e-02	3.23512e-02	-2.85198e-07
051/01	1.03546e-04	1.86062e-01	1.14940e-04	-3.63699e-02	2.38362e-02	-1.10046e-05
052/01	1.10720e-04	1.64229e-01	1.17424e-04	-3.23541e-02	1.52165e-02	-1.07630e-05
053/01	1.08060e-04	1.71417e-01	1.17198e-04	-2.82759e-02	1.46916e-02	5.05066e-07
054/01	1.49212e-04	6.15068e-02	1.27716e-04	-5.16360e-02	-3.05280e-03	-3.29600e-05
055/01	1.98245e-04	-2.13173e-02	1.10498e-04	-1.20681e-01	2.19928e-02	4.35977e-04
056/01	2.13211e-04	-6.12681e-02	1.13122e-04	-1.26870e-01	1.23156e-02	2.26322e-05
057/01	1.53712e-04	8.93264e-02	1.05159e-04	-8.33988e-02	2.00558e-02	-7.90370e-04
058/01	1.49023e-04	1.28402e-01	8.72601e-05	-1.13291e-01	3.21838e-02	-4.67147e-04
059/01	1.62858e-04	6.54864e-02	1.05552e-04	-9.45617e-02	2.56098e-02	-7.52571e-04
060/01	1.90486e-04	2.74122e-03	9.46889e-05	-1.13800e-01	2.38202e-02	3.17526e-04
061/01	2.14191e-04	-4.45433e-02	8.36166e-05	-1.40758e-01	2.77129e-02	1.04989e-03
062/01	1.14960e-04	9.27875e-02	1.67447e-04	3.66381e-03	1.34309e-02	-1.65302e-06
063/01	1.37329e-04	-1.23100e-02	2.17587e-04	2.66112e-02	4.79132e-04	-1.46334e-06
064/01	1.15631e-04	1.38674e-01	1.27150e-04	-2.95657e-02	1.93974e-02	-1.45086e-05
065/01	9.22149e-05	2.41799e-01	7.32512e-05	-5.39693e-02	4.50381e-02	-3.35108e-06
066/01	1.23800e-04	7.35261e-02	1.66503e-04	-2.58918e-03	1.40974e-02	-3.36654e-06
067/01	1.11876e-04	1.64507e-01	1.18069e-04	-1.69320e-02	-5.38051e-04	-1.14849e-05
068/01	1.29683e-04	1.50204e-01	9.93063e-05	-5.60419e-02	-2.04302e-02	-4.58816e-04
069/01	1.91440e-04	-1.46854e-01	2.07661e-04	-3.39323e-02	9.85132e-03	-4.23192e-05
070/01	1.85748e-04	-1.09497e-01	1.86848e-04	-7.75035e-02	2.40149e-02	-1.13240e-03
071/01	1.60692e-04	-3.60212e-03	1.52623e-04	-3.80790e-02	-4.89835e-03	-2.57710e-05
072/01	1.76777e-04	-7.24506e-02	1.76140e-04	-4.25764e-02	1.80533e-03	-4.09267e-05
073/01	-3.51410e-06	9.75289e-01	-1.66122e-05	-2.17606e-01	2.51437e-01	7.47329e-07
074/01	1.53948e-04	8.09140e-02	4.87110e-05	-1.25872e-02	1.22119e-02	-1.50695e-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)
075/01	1.19756e-04	7.55873e-02	2.38378e-04	-1.24350e-02	-7.27485e-02	3.77270e-07
076/01	9.53488e-05	2.40598e-01	1.07412e-04	-4.78546e-02	-3.75990e-02	4.18099e-08
077/01	5.78921e-05	4.11109e-01	5.13445e-05	-7.71839e-02	-1.98892e-02	-8.12738e-07
078/01	1.02759e-04	2.19978e-01	9.92450e-05	-4.22309e-02	-1.03259e-02	-1.38527e-05
079/01	1.93375e-04	-1.58724e-01	2.09745e-04	-2.22198e-02	-2.10152e-02	4.02854e-03
080/01	1.87996e-04	-1.27107e-01	1.96362e-04	-9.49105e-03	-2.63905e-02	2.90915e-03
081/01	1.76739e-04	-8.75101e-02	1.86226e-04	-3.39214e-02	1.27397e-04	-8.97477e-05
082/01	1.76912e-04	-7.42394e-02	1.75416e-04	-3.16382e-02	-1.88067e-02	1.64366e-03
083/01	1.78832e-04	-7.76968e-02	1.71499e-04	-5.98385e-02	-8.57399e-03	-4.94816e-05
084/01	3.98969e-05	5.00159e-01	2.78353e-05	-8.50630e-02	-4.47462e-02	4.49776e-03
085/01	1.16980e-04	1.11872e-01	1.53032e-04	2.00054e-03	9.91628e-04	-1.22271e-06
086/01	1.13536e-04	1.19795e-01	1.42643e-04	-1.18698e-02	1.67611e-02	-9.69668e-07
087/01	1.87087e-04	-1.26226e-01	1.98297e-04	-3.14851e-02	-9.92279e-05	2.47803e-05
088/01	1.92533e-04	-1.61444e-01	2.16361e-04	-1.47508e-02	-7.80191e-03	1.54608e-03
089/01	1.89569e-04	-2.02736e-01	2.66179e-04	-2.43305e-02	5.00499e-02	1.40901e-03
090/01	1.65591e-04	-5.20183e-02	1.80553e-04	-4.14435e-02	2.18113e-02	3.71434e-03
091/01	1.73566e-04	-8.16017e-02	1.88068e-04	-4.25339e-02	1.13712e-02	2.40804e-03
092/01	1.50263e-04	2.33843e-02	1.50190e-04	-4.68663e-02	1.14496e-02	1.49376e-03
093/01	1.66308e-04	-5.41981e-02	1.80149e-04	-3.48458e-02	1.44014e-02	-2.91107e-05
094/01	1.80212e-04	-1.19064e-01	2.06488e-04	-4.01466e-02	1.98302e-02	1.19344e-03
095/01	1.88999e-04	-1.34747e-01	2.00184e-04	-6.62974e-02	1.92062e-02	1.59815e-03
096/01	1.74105e-04	-6.50115e-02	1.74582e-04	-4.81395e-02	4.34113e-03	1.06304e-03
097/01	1.89097e-04	-1.35792e-01	2.03279e-04	-3.35200e-02	-4.20943e-03	2.78983e-04
098/01	1.80552e-04	-1.13076e-01	2.00405e-04	-5.90838e-02	2.78763e-02	1.93328e-03
099/01	1.78352e-04	-7.81488e-02	1.76171e-04	-5.16587e-02	2.10231e-03	1.06473e-03
100/01	8.63310e-05	2.78964e-01	8.64900e-05	-3.87579e-02	-4.91136e-03	1.35131e-03
101/01	9.89468e-05	2.06438e-01	1.13654e-04	-3.67844e-02	1.89458e-02	8.72462e-04
102/01	1.43264e-04	5.48839e-02	1.39847e-04	-5.17293e-02	1.49508e-02	4.80108e-04
103/01	1.40967e-04	5.05310e-02	1.46677e-04	-4.88563e-02	2.52282e-02	-3.51067e-05
104/01	1.73254e-04	-5.63671e-02	1.68641e-04	-5.81796e-02	8.92190e-03	1.36368e-03
105/01	1.82651e-04	-8.30390e-02	1.72137e-04	-5.91331e-02	4.19973e-03	1.12211e-03
106/01	1.78284e-04	-8.81099e-02	1.85139e-04	-5.48481e-02	1.50497e-02	1.61483e-03
107/01	1.80363e-04	-8.76797e-02	1.80660e-04	-5.31234e-02	7.71161e-03	1.64203e-03
108/01	1.76406e-04	-7.05627e-02	1.74616e-04	-4.61568e-02	2.67730e-03	7.92589e-04

Appendix C

WOCE96-S4I: CTD Shipboard and Processing Comments

Key to Problem/Comment Abbreviations	
BQ	bottle oxygen value(s) questionable/missing, need to estimate for ctdoxy fit
CO	ctd conductivity offset
CN	ctd conductivity signal noisy
CX	conductivity sensor drifting higher as cast proceeds
FS	frozen temperature and/or conductivity sensor at down-cast entry
HB	rosette "hit" ocean bottom; conductivity, oxygen and/or transmissometer signals drop suddenly at bottom
OB	bottom ctdoxy signal shift coincides with slowdown for bottom approach
OF	ctdoxy fit off more than 0.02 ml/l (deeper) or 0.10 ml/l (shallower) compared to bottle data and/or nearby ctd casts
OH	ctdoxy fit high near surface: high raw ctdoxy signal
ON	ctdoxy signal unusually noisy
OS	raw ctdoxy signal shifts
OX	sacrificed surface ctdoxy fit in order to optimize deeper ctdoxy fit; suspect inability to fit both caused by effects of extreme cold on ctdoxy sensor
SS	probable sea slime on conductivity sensor
TX	PRT1 drift caused by seawater in sensor housing; repaired after sta 31
WS	winch slowdown/stop, potential shift in ctdoxy signal (also, see "OB")

Key to Solution/Action Abbreviations	
CP	up-cast bottle-ctd conductivity custom-fit as a function of pressure to correct for large drift
DO	despiked raw ctdoxy, despiked data ok unless otherwise indicated
DS	despiked salinity, changed temperature and/or conductivity - see .ctd file codes
DU	down/up ctdoxy differ or similar features at different pressures in this area; but down-cast ctd salinity and oxygen structures often correspond well with each other
EB	used nearby bottles and/or casts to estimate bottle oxygen value(s) for ctdoxy fit
EX	extrapolated data from surface to specified mixed-layer pressure so down-cast ctdoxy could be used; ctdT/S data compare well with up-cast
NA	no action taken, used default quality code 2
O3/O4	quality code 3/4 oxygen in .ctd file for pressures specified
OC	offset conductivity channel to account for shift/offset (units: mS/cm)
PS	omitted deepest 0.3-0.7db of time-series data from pressure-sequencing, no change to pressure-series max. pressure
RO	offset raw ctdoxy data to account for signal shift caused by slowdown/stop/yoyo; usually "DO" in transition area near offset
S3	quality code 3 salinity in .ctd file for pressures specified
T2	PRT2 used as primary temperature sensor this cast, noisier salinity than usual due to greater distance between PRT2 and C sensors
UP	used up-cast data for final pressure-series data

Sta/Cast	Problem/Comment	Solution/Action
001	start leg using CTD #3 with Pressure/#77011, PRT1/#14373, PRT2/FSI-OTM #1320T, Conductivity/#E55	

Sta/Cast	Problem/Comment	Solution/Action
001/01	winch meter reading 95m too deep on up-cast by 500m; up noisy/multiple ctdC offsets, not usable	
	CO/-0.007PSU at 428 db, then +0.002PSU at 4080db down: water leak in CTD noticed during sta 2 apparently started here	OC -0.005/0-428db, +0.003 to +0.001/430-4080db; shift to match btls, rest of down-cast and nearby casts
	OX	O4/0-196db, O3/198-234db
002/01	ABORTED - CTD conductor/signal failure at 322m down: water found inside CTD #3 main housing. Opened CTD - dried out, checked, installed water sensor inside case	
002/02	CX/down is -0.0035PSU compared to up-cast at Smax, down/up overlay at btm	UP
	OX	O4/0-274db, O3/276-330db
003/01	tagline snagged on bar at launch: cut line, did cast with 3m of line attached	
	OX	O4/0-330db
004/01	OX; OF/max ±0.03ml/l compared to btls	O4/0-220db, O3/222-328db; DU/330-850db
005/01	CTD power problems/voltage dropouts starting 4656db down; WS/12 mins. near 4838db down to investigate; noisy/intermittently low voltage: ctdP/T ok, altimeter signal gone, junky/noisy ctdC through rest of cast; up-cast unusable: pressure noisy 4300m through 1400m trips, then voltage better but inconsistent; top 100m very different down and up.	
	OX/OH	O4/0-180db, O3/182-254db
	CN	DS/1016-1024db
	CO/ctdC values jumped whenever voltage dropped	OC -0.006/intermittent 4656-5092db, 7 distinct offset segments in this range
	OB/WS 12 mins. (including 10db yoyo)	RO +38 to +30/4838-5222db/btm
006/01	altimeter removed prior to cast, wire and termination looked ok; no CTD electronic problems during cast; did cast despite pinger problems: flat btm	
	OX	O4/0-182db
	OB	RO +2 to +4/5192-5270db/btm
007/01	OX	O4/0-234db
	HB/CO	DS/PS
008/01	replaced pinger and added back altimeter prior to cast	
	OX	O4/0-240db
	OB	RO +4 to +11/5210-5284db/btm
009/01	OX	O4/0-200db
	OB	RO +3 to +10/5178-5264db/btm

Sta/Cast	Problem/Comment	Solution/Action
010/01	OX	O4/0-194db
	OB	RO +2 to +4/5234-5274db/btm
	HB/CO/OS	DS/DO/PS
011/01	removed altimeter prior to cast	
	FS; OX	EX/top 6db; O4/0-154db
	OB	RO +4 to +12/5212-5276db/btm
012/01	OX	O4/0-198db
	OB	RO +7 to +20/5082-5208db/btm
013/01	slight sea-ice at launch	
	OX; OF/max -0.09 ml/l compared to btls	O4/0-122db, O3/124-154db; DU/156-450db
	OB	RO +3 to +22/5008-5186db/btm
014/01	WS/5 mins. at surface down to repair winch wire-out meter	use top of 12db yoyo back to srfc/2.7db
	OX; OF/max +0.05 ml/l compared to btls	O4/0-168db; DU/170-230db
	SS/CO/-0.002PSU offset from 4214db until near btm of cast	OC +0.002/4214-5102db
	WS/brief winch slowdown 4738-4744db caused ctdoxy drop	DO/4744-4762db
	OB	RO +3 to +10/5096-5138db/btm
	HB/CO	DS/PS
015/01	OX; OF/max ±0.20 ml/l compared to btls	O4/0-88db, O3/90-108db; DU/110-450db, very different down/up structure in all parameters
	OF/max ±0.08 ml/l compared to btls	DU/1300-1700db
	OB	RO +14 to +18/4954-4996db/btm
016/01	medium-size pancake ice at launch, water clear under rosette	
	FS/ctdC; OX	use top of 82db yoyo back to srfc/3.3db; O4/0-190db
	OS	RO +2 to +6/4550-4658db
017/01	OX	O4/0-208db, O3/210-242db
	OB	RO +10 to +5/3904-3948db, RO -3/3984-4000db
018/01	large ice chunks at launch, boomed in closer to ship while lowering	
	FS/ctdT, stabilizes ~64db	T3/S3/0-62db
	OX; OF/max ±0.06 ml/l compared to btls	O4/0-182db, O3/184-238db; DU/240-820db
	WS/0.5 min. stop at 2084-2088db caused small ctdoxy drop	DO/2084-2100db
	OB	RO +10 to +28/2736-2786db/btm
019/01	OX/OH; OF/max ±0.12 ml/l compared to btls	O4/0-100db; DU/102-390db
020/01	OX; OF/max ±0.04 ml/l compared to btls	O4/0-238db; DU/240-720db
	OB/larger drop than typical	RO +13 to +60/3106-3190db/btm

Sta/Cast	Problem/Comment	Solution/Action
021/01	SS/-0.04PSU at 2727db down, then mostly -0.007-9PSU until shifts back at btm	UP
	OF/±0.04 ml/l compared to many btls, erratic up-cast profile; large ctdoxy signal drops at every btl stop; does mesh ok with deep theta-ctdoxy transition (oxy decrease) between stas 18-20 and 22-25	O4/0-430db, DO/O3/432-4602db/btm; in the ballpark below 430db, but 3-4x worse ctdoxy fit than most casts after despiking stops: best fit of up-cast ctdoxy
022/01	SS/-0.016PSU at 2145db down, noisy+offset until shifts back at/near btm	UP
	OX/WS/2.5 mins. at 231db btl stop	O4/0-228db
023/01	OX	O4/0-102db
	OB	RO +2 to +20/4854-4930db/btm
024/01	CO/down deep ctdS -0.001 PSU compared to up before shift	OC +0.0005/0-4466db
	OX	O4/0-132db
	OB	RO +3 to +24/4854-4940db/btm
025/01	OX; OF/max ±0.06 ml/l compared to btls	O4/0-122db; DU/124-180db
	OB	RO +3 to +5/4780-4810db/btm
026/01	open water now; delayed cast for weather/wind/daylight - wind 15-25 knots, short period/confused swell	
	OX	O4/0-182db
027/01	OX	O4/0-176db
	OB	RO +6 to +9/4492-4536db/btm
028/01	transmissometer reading drops: unusually low and some noise 82-552db down	
	OX/OH/raw ctdoxy signal ~50% higher near surface compared to nearby casts	O4/0-386db
029/01	OX	O4/0-94db
	OF/+0.03 ml/l compared to btm 2 btls	NA/4150-4284db/btm, deep theta-ctdoxy consistent with nearby casts
	OB	RO -2 to +5/4268-4284db/btm
030/01	TX	T2/DS
	OX; OF/max +0.12 ml/l compared to btl	O4/0-184db; DU/186-230db
	OB/OF/max -0.04 ml/l compared to btl	O3/4374-4450db; RO +6 to +9/4388-4618db/btm
031/01	TX: found seawater in sensor housing after cast, unrelated to sta 2 problem	T2/DS
	OX; OF/max ±0.12 ml/l compared to btls	O4/0-116db; DU/118-450db
	OF/max ±0.04 ml/l compared to btls	DU/3500-4500db
	OB	RO +8/4824-4844db/btm
	BQ	EB/4844db, estimated btm btloxy using theta-ctdoxy profile, colder at btm than nearby casts

Sta/Cast	Problem/Comment	Solution/Action
032-038	new ctdC sensor has large, non-linear, positive drift; used up-casts for prs-seq. data, with ctdC corrections determined cast-by-cast	
032/01	repaired CTD, replaced ctdC sensor #E55 with new sensor #P42 prior to cast	
	CX/new C sensor, +0.35+PSU ctdS drift in down-cast surface mixed layer (top 80db); +0.15PSU ctdS drift between bases of down/up surface mixed layers	UP/CP
	OX	O4/0-150db
	ctdoxy structures also seen on down-cast, but not on nearby casts	NA/2700-4500db, looks real
	WS/5.5 mins. each at 3293db and 3908db btl stops	DO/3280-3312db and 3896-3910db
	CX/CO	OC +0.001 to +0.003/3904-4844db/btm
	OB	RO -3 to -20/4500-4844db/btm
	WS/5.5 mins. at 4773db btl stop; OF/+0.03 ml/l compared to deepest 2 btls; btls look low compared to nearby casts	DO/O3/4772-4844db, large drift at up-cast start, maxP through long btl stop: cannot determine true deep ctdoxy profile
033/01	CX/+0.04PSU ctdS drift in down-cast surface mixed layer, +0.025PSU ctdS drift between bases of down/up surface mixed layers	UP/CP
	OX	O4/0-130db
	OB	RO -8 to -13/4704-4896db/btm
034/01	steady 30-knot wind at launch with no swell; wind 40 knots at end, winch hauled in ~80 m/min to get on board faster/safely	
	CX/+0.075PSU ctdS drift between bases of down/up surface mixed layers	UP/CP
	OX	O4/0-142db
	same deep ctdoxy structure on down-cast, but not nearby casts	NA/3400-4528db, matches btls and looks real
	OB; OF/ to +0.05 ml/l compared to btm btl, up-cast	RO -3 to -17/4638-4700db; O3/4530-4700db/btm
035/01	delay cast start for winch power problem	
	FS to ~65db down; CX/+0.005PSU ctdS drift between bases of down/up surface mixed layers	UP/CP
	WS/10 mins. at 100db btl stop for pylon problem, 8 mins. at 50db btl stop	DO
	OF/-0.20 to -0.30 ml/l compared to btm 3 btls, very steep gradient at btm	O3/456-458db/btm

Sta/Cast	Problem/Comment	Solution/Action
036/01	small delay cast start for pylon problems; reposition ship to avoid ice floe	
	FS/to 124db ctdT and 30db ctdC down; CX/+0.007PSU ctdS drift between bases of down/up surface mixed layers	UP, 46db yoyo back to srfc not enough; CP
	OB	RO +30/1306-1310db/btm
037/01	FS to ~140db down; CX/+0.003PSU ctdS drift between bases of down/up surface mixed layers	UP/CP
038/01	CX/+0.065PSU ctdS drift in down-cast mixed layer, +0.008PSU ctdS drift between bases of down/up surface mixed layers	UP/CP
	OF/-0.03-4 ml/l compared to btls, -0.02 ml/l max. compared to sta 39 deep theta-ctdoxy; large raw ctdoxy drop at 1925db btl stop; much btloxy scatter	DO/O3/1800-2100db, good match to sta 39 theta-ctdoxy below 2100db
	OB	RO +3 to +5/2488-2498db/btm
039/01	replaced ctdC sensor #P42 with original sensor #E55 prior to cast	
	OX	O4/0-194db
	OF/max ±0.04 ml/l compared to btls	DU/400-1150db
	OF/max ±0.06 ml/l compared to btls, agrees well with sta 38 deep theta-ctdoxy	DU/1152-2350db
	OB	RO +9 to +17/3382-3530db/btm
040/01	some wire angle most of cast	
	OX	O4/0-110db
	BQ/no btl at btm, pylon problems	EB/4208db
041/01	OX; OF/max ±0.03 ml/l compared to btls	O4/0-108db; DU/110-280db
	SS/CO	OC +0.1155/598-608db
042/01	OS/ends in single-frame raw ctdoxy spike (2x normal values) at 360db; OX	DO/RO -365 to -15/2-360db; O4/0-204db
	OS	RO -2 to -6/4844-4854db
043/01	delay launch for pylon check	
	OX	O4/0-164db
044/01	OX	O4/0-100db
045/01	OX	O4/0-90db, O3/92-128db
	OF/max +0.02 ml/l compared to btl/nearby casts	NA/4484-4630db, corresponds to ctdS feature

Sta/Cast	Problem/Comment	Solution/Action
046/01	OS	DU/DO/RO -160 to -30/O3/154-254db, fit quality uncertain due to large raw ctdoxy offsets
	OF/max -0.04 ml/l compared to btls/nearby casts	O3/340-700db
047/01	fairly large wire angle	
	OX; OX/OF/max -0.25 ml/l compared to btls	O4/0-84db; DU/O3/86-116db, fit quality uncertain with large down/up difference
	SS/CO	DS/678-686db
	OB	RO +8 to +19/4344-4360db/btm
048/01	FS/ctdT stabilizes ~6db, ctdS deeper: down ctdS matches up ~37db; down-cast used for better ctdoxy profile	EX/ to p 4db; OC +0.37 to +0.012/6-20db, OC +0.012 to +0.004/22-30db, DS/S3/0-36db
	OX; OF/max +0.05 ml/l compared to btls	O4/0-216db; DU/218-300db
	OB	RO +3/4582-4592db/btm
049/01	OX/ON; OF/max -0.08 ml/l compared to btls	O4/0-76db; DU/78-260db
050/01	OX/ON	O4/0-140db
	OB; HB/CO: winch went 10m deeper after btm btl trip	RO +4/4246-4260db/btm; DS/PS
051/01	OX/ON	O4/0-86db
	BQ; OB	EB/4250-4404db; RO +5 to +13/4332-4404db/btm
052/01	BQ; OX/ON; OF/max -0.08 ml/l compared to btls	EB/0-40db; O4/0-100db; DU/102-150db
	OB/OF/-0.01 ml/l shift at btm slowdown, less than ±0.02 ml/l compared to btls after fit	NA/4356-4450db, 4380db to btm corresponds to ctdS structure, and deep theta-ctdoxy matches sta 53; 2 deepest btloxys seem inconsistent
053/01	OX/ON	O4/0-88db, O3/90-200db
	SS/CO	OC +0.16 to +0.42/632-638db, OC +0.005/640-686db
	OB/OF/-0.01 ml/l shift at btm slowdown, less than +0.02 ml/l compared to btls	NA/4330-4412db, corresponds to ctdS structure, and deep theta-ctdoxy matches sta 52
054/01	OX	O4/0-208db
	OB	RO +13/4254-4332db/btm
055/01	long cast delay for rough weather, long swell at cast start/recovery	
	FS/ctdC or CX to ~25db down; CX/+0.01PSU ctdS drift between bases of down/up surface mixed layers	UP
	OX	O4/0-156db
	BQ/no btloxy at btm	EB/4186db
	ON/OF/±0.02-4 ml/l deep variation compared to btls and smoother down-cast ctdoxy	NA, noise is artifact of ctdoxy drops at up-cast btl stops

Sta/Cast	Problem/Comment	Solution/Action
056-061	major ctdC response change: unstable/noisy/positive drift, espec. stas 56-58; 59 less noisy/large drift; stas 60-61 much less noise/drift, but not fixed	DS/UP: downs unusable, despiked/used ups for all pressure-sequenced data, with ctdC corrections determined cast-by-cast
056-058	CN/very noisy ctdC in addition to drift, downs much worse than ups	DS/many more levels than usual; final deep theta-ctdS overlays within 0.001 PSU of btls, also nearby casts for stas 56-57; sta 58 odd but matches its own btls
056/01	large swells, ship-roll, wire kinked	
	CX/+0.26+PSU ctdS drift in down-cast surface mixed layer (top 75db); +0.16PSU ctdS drift between bases of down/up surface mixed layers; extremely noisy ctdC	UP
	BQ; OX	EB/0-40db; O4/0-184db
	OS	RO -2 to -5/4122-4146db
	SS/CO; 8db yoyo at very btm of cast	OC +0.001/3932-4152db/btm; PS
	ON/OF/±0.02-3 ml/l deep variation compared to btls and down-cast ctdoxy	NA, artifact of ctdoxy drops at up-cast btl stops
057/01	cut off 50m of wire and reterminated prior to cast	
	CX/+0.07PSU ctdS drift between bases of down/up surface mixed layers; CN/ctdC slightly less noisy than sta 56	UP; DS
	OX	O4/0-134db
	OF/multiple ±0.04-5 ml/l btloxys, deep theta-ctdoxy looks ok compared to nearby casts and most btls	NA/300-3800db, disregarded suspicious btloxys during fit
	OF/+0.03-4 ml/l compared to btm btl and down-cast ctdoxy	O3/3984-4098db/btm
058/01	CX/+0.065PSU ctdS drift between bases of down/up surface mixed layers; CN/ON/ctdC still somewhat noisy	UP; DS
	OX/WS/3 mins. at 176-180db, between btl stops	O4/0-178db
	SS/CO	OC +0.001/3652-4022db/btm
	OF/+0.05 ml/l compared to btm btl, +0.01 ml/l compared to down-cast/nearby casts theta-ctdoxy; shape mirrors ctdS	O3/3964-4022db/btm, btm btloxy looks lower than drops at btm of nearby casts, down/up ctdoxy show same structure; but prev. cast ctdoxy coded uncertain and this is only cast without a ctdoxy drop at btm
059/01	cleaned ctdC sensor with RBS prior to cast: ctdC offset relative to previous cast, but noise gone and drift rate decreased	
	FS to ~40db down; CX/+0.04PSU ctdS drift between bases of down/up surface mixed layers	UP
	OX	O4/0-214db, O3/216-250db
	OB	RO -4/3964-4008db/btm
	BQ/no btloxy at btm; OF/+0.02 ml/l compared to deepest btls and btm of down-cast; ±0.01 ml/l compared to nearby casts theta-ctdoxy	EB/4008db; O3/3938-4008db/btm, diverges from down-cast ctdoxy here, cannot be sure without btm btl

Sta/Cast	Problem/Comment	Solution/Action
060/01	FS to ~32db down; CX/+0.008PSU ctdS drift between bases of down/up surface mixed layers	UP
	OX	O4/0-138db
	-0.005 sigma theta inversion, ctdT/S also drop here	NA/146-152db, looks real
	ON/±0.02-3 ml/l deep noise level, theta-ctdoxy generally matches btls, down-cast and nearby casts	NA/deep, artifact of ctdoxy drops at up-cast btl stops
	OF/+0.02-4 ml/l compared to btm btl; diverges high compared to down-cast here	O3/2964-2988db/btm
061/01	CX/+0.009PSU ctdS drift between bases of down/up surface mixed layers	UP
	OX	O4/0-164db
	ON/±0.02-3 ml/l deep noise level, theta-ctdoxy generally matches btls, down-cast and nearby casts	NA/deep, artifact of ctdoxy drops at up-cast btl stops
	OF/+0.04-5 ml/l compared to btm btls, down ctdoxy; does not match nearby casts theta-ctdoxy	O3/2614-2684db
062/01	replaced ctdC sensor #E55 with new sensor #O17; replaced PRT2/FSI-OTM #1320T with #1322T prior to cast	
	OX; OF/-0.25 ml/l compared to btloxy, mirrors ctdS structure	O4/0-118db; DU/O3/120-178db, fit quality uncertain with large down/up difference
	-0.04°C drop at btm 10db of cast, down-/up-casts agree	NA
063/01	OX	O4/0-124db
	OB	RO +13 to +23/2002-2142db/btm
064/01	big ship-rolls during down-cast	
	OX	O4/0-86db
	OB	RO +10 to +30/1522-1530db/btm
065/01	OX	O4/0-76db
066/01	OX	O4/0-138db
067/01	OX	O4/0-58db, O3/60-94db
	OF/max ±0.40 ml/l compared to btls; drifted deeper/West during down-cast, steep slope	DU/96-3000db, extremely different down/up structure in all parameters
	OB	RO -5 to +3/3598-3672db/btm
068/01	slowed winch 750m off btm (3698-3716db), some transmissometer noise - ok, back to 60m/min	
	OX; OF/max -0.40 ml/l compared to btls, mirrors ctdS structure: ship drifted W during cast	O4/0-108db; DU/O3/110-974db, but fit quality uncertain with large down/up difference
	OF/max +0.05 ml/l compared to btls, +0.03 ml/l compared to nearby casts; mirrors ctdS structure	DU/1850-2300db
	OF/max -0.03-4 ml/l compared to btls, matches up-cast ctdoxy and nearby casts theta-ctdoxy	NA/3350-3850db, 2 btls look suspicious
	OB/WS/2.5 min. s to p at 3696-3702db	RO +10 to +12/3698-4528db/btm

Sta/Cast	Problem/Comment	Solution/Action
069/01	OS; OX	DO/RO -250 to -100/2-364db; O4/0-292db
	OF/max -0.25 ml/l compared to btls	DU/294-1250db, down/up espec. different 430-600db
	OF/max -0.03 ml/l compared to btl, matches ctdoxy from nearby casts; mirrors ctdS structure	DU/2850-3150db
	OB	RO +4 to +12/3966-4116db/btm
070/01	OX; OF/max ±0.05 ml/l compared to btls, mirrors ctdS structure	O4/0-192db; DU/194-440db
	OF/max -0.20 ml/l compared to btls, -0.10 ml/l compared to nearby casts; mirrors ctdS structure	DU/O3/442-946db, fit quality uncertain with large down/up difference
	OB	RO +4/4256-4350db/btm
071/01	OX	O4/0-164db
	transmissometer cleaned after this cast	
072/01	OX; ON/OF/max +0.08 ml/l compared to btls, somewhat mirrors ctdS structure	O4/0-228db; DU/O3/230-310db, fit quality uncertain due to noisier signal that blends into shallower high ctdoxy section
	OB	RO +8/4656-4664db/btm
073/01	resume station work 14 June near Mirnyy, after 6.5-day break in casts	
	OS	DO/RO -350 to -50/2-36db
	OF/max +0.15 ml/l compared to btls	O3/220-380db
074/01	transmissometer cleaned/checked at cast start	
	SS/-0.155PSU at 256db down, returns about 278db; FS/top 150db down, below mixed layer	UP, 28db yoyo back to srfc not enough
	OS	DO/RO +30 to +15/0-48db
075/01	FS/OH; OF/max ±0.10 ml/l	EX/top 100db; O4/0-222db
	OB/larger drop than typical	RO +33 to +66/1204-1212db/btm
076/01	long delay in launch, problems initializing pylon	
	FS/OH; OF/max ±0.08 ml/l compared to btls, mirrors ctdS structure	EX/top 112db, 29db yoyo back to srfc not enough; DU/0-1400db
	OB/larger drop than typical	RO +3 to +57/1736-1770db/btm
077/01	FS	EX/top 88db
	OF/max -0.06 to -0.20 ml/l compared to btls	DU/250-520db

Sta/Cast	Problem/Comment	Solution/Action
078/01	pylon problems, restarted data acquisition in water during 30-min. stop at 3008db up-cast	
	FS/OH; OX	EX/top 32db; O4/0-218db
	OF/max ±0.06 ml/l compared to btls	DU/O3/220-318db, fit quality uncertain, blends into shallower high ctdoxy section
	OF/max ±0.30 ml/l compared to btls, mirrors ctdS structure	DU/320-750db
	OF/max -0.15 ml/l compared to btls, mirrors ctdS structure	DU/1100-1400db
	OB/larger drop than typical	DO/RO +2 to +115/2950-3044db/btm, result within ±0.02 ml/l of all 3 deep btls
079/01	pylon problems, restarted data acquisition in water at 1536db up-cast	
	FS; OX	EX/top 10db; O4/0-100db
	OF/max +0.13 ml/l compared to btls, mirrors ctdS structure	DU/102-450db
	BQ	EB/250-1500db
	OF/max -0.05 ml/l compared to nearest cast, no btloxy values	O3/612-1332db, noisy and low compared to sta 80 theta-ctdoxy, no btls in this area, so fit uncertain
	OB	RO +10 to +13/3166-3258db/btm
080/01	FS; OX	use top of 28db yoyo back to srfc/2.0db; O4/0-162db
	OF/max ±0.05 ml/l compared to btls, mirrors ctdS structure	DU/O3/164-250db, fit quality uncertain, blends into shallower high ctdoxy section
	OB/larger drop than typical	DO/RO +5 to +96/3560-3634db/btm
081/01	FS; OX	EX/top 26db; O4/0-138db
	OF/max ±0.08 ml/l compared to btls, mirrors ctdS structure	DU/140-650db
	BQ/code 4 btloxy values (switched stoppers) compared well to ctdoxy	EB/676-878db, included two code 4 btloxys for ctdoxy fit
	OB	RO +1 to +3/3842-3876db/btm
082/01	FS; OX	use top of 28db yoyo back to srfc/2.2db; O4/0-226db
	OF/max ±0.06 ml/l compared to btls, mirrors ctdS structure	DU/228-650db
	OB/larger drop than typical	RO +6 to +62/3820-3888db/btm
083/01	OX; OF/max ±0.70 ml/l compared to btls, mirrors ctdS structure	O4/0-266db; DU/O3/268-426db, fit quality uncertain, blends into shallower high ctdoxy section
	OF/max -0.25 ml/l compared to btls, mirrors ctdS structure	DU/428-900db, matches btloxys at top/bottom of section, ok despite large down/up difference
	OB	RO +4 to +12/3882-3982db/btm
084/01	no freezing problem at launch: warm enough for light rain	
	OX; OF/max ±0.12 ml/l compared to btls, somewhat mirrors ctdS structure	O4/0-236db; DU/238-528db, matches several btloxys in area
	OB	RO +5 to +24/3734-3822db/btm

Sta/Cast	Problem/Comment	Solution/Action
085/01	OX; OF/max -0.35 ml/l compared to btls, mirrors ctdS structure	O4/0-302db; DU/304-964db, matches btloxys at 3 points in section, ok despite large down/up difference
	OB/larger drop than typical	RO +20 to +47/2790-2964db/btm
086/01	OX	O4/0-150db
	OB	RO +25 to +39/2486-2582db/btm
087/01	wind 25-35 knots	
	FS; OX; OF/max ±0.10 ml/l compared to btls, mirrors ctdS structure	EX/top 6db; O4/0-196db; DU/198-550db
	OB	RO +5 to +27/3948-4034db/btm
088/01	FS; OX	EX/top 40db; O4/0-198db
	ctdT offset near end of frozen sensor area; down-cast used for better ctdoxy profile	offset ctdT +0.006 to +0.003/42-50db
	OF/max ±0.05 ml/l compared to btls, mirrors ctdS structure	DU/200-500db
	OB	RO +12 to +24/4004-4112db/btm
	HB/CO	DS/PS
089/01	large wire angle	
	FS; OX; OF/max ±0.06 ml/l compared to btls, somewhat mirrors ctdS structure	EX/top 16db; O4/0-88db; DU/90-900db
	OB/ON/±0.015 ml/l noise level and -0.02 ml/l compared to stas 90/91 theta-ctdoxy, but matches btm btloxy	RO +2 to +39/3900-3978db/btm
090/01	OX; OF/max +0.30 ml/l compared to btl, mirrors ctdS structure	O4/0-152db; DU/O3/154-206db, fit quality uncertain, blends into shallower high ctdoxy section
	OF/max -0.08 ml/l compared to btls, mirrors ctdS structure	DU/208-430db
	OB; ON/±0.02 ml/l noise level near btm	RO +5 to +25/3752-3856db/btm
091/01	OX; OF/max +0.30 ml/l compared to btl, mirrors ctdS structure	O4/0-138db; DU/O3/140-198db, fit quality uncertain, blends into shallower high ctdoxy section
	OF/max ±0.03 ml/l compared to btls, mirrors ctdS structure	DU/200-340db
	OB; ON/±0.015 ml/l noise level near btm	RO +2 to +13/3726-3978db/btm
092/01	OX; OF/max +0.10 ml/l compared to btls, mirrors ctdS structure	O4/0-142db; DU/O3/144-242db, fit quality uncertain, blends into shallower high ctdoxy section
	OF/max ±0.03 ml/l compared to btls, mirrors ctdS structure	DU/244-900db
	OB; ON/±0.015 ml/l noise level near btm	RO +9 to +16/4046-4148db/btm
093/01	FS?/no density inversion at surface	NA/possibly real, let end user decide
	OX; OF/max ±0.03 ml/l compared to btls, mirrors ctdS structure	O4/0-206db; DU/208-900db
	OB/-0.02 ml/l ctdoxy drop at 4212db; WS/small-scale yoyos 4304-4310db cause +0.03 ml/l in ctdoxy	O3/4212-4324db, shifting ctdoxy at drop would make deeper fit worse

Sta/Cast	Problem/Comment	Solution/Action
094/01	SS/CO, up-cast is worse	DS/OC -0.0035 to +0.008/intermittent most of down-cast, 8 distinct offset segments from surface to 60db above btm
	OX; ON/±0.05 ml/l ctdoxy noise level, more than usual	O4/0-88db; NA/90-700db
	OB/OF/-0.03 ml/l compared to btloxys and rest of ctdoxy at very btm	RO +5/4382-4506db/btm, O3/4502-4506db/btm
095/01	OX; OF/max ±0.45 ml/l compared to btls, mirrors ctdS structure	O4/0-144db; DU/146-650db
	OB	RO +7 to +28/4380-4480db/btm
096/01	OX; OF/max ±0.22 ml/l compared to btls, mirrors ctdS structure	O4/0-152db; DU/154-900db
	OB/max -0.03-4 ml/l compared to earlier casts, -0.02 ml/l compared to later casts on theta-ctdoxy	NA/4390-4440db, less than -0.02 ml/l compared to stas 97-99 theta-ctdoxy
	OB	RO +10/4456-4462db/btm
097/01	transmissometer fouled from 1302db down to 4246db up	
	OX; OF/max ±0.08 ml/l compared to btls, mirrors ctdS structure	O4/0-200db; DU/202-550db
	OB	RO +6 to +13/4290-4390db/btm
098/01	OX; OF/max ±0.12 ml/l compared to btls, mirrors ctdS structure	O4/0-120db; DU/122-650db
	OF/max +0.02 ml/l ctdoxy area starts as deep theta drops and ends at slowdown for btm approach	NA/4230-4268db
	SS/CO	OC +0.001/4254-4332db/btm, offset continued/fixed to 3544db up
	OB	RO +2 to +4/4322-4332db/btm
099/01	transmissometer cleaned at cast start	
	OX; OF/max ±0.08 ml/l compared to btls, mirrors ctdS structure	O4/0-130db; DU/132-350db
	OB	RO +3 to +11/4256-4340db/btm
	OB/OF/-0.02 ml/l compared to nearby ctdoxy casts, odd on theta-ctdoxy	O3/4296-4300db, caused by slowdown and likely not real
100/01	some wire angle; stray chunks of ice during launch.	
	OX; OF/max ±0.08 ml/l compared to btls, mirrors ctdS structure	O4/0-172db; DU/174-450db
	OB/OF/max +0.03-4 ml/l compared to btl at btm of cast	RO +3 to +12/4066-4138db/btm, O3/4084-4138db
101/01	replaced PRT2/FSI-OTM #1322T with #1321T prior to cast	
	OX	O4/0-98db
	OS; OB	RO -3/3608-3618db; RO +1 to +6/3624-3808db/btm

Sta/Cast	Problem/Comment	Solution/Action
102/01	transmissometer gave bad readings below 2450db on down-cast	
	OX; ctdoxy compares well to btls, but looks artificially low in between: should mirror ctdS shape better	O4/0-100db; O3/102-126db
	BQ; OB	EB/4002db; RO +3 to +9/3928-4002db/btm
103-106	replaced PRT2/FSI-OTM #1321T with secondary Pressure/FSI-OPM #1326 for testing	
103/01	FS; OX	EX/top 6db; O4/0-126db
	OF/max -0.05 ml/l compared to btls, somewhat mirrors ctdS structure DU/O3/128-214db, fit quality uncertain, blends into shallower high ctdoxy section	
	OF/max ±0.06 ml/l compared to btls, mirrors ctdS structure	DU/216-450db
	OB	RO +3 to +9/4148-4168db/btm
104/01	OX	O4/0-202db
	OB	RO +8/4160-4234db/btm
105/01	OX	O4/0-114db
	OB	RO +8 to +25/4196-4282db/btm
106/01	7-second gap in raw data when deck unit reset during cast to fix display problem; OX	interpolate CTD data 150-152db; O4/0-152db
	SS/CO	OC +0.002/872-940db
	OF/+0.03 ml/l shift in ctdoxy, blends in with nearby casts on theta-ctdoxy	NA/4232-4252db
	OB	RO +2 to +5/4264-4310db/btm
107/01	replaced secondary Pressure/FSI-OPM #1326 with PRT2/FSI-OTM #1320T	
	FS; OX	EX/top 18db; O4/0-150db
	OF/-0.02 ml/l shift in ctdoxy, matches single btl in the area, blends in with sta 106 drop near btm on theta-ctdoxy	NA/4030-4152db
	OB	RO +2 to +4/4186-4272db/btm
108/01	OX; OF/max ±0.08 ml/l compared to btls, mirrors ctdS structure	O4/0-158db; DU/160-414db
	OF/max -0.06 ml/l compared to btls, but mirrors ctdS structure	NA/416-700db
	OB	RO +3 to +7/4160-4228db/btm

Appendix D

WOCE96-S4I: Bottle Quality Comments

Remarks for deleted samples, missing samples, PI data comments, and WOCE codes other than 2 from WOCE S04I/NBP96-3. 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, Nitrite, and Phosphate. The first number before the comment is the cast number (CASTNO) times 100 plus the bottle number (BTLNBR).

Station 001

Cast 1	CTD Processor: "Water inside CTD case, conductivity offset started 428db down-cast; up-cast salinity offset back and forth (+/-0.005) most of up-cast; offset/despiked up-cast only as needed to generate bottle trip information."
132	Bottle salinity is high compared with CTD. See 132-101 PO4 comment. Footnote CTD salinity despiked, and PO4 bad. Pressure is 14db.
132-101	PI: "PO4 bad; cannot tell good from bad so mark entire cast bad" Nutrient analyst: "PO4 data bad, possible contamination from new rosette bottles." Pressure is 14-5522db.
132-126	CTD Processor: "Sacrificed surface CTDO fit to optimize deeper fit." Footnote CTDO bad. Pressure is 14-195db.
131	Bottle salinity is high compared with CTD. Salinity Analyses: "4 attempts for a good reading. Bottle ran low of water." 0.002 psu high causes instability in calculated density. See 132-101 PO4 comment. Footnote CTD salinity despiked, bottle salinity questionable and PO4 bad. Pressure is 30db.
130	PI: "PO4 of 2.43 is high and NO3/PO4 is low; mark PO4 as questionable?" PO4 peak has an odd shape, code questionable. See 132-101 PO4 comment. Footnote PO4 bad. Pressure is 52db.
129	O2 data: "two stir-bars added, sample lost." See 132-101 PO4 comment. Footnote CTD salinity despiked, O2 lost and PO4 bad. Pressure is 80db.
128-124	See 132-101 PO4 comment. Footnote CTD salinity despiked, and PO4 bad. Pressure is 110-297db.
125	Sample Log: "spigot difficult to push in." Pressure is 247db.
123	O2 problem. Oxy data "OT" See 132-101 PO4 comment. Footnote oxygen bad and PO4 bad. Pressure is 398db.
115-114	O2 problem here. See 132-101 PO4 comment. Footnote oxygen and PO4 bad. Pressure is 2267-2525db.
113	Sample Log: "leaking top cap." Salt and O2 okay on theta plot. Pressure is 2786db.
105	Sample Log: "leaking from bottom endcap." Salt and O2 okay on theta plot. Pressure is 4827db.
104	Bottle salinity is high compared with CTD. Salinity Analyses: "3 attempts for a good reading." High salinity value, inconsistent with t-s, CTD. Footnote salinity and PO4 bad. Pressure is 5084db.
102	Low value, inconsistent with T-S, CTD. See 132-101 PO4 comment. Footnote CTD salinity despiked, salinity questionable and PO4 bad. Pressure is 5448db.

Station 002

Cast 1	Console Log: "CTD conductivity failure @322 MWO down. Cast aborted."

Cast 2	Console Log: "Up vs down conductivity sensor hysteresis."
236-229	CTD Processor: "Sacrificed surface CTDO fit to optimize deeper fit." Footnote CTDO bad. Pressure is 24-228db.
234	Salinity Analyses: "Low water level." Data are acceptable. See 236-229 comment. Footnote CTDO bad. Pressure is 78db.
233	Sample Log: "Spigot hard to open." Data are acceptable. See 236-229 comment. Footnote CTDO bad. Pressure is 109db.
228-221	PI: "Although PO4 looks high, NO3 is also high, suggesting that the high values are real." Pressure is 277-805db.
228-227	CTD Processor: "Sacrificed surface CTDO fit to optimize deeper fit." Footnote CTDO questionable. Pressure is 277-328db.
219	Salinity Analyses: "Flashing read light and level low." Bottle salinity is high compared with CTD. Footnote salinity bad. Pressure is 1268db.
218	Salt Log: "Problem with 18." Sample was not run. Footnote salinity lost. Pressure is 1522db.
217	Sample Log: "Salt bottle 17 replaced with new bottle." Salinity is acceptable. Pressure is 1774db.
216	Salinity Analyses: "Water level Low." Salinity is acceptable. Pressure is 2022db.
215	Bottle salinity is high compared with CTD. Salinity Analyses: "3 attempts for a good reading." Duplicate draw with 216, or analysis error. Footnote salinity bad. Pressure is 2284db.
213	Sample Log: "Top o-ring air leak (reseated, top-leak stopped)." Pressure is 2794db.
208	Sample Log: "Slight drip at spigot after venting." Pressure is 4070db.
202	PI: "PO4 2.34 high on property plots. May still be contaminated (see station 001 PO4). Code bad." Nutrient analyst: "PO4 peak shape ok, computer reading ok. Concentration appears high, code bad per PI review." Footnote PO4 bad. Pressure is 5304db.

Station 003

Cast 1	Salinity Analyses: "Standard seawater level low." Salinity samples appear reasonable. Deck Log: "tag line knotted on rosette at deploy, cut and sent down with rosette, at end, line still attached, but no apparent problems caused." CTD Processor: "Bottles 108, 110, 119, 120 somewhat overlay Station 4 data, but Station 3/4 CTDOs and all other bottle O2s do not overlay each other, have different deep theta-O2 slopes."
136-101	Salt data: "Water level low." Salinity is acceptable, bottom density is similar to Stations 002 and 004. Pressure is 29-5437db.
136-129	CTD Processor: "Sacrificed surface CTDO fit to optimize deeper fit." Footnote CTDO bad. Pressure is 29-304db.
120	Salinity Analyses: "Water level low." Okay on Theta-S. CTD Processor: "O2 -0.06 ml/l vs CTDO/down or up." See Cast 1 CTD comment. No analytical problems for bottle O2 noted. Pressure is 970db.
119	CTD Processor: "O2 -0.05 ml/l vs CTDO/down or up." See Cast 1 CTD comment. No analytical problems for bottle O2 noted. Pressure is 1123db.
113	Salinity Analyses: "Water level low." Okay on Theta-S. Pressure is 2543db.
110	CTD Processor: "O2 +0.02-3 ml/l vs CTDO/down or up." See Cast 1 CTD comment. No analytical problems for bottle O2 noted. Pressure is 3359db.
108	CTD Processor: "O2 +0.02-3 ml/l vs CTDO/down or up." See Cast 1 CTD comment. No analytical problems for bottle O2 noted. Pressure is 3970db.

107	Oxy data: "Stopper 898 on flask 1090" Footnote oxygen bad. Pressure is 4271db.
106	Oxy data: "Stopper 1090 on flask 898" Footnote oxygen bad. Pressure is 4569db.
Station 004	
136-130	CTD Processor: "Sacrificed surface CTDO fit to optimize deeper fit." Footnote CTDO bad. Pressure is 35-220db.
129	Salinity Analyses: "4 attempts for a good reading." Salinity Analyses: "Low water." Theta-S is okay. Salinity is acceptable. CTD Processor: "Sacrificed surface CTDO fit to optimize deeper fit." Footnote CTDO questionable. Pressure is 271db.
128	See 129 CTD Processor CTDO comments. Footnote CTDO questionable. Pressure is 322db.
114	Salinity Analyses: "4 attempts for a good reading, low water." Salinity is acceptable. Pressure is 2755db.
102	Sample Log: "Spigot is stiff." Bottle salinity is slightly high compared with CTD. Within the precision of the measurement, salinity is acceptable. Oxy data: "Mandatory OT" O2 low value, inconsistent with theta-o2. Footnote bottle oxygen bad. Pressure is 5214db.
Station 005	
Cast 1	Console Log: "Signal voltage problem starts at 4650 meter down cast; problem continued on up cast. Problem due to bad Datasonics altimeter."
136-101	CTD Processor: "Upcast conductivity bad due to voltage fluctuations caused by malfunctioning altimeter." Footnote CTD salinity bad. No CTDO is calculated because the CTD salinity is coded bad. Pressure is 20-5221db.
129	Sample Log: "Slow flow from bottle." Theta-O2 is okay, salinity is acceptable. Pressure is 286db.
108	Sample Log: "Slight drain valve leak." Data are acceptable. Pressure is 3760db.
102	Sample Log: "Spigot is sticky." Pressure is 5171db.
Station 006	
Cast 1	Console Log: "Altimeter removed before cast." Deck Log: "Pinger double-pings intermittently."
136-129	CTD Processor: "Sacrificed surface CTDO fit to optimize deeper fit." Footnote CTDO bad. Pressure is 17-171db.
127-126	Deck Log: "tightened spigot holder." Pressure is 235-287db.
124	Deck Log: "tightened spigot holder." Pressure is 409db.
118	Deck Log: "tightened spigot holder." Sample Log: "stop cock sticky" Pressure is 1115db.
115	Salinity possible drawing problem. Salinity Analyses: "4 attempts for a good reading." Bottle salinity is high compared with CTD. Footnote salinity bad. Pressure is 1770db.
111	Salinity Analyses: "4 attempts for a good reading." Bottle salinity is high compared with CTD. High value, inconsistent with t-s, CTD. Footnote salinity bad. Pressure is 2842db.
109	Salinity Analyses: "4 attempts for a good reading." Bottle salinity is high compared with CTD. Footnote salinity bad. Pressure is 3448db.
108	Salinity Analyses: "5 attempts for a good reading." Bottle salinity is high compared with CTD. Footnote salinity bad. Pressure is 3754db.
107	Sample Log: "stop cock sticky" Pressure is 4062db.
105	Bottle salinity is high compared with CTD. Salinity possible drawing problem. Footnote salinity questionable. Pressure is 4671db.
103	Sample Log: "Stop cock sticky." Pressure is 5091db.

102	Deck Log: "New spigot O-rings, baked" Pressure is 5194db.
101	Salinity Analyses: "3 attempts for a good reading." Bottle salinity is high compared with CTD. Salinity possible drawing problem. Footnote salinity bad. Pressure is 5268db.
Station 007	
136-130	CTD Processor: "Sacrificed surface CTDO fit to optimize deeper fit." Footnote CTDO bad. Pressure is 21-232db.
117	PI: "O2 high value, inconsistent theta-o2." Footnote oxygen questionable. Pressure is 2048db.
113	Salinity Analyses: "5 attempts for a good reading. Sample got too low." Bottle salinity is high compared with CTD. Footnote salinity bad. Pressure is 2862db.
107	O2 high, does not agree with theta-o2 comparison with adjoining stations. Footnote oxygen questionable. Pressure is 4088db.
101	CTD Processor: "CTD hit bottom, no conductivity/salinity spike near trip."
Station 008	
Cast 1	Deck Log: "New altimeter and pinger this cast."
136-129	CTD Processor: "Sacrificed surface CTDO fit to optimize deeper fit." Footnote CTDO bad. Pressure is 18-207db.
133	Bottle salinity is high compared with CTD. Salinity appears reasonable compared to adjoining stations, sample was taken just after a gradient. Salinity is acceptable. See 136-129 comment. Footnote CTDO bad. Pressure is 88db.
115	Oxy data: "paused analysis after 115 to sample" Pressure is 1672db.
108	Sample Log: "spigot leaks a little after venting." Pressure is 3762db.
Station 009	
136-130	CTD Processor: "Sacrificed surface CTDO fit to optimize deeper fit." Footnote CTDO bad. Pressure is 24-198db.
134	Salinity Analyses: "4 attempts for a good reading." Salinity is acceptable for gradient value. See 136-130 comment. Footnote CTDO bad. Pressure is 82db.
132	Salinity Analyses: "operator made a mistake." Salinity is acceptable for gradient value. See 136-130 comment. Footnote CTDO bad. Pressure is 138db.
130	Sample Log: "sticky air vent" Pressure is 198db.
129	Sample Log: "sticky valve" Pressure is 233db.
126	Salinity Analyses: "water level low." Salinity is acceptable. Pressure is 379db.
125	Sample Log: "sticky drain valve" Pressure is 450db.
121	Oxy data: "flask 1171 with stopper 1088." Footnote oxygen bad. Pressure is 811db.
120	Oxy data: "flask 1088 with stopper 1171." Footnote oxygen bad. Pressure is 913db.
119	Sample Log: "sticky drain valve" Data are acceptable. Pressure is 1014db.
110	Console Log: "Bumped button; bottle tripped on fly." Data are acceptable. Pressure is 3456db.
108	Sample Log: "Slight drain valve leak." Data are acceptable. Pressure is 3762db.
Station 010	
136	Sample Log: "Ran out of water for last Alky sample." See 136-130 comment. Footnote CTDO bad. Pressure is 18db.
136-130	CTD Processor: "Sacrificed surface CTDO fit to optimize deeper fit." Footnote CTDO bad. Pressure is 18-182db.

130	PI: "PO4 of 2.43 is high and NO3/PO4 is low; mark PO4 as code 3?" Nutrient analyst: "PO4 peak an odd shape, footnote questionable." Footnote PO4 questionable. See 136-130 comment. Footnote CTDO bad. Pressure is 182db.
129	PI: "The PO4 value for bottle 29 is also high. Shows up as high on NO3/PO4 and NO/PO." Pressure is 207db.
121	CTD Processor: "O2 -0.04 ml/l vs CTDO down; typical signal dropout at bottle stop/up, not likely a real feature." No analytical problems for bottle O2. Pressure is 1214db.
117	CTD Processor: "O2 +0.04 ml/l vs CTDO/down or up." No analytical problems for bottle O2. Pressure is 2027db.
103	Sample Log: "sticky petcock." Pressure is 4893db.
101	Console Log: "13 duplicate/odd trip confirms." Bottle trips appear to be correctly assigned. Bottle salinity is high compared with CTD. Within precision of measurement, salinity is acceptable. CTD Processor: "CTD hit bottom, conductivity/salinity at trip ok after despike." Footnote CTD salinity despiked. Pressure is 5274db.

Station 011

Cast 1	Deck Log: "Altimeter removed before this cast."
136-132	CTD Processor: "Sacrificed surface CTDO fit to optimize deeper fit." Footnote CTDO bad. Pressure is 17-107db.
128	Salinity Analyses: "5 attempts for a good reading. Water low." Salinity is acceptable. Pressure is 305db.
112	Salinity Analyses: "5 attempts for a good reading. Water level low." Salinity is acceptable. Pressure is 3096db.
111	Bottle salinity is low compared with CTD. Low compared with adjoining stations. Footnote salinity questionable. Pressure is 3300db.
108	Salinity Analyses: "5 attempts for a good reading. Sample water level low." Bottle salinity is high compared with CTD. Footnote salinity bad. Pressure is 3915db.
107	CTD Processor: "O2 +0.02-3 ml/l vs CTDO/down or up; matches bottle O2 for bottle 106 - duplicate draw?" No analytical problems for bottle O2. Pressure is 4119db.

Station 012

136-130	CTD Processor: "Sacrificed surface CTDO fit to optimize deeper fit." Footnote CTDO bad. Pressure is 16-171db.
133	Salinity Analyses: "3 attempts for a good reading." Salinity is high, but right in the middle of salinity gradient. Salinity is acceptable. See 136-130 comment. Footnote CTDO bad. Pressure is 80db.
116	CTD Processor: "O2 +0.02-3 ml/l vs CTDO/down or up, nearby casts." No analytical problems for bottle O2. Pressure is 1674db.
109	PI: "O2 5.57 ml/l is slightly high on property plots. Code 3?" Inconsistent with t-o2 and CTD. Footnote oxygen questionable. Pressure is 3710db.
108	Sample Log: "slight drain valve leak." Data are acceptable. Pressure is 4013db.
107	Oxy data: "pause analysis for rosette retrieval." oxy sample 108 okay also. Pressure is 4268db.
103	PI: "O2 5.75 is too high by ca. 0.08 ml/l. Code 4?" Inconsistent with theta-o2." Footnote oxygen questionable. Pressure is 4994db.
102	Sample Log: "O2 draw temperature slightly high? misread?" Pressure is 5124db.

Station 013

Cast 1	Console Log: "up and down cast differ 0-600 meters, due to changes in water features." Bottle numbering from shallow to deep, 36-9, 37, 7-1. Salt Log: "Beginning STD no good [big std dial change]; end std good but off by -0.00010; first standard bad." Bottom salinity samples and densities agree with Station 012.
136-132	CTD Processor: "Sacrificed surface CTDO fit to optimize deeper fit." Footnote CTDO bad. Pressure is 17-122db.
131	Sample Log: "Slight leak before venting." Theta-o2 and salinity are acceptable. CTD Processor: "Sacrificed surface CTDO fit to optimize deeper fit." Footnote CTDO questionable. Pressure is 161db.
130	Oxy Data: "Flask 1090 with stopper 1187. Footnote oxygen bad. Pressure is 197db.
129	Oxy Data: "Flask 1187 with stopper 1090. Footnote oxygen bad. Pressure is 232db.
122	Sample Log: "Leaks (lid not seated)." Theta-o2 and salinity are acceptable. Pressure is 608db.
118	Oxy Data: "Flask 1088 with stopper 750. Footnote oxygen bad. Pressure is 1107db.
117	Oxy Data: "Flask 750 with stopper 1088. Footnote oxygen bad. Pressure is 1254db.
113	Oxy Data: "Flask 1163 with stopper 1142. Footnote oxygen bad. Pressure is 2127db.
112	Oxy Data: "Flask 1142 with stopper 1163." Footnote oxygen bad. Pressure is 2433db.
137	Deck Log: "Bottle 8 replaced with new bottle 37." Pressure is 3653db.
107	High value, inconsistent with t-o2 and CTD. Footnote oxygen questionable. Pressure is 3961db.
106	Oxy data: "O2 program interrupted." oxy sample 107 okay also. Pressure is 4273db.
105	Sample Log: "Dripping at bottom." Pressure is 4530db.

Station 014

Cast 1	Salt Log: "Program aborted after end worm, [no problem]."
136-132	CTD Processor: "Sacrificed surface CTDO fit to optimize deeper fit." Footnote CTDO bad. Pressure is 18-139db.
117	CTD Processor: "O2 +0.04 ml/l vs CTDO/down or up; both Station 14/15 CTDOs and other bottle O2s do not overlay each other near these bottles, 103 and 117." No analytical problems for bottle O2. Pressure is 1858db.
112	Salinity Analyses: "3 attempts for a good reading." Bottle salinity is high compared with CTD. Footnote salinity bad. Pressure is 2874db.
106	Salinity Analyses: "3 attempts for a good reading." Bottle salinity is high compared with CTD. Footnote salinity bad. Pressure is 4098db.
105	High value, inconsistent with t-s, CTD. Bottle salinity is high compared with CTD. Footnote salinity questionable. Pressure is 4302db.
103	CTD Processor: "O2 +0.03 ml/l vs CTDO/down or up; both Station 14/15 CTDOs and other bottle O2s do not overlay each other near these bottles, 103 and 117." No analytical problems for bottle O2. Pressure is 4719db.
101	CTD Processor: "CTD hit bottom, conductivity/salinity at trip ok after despike." Footnote CTD salinity despiked.

Station 015

Cast 1	CTD Processor: "Other apparently offset bottle O2s this cast are okay; correspond with up-cast features, down/up CTDO different."
136-133	CTD Processor: "Sacrificed surface CTDO fit to optimize deeper fit." Footnote CTDO bad. Pressure is 14-80db.

132 CTD Processor: "Sacrificed surface CTDO fit to optimize deeper fit." Footnote CTDO bad. Pressure is 105db.

119 Console Log: "Bottle tripped on the fly." Pressure is 1372db.

118 Sample Log: "leaking from bottom end-cap." Pressure is 1527db.

109 CTD Processor: "O2 +0.03 ml/l vs CTDO/down or up; Stations 14/15 CTDOs and other bottle O2s do not overlay well." No analytical problems for bottle O2. Pressure is 3386db.

Station 016

Cast 1 Console Log: "frozen conductivity sensor, returned to surface and start back down." Salinity Analyses: "worm water level low as read out was high." Salinity is acceptable.

136-130 CTD Processor: "Sacrificed surface CTDO fit to optimize deeper fit." Footnote CTDO bad. Pressure is 16-168db.

113 Low oxygen value. Inconsistent with t-o2 and CTD. Footnote oxygen questionable. Pressure is 1978db.

105 Sample Log: "Bad vent, not leaking." Pressure is 4000db.

Station 017

133-120 Salinity Analyses: "Salinity bottles got out of sequence before 20." It appears that 20 was not run, salinity bottle 23 was not run at all, there is no indication that there was a sampling error. Footnote salinity for 20 as lost, other salinities appear acceptable. Pressure is 15-529db.

133-127 CTD Processor: "Sacrificed surface CTDO fit to optimize deeper fit." Footnote CTDO bad. Pressure is 15-186db.

130 Oxy data: "flask 693, stopper 1172 Bottle salinity is low compared with CTD. Salinity is acceptable for shallow water. Footnote oxygen bad. See 133-127 comment. Footnote CTDO bad. Pressure is 90db.

129 Sample Log: "Hard to close." Oxy data: "flask 1172, stopper 693 Footnote oxygen bad. See 133-127 comment. Footnote CTDO bad. Pressure is 125db.

126 CTD Processor: "Sacrificed surface CTDO fit to optimize deeper fit." Footnote CTDO questionable. Pressure is 216db.

122 Sample Log: "Slight leak at spigot." Pressure is 388db.

120 Salt Log: "Not seated well at first." Salinity Analyses: "3 attempts for a good reading." Salinity sample not run. See 133-120 salinity comments. Footnote salinity lost. Pressure is 529db.

114 Sample Log: "Left open [during cast]. Pressure is 1267db.

111 Oxy data: "Mandatory OT." Inconsistent with theta-o2. Footnote oxygen bad. Pressure is 1875db.

137 Sample Log: "Drips at spigot." Pressure is 2639db.

106 Oxy data: "pause analysis for Ros launch." oxy sample 107 okay also Pressure is 3149db.

103 CTD Processor: "O2s +/-0.02 ml/l vs CTDOs, bottom 2 bottles same value, one fits." No analytical problems for bottle O2. Pressure is 3864db.

102 CTD Processor: "High/one low vs CTD; theta-O2 indicates bottom bottle might be low." No analytical problems for bottle O2. Pressure is 3947db.

101 CTD Processor: "Final fit averages out conductivity difference between CTD/bottle for bottom 3 bottles." No analytical problems for bottle O2. Pressure is 4013db.

Station 018

127-122	CTD Processor: "Sacrificed surface CTDO fit to optimize deeper fit." Footnote CTDO bad. Pressure is 15-156db.
121	CTD Processor: "Sacrificed surface CTDO fit to optimize deeper fit." Footnote CTDO questionable. Pressure is 206db.
107	CTD Processor: "O2 +0.03 ml/l vs CTDO/down or up." No analytical problems for bottle O2. Pressure is 1666db.
102	Salinity Analyses: "3 attempts for a good reading." Bottle salinity is high compared with CTD. Footnote salinity questionable. Pressure is 2675db.
101	Salinity Analyses: "3 attempts for a good reading." Bottle salinity is high compared with CTD. Footnote salinity questionable. Pressure is 2785db.

Station 019

121-118	CTD Processor: "Sacrificed surface CTDO fit to optimize deeper fit; CTDO signal high near surface." Footnote CTDO bad. Pressure is 12-82db.
105	Sample Log: "spigot loose." Pressure is 1216db.

Station 020

Cast 1	Deck Log: "Start routine of replacing D.I. water in CTD sensor cover with seawater 45 min. to 1 hour before deployment. Aim to reduce sensor freezing." Salt Log: "Sample time wrong."
130-124	CTD Processor: "Sacrificed surface CTDO fit to optimize deeper fit." Footnote CTDO bad. Pressure is 14-194db.
122	Sample Log: "drips from spigot [after venting]." Pressure is 294db.
111	Oxy data: "pause analysis for rosette launch." oxy sample 112 okay also. Salt Log: "low water" Salinity Analyses: "3 attempts for a good reading." Salinity is acceptable. Pressure is 1307db.
137	Sample Log: "tight spigot." Pressure is 2013db.

Station 021

Cast 1	Console Log: "Conductivity offset, 2728 db on down-cast."
136-125	CTD Processor: "Sacrificed surface CTDO fit to optimize deeper fit." Footnote CTDO bad. Pressure is 17-428db.
134	Salinity Analyses: "3 attempts for a good reading." Salinity is acceptable. See 136-125 CTD Processor comment. Footnote CTDO bad. Pressure is 86db.
124-101	CTD Processor: "CTDO ±0.04 ml/l compared to many bottles, erratic profile; large CTDO signal drops at every bottle stop 3-4x worse fit than most casts after despiking stops/best fit of up-cast CTDO; does mesh okay with deep theta-CTDO transition (O2 decrease) between stas 18-20 and 22-25." Footnote CTDO questionable.
114	Salt Log: "14 low water." Salinity Analyses: "3 attempts for a good reading." Salinity slightly high compared to CTD, but matches 022 theta-salt. Inconsistent with Down/Up CTD. See 124-113 CTD Processor CTDO comment. Footnote CTDO questionable and salinity questionable. Pressure is 1871db.
137	Sample Log: "Spigot a little tight" Data are acceptable. See 124-109 CTDO comments. Footnote CTDO questionable. Pressure is 3397db.
103	Sample Log: "Spigot a little tight." Data are acceptable. See 124-109 CTDO comments. Footnote CTDO questionable. Pressure is 4421db.
101	CTD Processor: "CTD conductivity/salinity okay after despiking." Footnote CTD salinity despiked.

Station 022

136-130	CTD Processor: "Sacrificed surface CTDO fit to optimize deeper fit; 2.5 mins. at 231db bottle stop." Footnote CTDO bad. Pressure is 15-191db.
134	Console Log: "tripped accidentally, bottle tripped on the fly." Data are acceptable. See 136-133 CTD Processor comment. Footnote CTDO bad. Pressure is 67db.
129	Console Log: "No-confirm from pylon at first trip attempt, not reset; second trip confirm okay." Bottle trips appear to be correctly assigned. Pressure is 231db.
112	Salt Log: "12 bottle lip chipped. Replaced bottle" Pressure is 2516db.
110	CTD Processor: "O2 +0.05 ml/l vs CTDO (up-cast), within 0.01 of bottle 109 - dup?." No analytical problems for bottle O2. Pressure is 2924db.
109	Salinity Analyses: "3 attempts for a good reading." Salinity Analyses: "water level low." Salinity is acceptable. Pressure is 3126db.
137	PI: "O2 5.68 ml/l is high by ca. 0.2 ml/l on property plots without anomalies in other characteristics." Value high, inconsistent theta-o2. Footnote oxygen questionable. Pressure is 3330db.

Station 023

Cast 1	Deck Log: "12-inch long fish caught on Ros. frame between bottles 9-10. Fish had large shrimp in its mouth." Salt Log: "Used two stds at start of run, 1st was bad."
136-133	CTD Processor: "Sacrificed surface CTDO fit to optimize deeper fit." Footnote CTDO bad. Pressure is 16-66db.
131	Sample Log: "spigot tight." Pressure is 141db.
125	Sample Log: "spigot tight." Pressure is 404db.
122	Sample Log: "slight leak at spigot before venting." Pressure is 606db.
112	Salinity Log: "low water" Salinity Analyses: "4 attempts for a good reading." Salinity Analyses: "same as the last, error??." Salinity is acceptable. Pressure is 2737db.
111	Salinity Log: "low water" Salinity Analyses: "4 attempts for a good reading." Salinity Analyses: "low water???." Salinity is acceptable. Pressure is 3045db.
137	Sample Log: "slight leak at spigot before venting." Pressure is 3660db.
107	Salinity Analyses: "4 attempts for a good reading." Bottle salinity is high compared with CTD. Inconsistent with t-s. Footnote salinity bad. Pressure is 3917db.
101	Salinity Analyses: "4 attempts for a good reading. Took sample twice due to machine and operator error." Bottle salinity is high compared with CTD. Footnote salinity bad. Pressure is 4928db.

Station 024

136-131	CTD Processor: "Sacrificed surface CTDO fit to optimize deeper fit." Footnote CTDO bad. Pressure is 16-121db.
112	CTD Processor: "O2 +0.08 ml/l vs CTDO/down or up, nearby casts." No analytical problems for bottle O2. Pressure is 2127db.
137	Salt Log: "8 wouldn’t accept (x)" [x = abort]." Sample not run. Footnote salinity lost. Pressure is 3330db.
103	PI: "SiO3 129.2 appears to be low by ca. 4-5 um/l but salt is a bit low, and O2 high, too, so probably leave as code 2." Nutrient analyst: "SiO3 peak shape ok, computer reading ok. Conc. appears low." Pressure is 4732db.

Station 025

136-132	CTD Processor: "Sacrificed surface CTDO fit to optimize deeper fit." Footnote CTDO bad. Pressure is 16-106db.
129	Oxy Data: "Sample lost, analyst error." Footnote oxygen lost. Pressure is 181db.
120	CTD Processor: "O2 -0.03 ml/l vs CTDO down, nearby casts; typical signal dropout at bottle stop/up, not likely a real feature." No analytical problems for bottle O2. Pressure is 1068db.
115	Salinity Analyses: "3 attempts for a good reading." Okay on Theta-S. CTD Processor: "O2 +0.03 ml/l vs CTDO/down or up." No analytical problems for bottle O2. Pressure is 2289db.

Station 026

Cast 1	Salt Log: "Replaced autosal rubber stopper."
136	Console Log: "Bottle tripped on the fly." Data are acceptable. See 136-129 Processor comment. Footnote CTDO bad. Pressure is 15db.
136-129	CTD Processor: "Sacrificed surface CTDO fit to optimize deeper fit." Footnote CTDO bad. Pressure is 15-181db.
119	Salinity Analyses: "4 attempts for a good reading." Salinity Analyses: "really low water." Salinity is acceptable. Pressure is 754db.
161	Deck Log: "Test bottle, Ocean Instrument Tech., replaced bottle 37. bottle has bag and no air vent. Replaced black tubing, 32-34 pounds spring tension, with ODF spring." Pressure is 2935db.
162	Deck Log: "Test bottle, General Oceanics - replaced bottle 10. GO external spring bottle, black rubber band tubing springs; 14-16 pounds tension to open bottle. Bottle sent down with inner bag vent closed." High value, inconsistent with t-o2 and CTD. Low value, inconsistent with t-s and CTD. Footnote salinity and oxygen bad. Pressure is 2936db.

Station 027

171	Oxy Data: "Second O2 from 61, 2 hours after first draw." Pressure is db.
172	Oxy Data: "Second O2 from 62, 2 hours after first draw." Pressure is db.
136-132	CTD Processor: "Sacrificed surface CTDO fit to optimize deeper fit." Footnote CTDO bad. Pressure is 19-128db.
131	Sample Log: "sticky petcock." Pressure is 180db.
129	CTD Processor: "O2 +0.06 ml/l vs CTDO/down or up." No analytical problems for bottle O2. Pressure is 255db.
161	Only a test bottle Sample Log: "test bottle." Bottle salinity is slightly low compared with CTD. Within the precision of the measurement, salinity is acceptable. Footnote bottle did not trip as scheduled, salinity questionable. Pressure is 3300db.
162	Only a test bottle. Sample Log: "test bottle." Deck Log: "Sent down with inner bag vent open." High oxygen value, inconsistent with t-o2 and CTD. Footnote bottle did not trip as scheduled, oxygen questionable. Pressure is 3300db.
103	High value, inconsistent with t-o2 and CTD. Salinity Analyses: "3 attempts for a good reading." Salinity is acceptable. Footnote oxygen questionable. Pressure is 4370db.
101	Salt Log: "1 low water" Salinity Analyses: "6 attempts for a good reading." Salinity is a little low compared to CTD, but within the precision of the measurement. Salinity is acceptable. Pressure is 4534db.

Station 028

Cast 1	Console Log: "Unusual Transmissometer readings, 87-554 decibars on down cast."

136	Sample Log: "New salt bottle. Last use 02601." Data are acceptable. See 136-126 CTD Processor comment. Footnote CTDO bad. High NO2 value. Pressure is 18db.
136-126	CTD Processor: "Sacrificed surface CTDO fit to optimize deeper fit; raw CTDO signal ~50% higher near surface vs nearby casts." Footnote CTDO bad. Pressure is 18-327db.
133	Sample Log: "New salt bottle insert. Last use 02601." Pressure is 78db.
130	Sample Log: "New salt bottle insert. Last use 02601." Data are acceptable. See 136-126 CTD Processor comment. Footnote CTDO bad. Pressure is 157db.
129	Sample Log: "tight spigot." Data are acceptable. See 136-126 CTD Processor comment. Footnote CTDO bad. Pressure is 197db.
125	Sample Log: "tight spigot." Data are acceptable. Pressure is 388db.
124	Sample Log: "New salt bottle insert. Last use 02601" Pressure is 458db.
122	Sample Log: "New salt bottle insert. Last use 02601." Data are acceptable. Data are acceptable. Pressure is 601db.
121	Oxy Data: "pause here during analysis." Data are acceptable. oxy sample 122 okay also Pressure is 689db.
119	Sample Log: "tight spigot." Data are acceptable. Pressure is 965db.
113	Sample Log: "Air leak. No obvious problem." Data are acceptable. Pressure is 2277db.
109	sampled 3 times for freon and oxygen, test comparison. Pressure is 3046db.
161	Test bottle, sampled 3 times for freon and oxygen. Pressure is 3046db.
162	Test bottle, sampled twice for freon and 3 times for oxygen. High value, inconsistent with t-o2 and CTD. Footnote oxygen questionable. Pressure is 3046db.

Station 029

136	Sample Log: "C14 sampled before Keeling CO2." Pressure is 14db.
136-132	CTD Processor: "Sacrificed surface CTDO fit to optimize deeper fit." Footnote CTDO bad. Pressure is 14-95db.
129	Deck Log: "new spigot (baked) O-rings." Pressure is 189db.
125	Deck Log: "new spigot (baked) O-rings." Pressure is 356db.
117	Salt Log: "Removed bottle before 2nd reading. 3 attempts for a good reading." Inconsistent with t-s, also. Bottle salinity is high compared with CTD. Footnote salinity bad. Pressure is 1267db.
115	High oxygen value, inconsistent with t-o2 and CTD. Footnote oxygen questionable. Pressure is 1620db.
110	Deck Log: "Replaced (test) bottle 62 with bottle 10." High oxygen value, inconsistent with t-o2 and CTD. Footnote oxygen questionable. Pressure is 2791db.
161	High oxygen value, inconsistent with t-o2 and CTD. 61 tripped at same level as 9. Oxygen is the same value as 7 and 0.16 higher than 9. Footnote oxygen bad. Pressure is 3042db.
109	High oxygen value, inconsistent with t-o2 and CTD. Footnote oxygen questionable. Pressure is 3042db.
107	High oxygen value, inconsistent with t-o2 and CTD. Footnote oxygen questionable. Pressure is 3295db.
102-101	CTD Processor: "Bottom 2 bottle O2s -0.03 ml/l vs CTDO/down or up, nearby casts; could both have been drawn from bottles one level shallower?." No analytical problems for bottle O2. Pressure is 4212-4283db.

Station 030

Cast 1	CTD Processor: "CTD primary PRT malfunctioning due to flooded turret, stations 30-31: PRT2 used for final/reported CTD temperature data these 2 casts only. PRT1 appeared to function normally after repair prior to station 32."
136-131	CTD Processor: "Sacrificed surface CTDO fit to optimize deeper fit." Footnote CTDO bad. Pressure is 16-148db.
131	Sample Log: "Sticky petcock." Data are acceptable. See 136-131 CTD Processor comment. Footnote CTDO bad. Pressure is 148db.
122	Sample Log: "Spigot leaked before venting." Data are acceptable. Pressure is 760db.
115	Nutrient analyst: "PO4 high, odd shaped peak, reran, odd shaped peak again. Bad sample." Footnote PO4 bad. Pressure is 2178db.
161	Sample Log: "Spigot leaking when came on board." Pressure is 3399db.
109	Salinity Analyses: "5 attempts for a good reading." Salinity Analyses: "water level low." Data are acceptable. Pressure is 3400db.
103	CTD Processor: "CTDO max -0.04 ml/l below bottom slowdown compared to bottle." Footnote CTDO questionable. Console Log: "No-confirm from pylon at first trip attempt, reset?; second trip confirm okay." Bottle trips appear to be correctly assigned. Pressure is 4426db.

Station 031

Cast 1	CTD Processor: "CTD primary PRT malfunctioning due to flooded turret, stations 30-31: PRT2 used for final/reported CTD temperature data these 2 casts only. PRT1 appeared to function normally after repair prior to station 32." Salt Log: "Bad initial Wormley std, high." Salt Log: "2 degree C. drop in room temp. during run."
136-133	CTD Processor: "Sacrificed surface CTDO fit to optimize deeper fit." Footnote CTDO bad. Pressure is 20-89db.
119	Salinity Analyses: "3 attempts for a good reading." CTD Processor: "CTD conductivity/salinity okay after despiking." Footnote CTD salinity despiked. Pressure is 1115db.
112	Console Log: "No-confirm from pylon at first trip attempt, reset?; second trip confirm okay." Bottle trips appear to be correctly assigned. Pressure is 2738db.
103	Sample Log: "spigot tight." Pressure is 4684db.
101	High oxygen value, inconsistent with t-o2 and CTD. Footnote oxygen questionable. Pressure is 4843db.

Station 032

Cast 1	Console Log: "New conductivity sensor (P42 replaces E55)" CTD Processor: "CTD primary PRT turret flooded during stations 30-31; PRT1 appeared to function normally after after repair prior to this cast." Salt Log: "Autosal bath now 21 degrees C., new bath temperature causes shift in std dial, okay." Deck Log: "DSRT racks on bottles 2, 6, 10." Oxy Data: "First use KIO3 standard no. 3."
136-132	CTD Processor: "Sacrificed surface CTDO fit to optimize deeper fit." Footnote CTDO bad. Pressure is 15-115db.
130	Salt Log: "30 ?" Salinity Analyses: "3 attempts for a good reading." Salt Analyses: "Odd reading?" Pressure is 206db.
123	Salt Log: "23 ?" Salinity Analyses: "3 attempts for a good reading." Pressure is 606db.
113	Deck Log: "New end caps, with baked O-rings. " Pressure is 2683db.
105-102	CTD Processor: "CTD conductivity/salinity okay after despiking." Footnote CTD salinity despiked.

103-101	CTD Processor: "5.5 minutes at 4773db bottle stop; CTDO +0.03 ml/l compared to deepest 2 bottles; bottles look low/CTDO okay vs. nearby casts large drift at up-cast start through long bottle stop, cannot extract true deep CTDO profile from multiple offset areas." Footnote CTDO questionable. Pressure is 4570-4844db.
101	Bottle salinity is high compared with CTD. CTD Processor: "CTD value okay after despiking." See 103-101 CTDO comments. Footnote CTD salinity despiked and CTDO questionable. Pressure is 4844db.

Station 033

Cast 1	Console Log: "DSRT racks not soaked."
136-133	CTD Processor: "Sacrificed surface CTDO fit to optimize deeper fit." Footnote CTDO bad. Pressure is 15-91db.
131	Sample Log: "spigot tight." Pressure is 182db.
130	Salt Data: "4 tries to get reading." Salinity Analyses: "4 attempts for a good reading." Salinity Analyses: "water level fine...can’t explain this one either!." Pressure is 222db.
129	Salinity Analyses: "3 attempts for a good reading." Salinity Analyses: "water level low." Pressure is 248db.
125	Sample Log: "spigot tight." Pressure is 426db.
122	Sample Log: "Spigot drips before venting." Pressure is 933db.
119	Salt Log: "19 ?" Salinity Analyses: "3 attempts for a good reading." Slightly high compared with CTD, ˜0.0006, but within the precision of the measurement. Compares with adjoining stations. Salinity is acceptable. Pressure is 1539db.
117	Sample Log: "spigot tight." Pressure is 1947db.
115	Salinity Analyses: "3 attempts for a good reading." Inconsistent with t-s, also. Bottle salinity is high compared with CTD. Footnote salinity bad. Pressure is 2352db.
161	Bottle salinity is low compared with CTD. Salinity are acceptable. CTD Processor: "O2 +0.03-4 ml/l vs CTDO." No analytical problems for bottle O2 noted. Pressure is 3615db.
106	Possible duplicate of 07. Bottle salinity is high compared with CTD. Footnote salinity questionable. Pressure is 4082db.
103	Sample Log: "Spigot tight." Salinity Analyses: "3 attempts for a good reading; low water." Inconsistent with t-s, also. Bottle salinity is high compared with CTD. Footnote salinity bad. Pressure is 4696db.

Station 034

Cast 1	Deck Log: "Wind and swell increase during cast. Tough recovery, should not have launched this one." Deck Log: "DSRT racks removed before cast." Sample Log: "New PRT probe for O2 draw temperature." Oxy Data: "Filled Thiosulfate and H2SO4 reagents. Same chemical batches." Salt Log: "Room temperature drop 2.6 degC. during run." Salinities appear reasonable.
136	Sample Log: "Sample low during salt draw." Data are acceptable. See 136-132 CTD Processor comment. Footnote CTDO bad. Pressure is 19db.
136-132	CTD Processor: "Sacrificed surface CTDO fit to optimize deeper fit." Footnote CTDO bad. Pressure is 19-120db.
135	Sample Log: "Sample low during salt draw." Data are acceptable. See 136-132 CTD Processor comment. Footnote CTDO bad. Pressure is 44db.
131	Deck Log: "New spigot O-rings." Pressure is 144db.
130	Salt Log: "Odd reading." Salinity Analyses: "water level fine...can’t explain this one either!." Pressure is 170db.

129 Salt Log: "Sample low." Sample Log: "New salt bottle insert." Pressure is 200db.

127 Salt Log: "Odd reading." Salinity Analyses: "I don’t know what happened...something screwy." Pressure is 285db.

125 Deck Log: "New spigot O-rings." Pressure is 428db.

124 Sample Log: "New salt bottle insert." Pressure is 507db.

122 Sample Log: "New salt bottle insert." Deck Log: "Re-surfaced scratch on top O-ring surface." CTD Processor: "O2 +0.04 ml/l vs CTDO (up-cast)." No analytical problems for bottle O2. Pressure is 707db.

120 Sample Log: "New salt bottle insert." Pressure is 1013db.

117 Deck Log: "New spigot O-rings." Pressure is 1519db.

161 Salt Log: "Air temperature drop? 4 tries to get reading" Salinity Analyses: "4 attempts for a good reading." Pressure is 3454db.

103 Deck Log: "New spigot O-rings, and top vent nut." Salt Log: "Sample low." Pressure is 4530db.

102-101 CTD Processor: "CTDO to +0.05 ml/l compared to bottom bottle." Footnote CTDO questionable. Pressure is 4632-4698db.

Station 035

Cast 1 Console Log: "Delay cast start, winch power problem." Console Log: "Hold at 100 meter up cast for pylon problem." Deck Log: "Replace (test) bottle 61 with bottle 37."

120 Console Log: "No-confirm from pylon at first trip attempt, reset?; second trip confirm okay." Bottle trips appear to be correctly assigned. Pressure is 51db.

117 Console Log: "1 duplicate/odd trip confirm." Bottle trips appear to be correctly assigned. Pressure is 151db.

114 Sample Log: "New salt bottle 14." Pressure is 199db.

101 Bottle salinity is low compared with CTD. CTD Processor: "CTDO -0.20 to -0.30 ml/l compared to bottom 3 bottles, very steep gradient at bottom." Footnote CTDO questionable. Pressure is 458db.

Station 036

Cast 1 Console Log: "Trouble initializing data acquisition." Console Log: "Sensors frozen, down to 50 m then back to surface and start down again." Sample Log: "Using original O2 draw probe again."

135 Footnote salinity and oxygen not drawn per sampling schedule. Pressure is 12db.

131 Footnote salinity and oxygen not drawn per sampling schedule. Pressure is 62db.

129 Footnote salinity and oxygen not drawn per sampling schedule. Pressure is 93db.

127 Sample Log: "Spigot not closed during cast? No leak." Pressure is 124db.

125 Footnote salinity and oxygen not drawn per sampling schedule. Pressure is 154db.

123 Footnote salinity and oxygen not drawn per sampling schedule. Pressure is 252db.

121 Footnote salinity and oxygen not drawn per sampling schedule. Pressure is 302db.

119 Footnote salinity and oxygen not drawn per sampling schedule. Pressure is 376db.

115 Footnote salinity and oxygen not drawn per sampling schedule. Pressure is 522db.

113 Footnote salinity and oxygen not drawn per sampling schedule. Pressure is 594db.

111 Footnote salinity and oxygen not drawn per sampling schedule. Pressure is 693db.

109 Footnote salinity and oxygen not drawn per sampling schedule. Pressure is 791db.

137	Sample Log: "Leaks before venting [air leak]." Only salinity and nutrients drawn per sampling schedule. Oxygen not drawn. Data are acceptable. Pressure is 890db.
107	Sample Log: "O2 drawn after CO2s and C14." Sample Log: "Tight spigot." Pressure is 890db.
105	Footnote salinity and oxygen not drawn per sampling schedule. Pressure is 1041db.
103	Footnote salinity and oxygen not drawn per sampling schedule. Pressure is 1192db.

Station 037

122	CTD Processor: "O2 +0.13 ml/l vs CTDO (up-cast), nearby casts, and duplicate bottle 123." No analytical problems for bottle O2. Pressure is 12db.
121	Salt Log: "21 Bad value, erratic" Pressure is 32db.
101	CTD Processor: "O2 +0.03 ml/l vs CTDO (up-cast), nearby casts, and duplicate bottle 102." No analytical problems for bottle O2. Pressure is 1905db.

Station 038

Cast 1	Salt Data: "03701 and 03801 run together." CTD Processor: "6 duplicate pressure bottles have bottle O2 differences 0.02 to 0.10 ml/l, rest are within ±0.02 ml/l. Best fit to CTDO seemed to run through lower-O2 duplicate bottles; 2 other non-duplicate bottle O2s also high vs CTDO after fit. Deep CTDO fit within 0.01 ml/l of Station 39 on theta-CTDO comparison." O2 okay as is.
136-135	CTD Processor: "O2 is +0.05 ml/l vs duplicate 135 bottle O2; 136 high vs CTDO (up-cast)/Stations 37+39." No analytical problems for bottle O2. Pressure is 13-14db.
135	Footnote salinity not drawn per sampling schedule. Pressure is 14db.
134	Footnote salinity not drawn per sampling schedule. Pressure is 43db.
129	Footnote salinity not drawn per sampling schedule. Pressure is 145db.
128	Footnote salinity not drawn per sampling schedule. Pressure is 202db.
128-127	CTD Processor: "O2 is +0.08 ml/l vs duplicate 127 bottle O2; sharp gradient, but 128 appears high vs CTDO (up-cast) (Stations 37/39 not comparable here)." O2 128 high compared to duplicate 127, large O2 gradient. No analytical problems for bottle O2. Pressure is 202-202db.
126	Footnote salinity not drawn per sampling schedule. Pressure is 253db.
124	PI: "PO4 high or NO3 low from NO3/PO4 plot. From other plots the most likely is that PO4 is high. Probably code 3 on PO4? Nutrient analyst: "Peak looks okay, but concentration seems high. Footnote PO4 questionable. Pressure is 298db.
123	Footnote salinity not drawn per sampling schedule. Pressure is 395db.
123-122	CTD Processor: "O2 is +0.09 ml/l vs duplicate 123 bottle O2; 122 high vs CTDO (up-cast)/Station 37 (Station 39 not comparable here)." 122 high compared to duplicate 123, lot of structure in O2 CTD trace. No analytical problems for bottle O2. Pressure is 392-395db.
119	Footnote salinity not drawn per sampling schedule. Pressure is 571db.
120-119	CTD Processor: "O2 is +0.10 ml/l vs duplicate 119 bottle O2; 120 high vs CTDO (up-cast)/Station 37 (Station 39 not comparable here)." 120 high compared to duplicate 119, lot of structure in O2 CTD trace. Pressure is 574-571db.
118	Footnote salinity not drawn per sampling schedule. Pressure is 665db.
115	Footnote salinity not drawn per sampling schedule. Pressure is 758db.
112	Salinity Analyses: "4 attempts for a good reading." Bottle salinity is high compared with CTD. Footnote salinity bad. Pressure is 948db.
113	Footnote salinity not drawn per sampling schedule. Pressure is 949db.
109	Salinity not drawn per sampling schedule. CTD Processor: "O2 is +0.02 ml/l vs duplicate 110 bottle O2; CTDO fits halfway between 2 bottle O2s after fit, Station 39 agrees with lower bottle

	O2 (110); (Station 37 not comparable here)." O2, 109 high compared to duplicate 110, large O2 gradient. Stations 038 to 053, noticed many cases where oxygen flask 1193 was used on 109 and a problem with the oxygen sample was noted during CTDO processing. There were no notes on the sample logs indicating problems with 109 for these cases. O2 flask 1193 was located and no chips were found in flask or stopper. The stopper fit is slightly loose which could introduce an air bubble if the stopper were not held tight during the 2nd oxygen shake. There are many uses of O2 flask 1193 without obvious problems. Flask 1193 was set aside for possible recalibration. Footnote salinity not drawn and O2 questionable. Pressure is 1334db.
137	Sample Log: "Top endcap not seated [air leak]." Pressure is 1527db.
106	Footnote salinity not drawn per sampling schedule. Pressure is 1725db.
105	Salinity Analyses: "3 attempts for a good reading." High salinity value, inconsistent with t-s, CTD. Footnote salinity bad. CTD Processor: "O2 +0.03 ml/l vs CTDO (up-cast)/Station 39 halfway between CTD and bottle (Station 37 too shallow to compare)." No analytical problems for bottle O2. CTD Processor: "CTDO -0.03-4 ml/l compared to bottles, -0.02 ml/l maximum compared to Station 39 deep theta-CTDO; large raw CTDO drop at 1925db bottle stop; much bottle O2 scatter good match to sta 39 theta-CTDO below 2100db." Footnote CTDO questionable. Pressure is 1926db.
104	CTD Processor: "O2 +0.03 ml/l vs CTDO (up-cast)/Station 39 (Station 37 too shallow)." No analytical problems for bottle O2. Pressure is 2129db.
103	Salinity Analyses: "4 attempts for a good reading." Bottle salinity is high compared with CTD. Footnote salinity bad. Pressure is 2331db.
102	Footnote salinity not drawn per sampling schedule. Pressure is 2498db.
102-101	CTD Processor: "O2 is +0.04 ml/l vs duplicate 101 bottle O2; 102 high vs CTDO (up-cast)/Station 39 (Station 37 too shallow to compare)." No analytical problems for bottle O2. Pressure is 2498-2498db.
Station 039	
Cast 1	Console Log: "Put original conductivity sensor back on CTD (E55 replaces P42)
134-127	CTD Processor: "Sacrificed surface CTDO fit to optimize deeper fit." Footnote CTDO bad. Pressure is 15-168db.
112	Sample Log: "Possible NaOH/NaI dispensing problem." Pressure is 1618db.
137	Sample Log: "Dripping at spigot before venting." Pressure is 2423db.
105	Deck Log: "slight leak at bottom o-ring after venting." Pressure is 3005db.
Station 040	
136-135	Sample Log: "Not closed." See Cast 1 comment, no samples.
Cast 1	Console Log: "Bottles 1-7,37,9-34 apparently tripped at levels 3-36, 2 levels shallower than expected. All trip confirm values were -1 compared to intended bottle, and +1 compared to actual bottle - which still does not explain the shift." PI: "Salt vs Pressure plot suggests most/all salts (certainly all 101-117) are mis-assigned by one depth, i.e. these are reported one bottle deeper than their true depths. Theta vs Salt plot suggests same thing. O2 vs Pressure plot may suggest same problem. Some portions of nutrient plots suggest same problem." Footnote bottles not tripped as scheduled.
134-129	CTD Processor: "Sacrificed surface CTDO fit to optimize deeper fit." Footnote CTDO bad. See Cast 1 tripping problem comment. Footnote bottles not tripped as scheduled and CTDO bad. Pressure is 16-107db.
128-109	Footnote bottles not tripped as scheduled. Pressure is 136-2478db.

137 Sample Log: "Drain valve leak, [top cap air leak]." Niskin air leak, possible end cap problem, high O2 should be coded bad. Deck Log: "resurfaced top O-ring surface, new spigot and spigot holder, reversed end caps." Footnote bottles not tripped as scheduled and O2 bad. Pressure is 2710db.

107 CTD Processor: "Bottle O2 +0.02 ml/l vs duplicate bottle 106 at 3004db, +0.03 ml/l vs CTDO." No analytical problems for bottle O2. Pressure is 3004db.

107-101 See Cast 1 tripping problem comment. Footnote bottles not tripped as scheduled. Pressure is 3004-4081db.

102 Sample Log: "Removed rosette bottle to pour salt sample" Comment from Sample Log indicates that the bottle was low on water by the time the salinity sample was drawn. However, the samples are acceptable. Pressure is 3915db.

Station 041

136-131 CTD Processor: "Sacrificed surface CTDO fit to optimize deeper fit." Footnote CTDO bad. Pressure is 14-103db.

119 CTD Processor: "O2 -0.03 ml/l vs CTDO/nearby casts on theta-CTDO plot; difference not detectable on pressure-CTDO plot." No analytical problems for bottle O2. Pressure is 1012db.

118 CTD Processor: "O2 +0.03 ml/l vs CTDO/nearby casts." No analytical problems for bottle O2. Pressure is 1215db.

109 CTD Processor: "O2 +0.02 ml/l vs duplicate bottle 137 and CTDO/nearby casts." Duplicate samples, 109/137, may differ due to oxygen gradient. There may have been a problem with the loose stopper, Stations 038-053. See Station 038 O2 comment for details. Footnote O2 questionable. Pressure is 3013db.

137 Salinity Analyses: "4 attempts for a good reading." Bottle salinity is high compared with CTD, but just within accuracy of measurement. Salinity overlays with adjoining stations show variations, but this bottle seems to have problems. Footnote salinity questionable. Pressure is 3014db.

Station 042

Cast 1 Salt Log: "ET cleaned [Autosal] cell prior to rerun" Salt Data: "salts run in 2 batches, 1-5 and 1-36.

136-131 CTD Processor: "Sacrificed surface CTDO fit to optimize deeper fit." Footnote CTDO bad. Pressure is 15-166db.

131 Oxy Data: "Sample lost during analysis, computer glitch." See 136-131 CTDO comment. Footnote CTDO bad and oxygen lost. Pressure is 166db.

130 Sample Log: "tight air vent and spigot." Pressure is 226db.

125 Sample Log: "very sticky drain valve." Pressure is 399db.

137 Sample Log: "Top cap, slight [air] leak." Pressure is 3487db.

107 Salinity Analyses: "4 attempts for a good reading." Salinity Analyses: "low water level in sample bottle." Pressure is 3689db.

105 Salt Data: "unstable readings, sample lost. See 105-101 salinity comments. Footnote salinity lost. Pressure is 4103db.

105-101 Salinity Analyses: "Autosal unstable, run aborted before reading 5." Tried analyzing salinities 10 hours later. Pressure is 4103-4851db.

104 Salinity Analyses: "3 attempts for a good reading." Bottle salinity is high compared with CTD. See 105-101 salinity comments. Footnote salinity bad. Pressure is 4308db.

103 Salinity Analyses: "sample 3 aborted first run, asal messed up." Unstable readings, sample lost. See 105-101 salinity comments. Footnote salinity lost. Pressure is 4538db.

102 Salinity Analyses: "sample run before and therefore water level too low." Salinity Analyses: "3 attempts for a good reading." Pressure is 4747db.

101 Salinity Analyses: "water level low sample has been run before." Pressure is 4851db.

Station 043

Cast 1 Console Log: "delay start, trouble initiating computer."

136-130 CTD Processor: "Sacrificed surface CTDO fit to optimize deeper fit." Footnote CTDO bad. Pressure is 15-166db.

127 Sample Log: "New salt bottle insert." Salinity Analyses: "4 attempts for a good reading." Salinity Analyses: "have no idea what the problem is...happened on 26 too?." Pressure is 291db.

137 Sample Log: "drip from drain valve after venting." Pressure is 3810db.

106 Sample Log: "New salt bottle insert." Pressure is 4270db.

Station 044

136-133 CTD Processor: "Sacrificed surface CTDO fit to optimize deeper fit." Footnote CTDO bad. Pressure is 16-87db.

122 CTD Processor: "O2 +0.03-4 ml/l vs CTDO/down or up." No analytical problems for bottle O2. Pressure is 584db.

120 Sample Log: "Nutrient sampled before CO2." Pressure is 810db.

109 CTD Processor: "O2 +0.03-4 ml/l vs CTDO/down or up, nearby casts." There may have been a problem with the loose stopper, Stations 038-053. See Station 038 O2 comment for details. Footnote O2 questionable. Pressure is 3302db.

107 Sample Log: "tight drain valve." Pressure is 3810db.

Station 045

Cast 1 Sample Log: "O2 sampling followed CFC/Helium order."

136-134 CTD Processor: "Sacrificed surface CTDO fit to optimize deeper fit." Footnote CTDO bad. Pressure is 15-60db.

128 CTD Processor: "Sacrificed surface CTDO fit to optimize deeper fit." Footnote CTDO questionable. Pressure is 287db.

110-109 Salt Log: "reversed 9 & 10", mislabeled at analysis. Corrected entry. Pressure is 3297-3044db.

137 Sample Log: "Leaks from spigot [Air Leak]." Data are acceptable. Pressure is 3496db.

Station 046

136-132 CTD Processor: "Sacrificed surface CTDO fit to optimize deeper fit; raw CTDO signal ~40% higher near surface vs nearby casts." Footnote CTDO bad. Pressure is 15-130db.

133 CTD Processor: "O2 looks like it belongs in mixed layer, but 25m deeper - drawn from 34?" No analytical problems for bottle O2 noted. Pressure is 93db.

132 Salt Data: "4 tries to get reading." High value, inconsistent with t-s. Footnote salinity bad. CTD Processor: "O2 +0.30+ ml/l vs CTDO - high even for gradient - drawn from 33?" Footnote CTDO bad. See 136-132 CTDO comment. No analytical problems for bottle O2 noted. Pressure is 130db.

131-129 CTD Processor: "surface raw CTDO signal high down/up CTDO differ, but questionable due to size of offsets/despiking." Footnote CTDO questionable. Pressure is 156-206db.

125 Salt Data: "Sample low." Data are acceptable. See 125-122 CTDO comment. Footnote CTDO questionable. Pressure is 357db.

125-122	CTD Processor: "CTDO max -0.04 ml/l compared to bottles/nearby casts." Footnote CTDO questionable. Pressure is 357-642db.
124	Salt Data: "Mistake made on 2nd bottle reading." Data are acceptable. See 125-122 CTDO comment. Footnote CTDO questionable. Pressure is 448db.
119	Salt Data: "Sample low, 3 tries to get reading." Salinity is acceptable. Pressure is 1052db.
116	CTD Processor: O2 -0.03 ml/l vs CTDO." No analytical problems for bottle O2 noted. Pressure is 1642db.
112	Salt Data: "3 tries to get reading." High value, inconsistent with t-s. Bottle salinity is high compared with CTD and adjoining stations. Footnote salinity bad. Pressure is 2499db.
109	Salt Data: "Analysis problem ?, 3 tries to get reading." Bottle salinity is high compared with CTD and adjoining stations. Footnote salinity bad. Pressure is 3126db.
107	Sample Log: "Very slow flow." Bottle salinity is high compared with CTD and adjoining stations. Footnote salinity bad. CTD Processor: "O2 +0.03 ml/l vs CTDO." No analytical problems for bottle O2 noted. Pressure is 3528db.
106	Bottle salinity is high compared with CTD. Footnote salinity bad. Pressure is 3732db.
105	Bottle salinity is high compared with CTD and adjoining stations. Footnote salinity bad. Pressure is 3938db.
104	Bottle salinity is high compared with CTD and adjoining stations. Footnote salinity bad. Pressure is 4144db.
103	Salt Data: "3 tries to get reading." Bottle salinity is high compared with CTD and adjoining stations. The difference is within the precision of the measurement, but will footnote as bad since there does appear to have been an analyses problem. Footnote salinity bad. Pressure is 4351db.

Station 047

136-132	CTD Processor: "Sacrificed surface CTDO fit to optimize deeper fit." Footnote CTDO bad. Pressure is 15-84db.
131	Salt Data: "3 tries to get reading." Data are acceptable. CTD Processor: "Sacrificed surface CTDO fit to optimize deeper fit; CTDO max -0.25 ml/l compared to bottles down/up CTDO differ, but fit quality uncertain with large down/up difference." Footnote CTDO questionable. Pressure is 112db.
128	Deck Log: "New spigot O-rings, baked." Pressure is 209db.
125	Sample Log: "tight spigot." Salt Data: "sample low, 3 tries to get reading." Pressure is 325db.
120	Sample Log: "New salt bottle insert." Pressure is 707db.
113	Console Log: "No-confirm from pylon at first trip attempt, reset; second trip confirm okay." Bottle trips appear to be correctly assigned. Pressure is 1753db.
137	Sample Log: "leaks before venting." Pressure is 2876db.
107	Deck Log: "New spigot O-rings, baked." Pressure is 3122db.

Station 048

Cast 1	Console Log: "Sensors frozen at start of down cast?" Bottle numbering from shallow to deep, 36-9, 63, 7-1.
136-131	CTD Processor: "Sacrificed surface CTDO fit to optimize deeper fit; deeper fit; frozen sensors at start of cast." Footnote CTDO bad. Pressure is 15-186db.
125	Deck Log: "New spigot O-rings (baked)." Pressure is 406db.
123	Sample Log: "re-sampled oxygen." Pressure is 658db.

110 Oxygen high, inconsistent with theta/o2 and adjacent stations. Footnote oxygen questionable. Pressure is 2993db.

163 Deck Log: "Bottle 37 replaced with bottle 63. ASA barrel with ODF end caps." Pressure is 3250db.

Station 049

136 Console Log: "1 duplicate/odd trip confirm." Bottle trips appear to be correctly assigned. Pressure is 19db.

136-134 CTD Processor: "Sacrificed surface CTDO fit to optimize deeper fit; CTDO noisy." Footnote CTDO bad. Pressure is 19-73db.

119 Duplicate draw of 18 salinity? Bottle salinity is low compared with CTD. Footnote salinity questionable. Pressure is 1136db.

118 High value, inconsistent with t-s, CTD. Footnote salinity questionable. Pressure is 1338db.

116 Salt Log: "screwed up on 16" Salt Data: "3 tries to get reading." Inconsistent with t-s, CTD. Bottle salinity is low compared with CTD. Footnote salinity bad. Pressure is 1746db.

109 CTD Processor: "O2 +0.03 ml/l vs duplicate bottle 163, CTDO down or up, and nearby casts." Duplicate O2 samples, 109/163 may differ due to oxygen gradient. There may have been a problem with the loose stopper, Stations 038-053. See Station 038 O2 comment for details. Footnote O2 questionable. Pressure is 3253db.

Station 050

Cast 1 Console Log: "Winch went wrong way at bottom, may have touched bottom after trip 1. Went 10 meters down after bottom trip. Rosette and wire okay at surface."

136-131 CTD Processor: "Sacrificed surface CTDO fit to optimize deeper fit; CTDO noisy." Footnote CTDO bad. Pressure is 14-123db.

118 CTD Processor: "O2 +0.06 ml/l vs CTDO/down or up, nearby casts; matches bottle O2 for bottle 116 (2 levels deeper) - duplicate draw?." No analytical problems for bottle O2. Pressure is 1060db.

112 Salt Data: "3 tries to get reading." High value, inconsistent with t-s, CTD. Footnote salinity bad. Pressure is 2280db.

110 CTD Processor: "O2 +0.03 ml/l vs CTDO/down or up, nearby casts." No analytical problems for bottle O2. Pressure is 2788db.

105 Oxy Data: "pause analysis here for rosette deployment."
oxy sample 106 okay also. Pressure is 3757db.

102 CTD Processor: "O2 -0.03 ml/l vs CTDO/down or up, nearby casts." No analytical problems for bottle O2. Pressure is 4157db.

101 Salt Data: "3 tries to get reading." Bottle salinity is slightly high compared with CTD. Within the precision of the measurement, salinity is acceptable. CTD Processor: "CTD hit bottom, no conductivity/salinity spike near trip." Pressure is 4253db.

Station 051

Cast 1 Salt Log: "first std bad"

136-133 CTD Processor: "Sacrificed surface CTDO fit to optimize deeper fit; CTDO noisy." Footnote CTDO bad. Pressure is 15-82db.

127 Console Log: "1 duplicate/odd trip confirm." Bottle trips appear to be correctly assigned. Pressure is 288db.

124 CTD Processor: "O2 +0.03 ml/l vs CTDO/down or up, nearby casts." No analytical problems for bottle O2. Pressure is 433db.

118	CTD Processor: "O2 +0.03 ml/l vs CTDO/down or up, nearby casts." No analytical problems for bottle O2. Pressure is 1113db.
109	CTD Processor: "O2 +0.03 ml/l vs duplicate bottle 163, CTDO runs down the middle." Duplicate O2 samples, 109/163, may differ due to oxygen gradient. There may have been a problem with the loose stopper, Stations 038-053. See Station 038 O2 comment for details. Footnote O2 questionable. Pressure is 3041db.
102	Low value, inconsistent with t-o2, CTD. CTD Processor: "O2 -0.08 ml/l vs CTDO/down or up, nearby casts." No analytical problems for bottle O2. Pressure is 4302db.
101	Oxygen not run, analyst error. Footnote oxygen lost. Pressure is 4403db.
Station 052	
102-101	Apparent pre-trip on down-cast. See Cast 1 Console Log comment regarding bottle trips. No data.
Cast 1	Console Log: "Bottles 3-36 apparently tripped at levels 1-34, 2 levels deeper than expected. All trip confirm values matched the pylon positions of the intended bottles. No explanation for the shift. Same thing happened Station 56." Bottle trips appear to be correctly assigned. Footnote bottles did not trip as scheduled. Salt Data: "10 unit wormley drift, recheck gave 6 unit drift." Salinities appear acceptable.
136-135	CTD Processor: "Sacrificed surface CTDO fit to optimize deeper fit; CTDO noisy." See Cast 1 Console Log comment regarding bottle trips. Footnote bottle did not trip as scheduled and CTDO bad. Pressure is 46-78db.
134-132	See Cast 1 Console Log comment regarding bottle trips. Footnote bottle did not trip as scheduled. Pressure is 106-182db.
131	CTD Processor: "O2 +0.08 ml/l vs CTDO/down or up, nearby casts." No analytical problems for bottle O2. See Cast 1 Console Log comment regarding bottle trips. Footnote bottle did not trip as scheduled. Pressure is 207db.
130	CTD Processor: "O2 +0.15 ml/l vs CTDO/down or up, nearby casts." No analytical problems for bottle O2. See Cast 1 Console Log comment regarding bottle trips. Footnote bottle did not trip as scheduled. Pressure is 232db.
129-121	See Cast 1 Console Log comment regarding bottle trips. Footnote bottle did not trip as scheduled. Pressure is 257-1060db.
120	High oxygen value, inconsistent with t-o2 and CTD. See Cast 1 Console Log comment regarding bottle trips. Footnote bottle did not trip as scheduled and O2 questionable. Pressure is 1215db.
119-109	See Cast 1 Console Log comment regarding bottle trips. Footnote bottle did not trip as scheduled. Pressure is 1414-3249db.
163	Salt Data: "4 tries to get reading." High salinity value, inconsistent with t-s and CTD. See Cast 1 Console Log comment regarding bottle trips. Footnote bottle did not trip as scheduled and salinity bad. Pressure is 3455db.
107	See Cast 1 Console Log comment regarding bottle trips. Footnote bottle did not trip as scheduled. Pressure is 3710db.
106	Salt Data: "4 tries to get reading." High salinity value, inconsistent with t-s and CTD. Within precision of measurement, but since there appears to be an analytical problem, will footnote bad. Footnote bottle did not trip as scheduled and salinity bad. Pressure is 3965db.
105	See Cast 1 Console Log comment regarding bottle trips. Footnote bottle did not trip as scheduled. Pressure is 4170db.
104	CTD Processor: "O2 +0.015 ml/l vs CTDO/down or up, nearby casts." No analytical problems for bottle O2. See Cast 1 Console Log comment regarding bottle trips. Footnote bottle did not

	trip as scheduled. Pressure is 4376db.
103	CTD Processor: "O2 -0.015 ml/l vs CTDO/down or up, nearby casts." No analytical problems for bottle O2. See Cast 1 Console Log comment regarding bottle trips. Footnote bottle did not trip as scheduled. Pressure is 4448db.
Station 053	
136-133	CTD Processor: "Sacrificed surface CTDO fit to optimize deeper fit; CTDO noisy." Footnote CTDO bad. Pressure is 15-70db.
132-129	CTD Processor: "Sacrificed surface CTDO fit to optimize deeper fit." Footnote CTDO questionable. Pressure is 96-196db.
121	Oxy Data: "Pause analysis here for rosette deployment." oxy sample 122 okay also. Pressure is 806db.
114	Salt Data: "Water level very low". High value, inconsistent with t-s and CTD. Footnote salinity bad. Pressure is 2073db.
113	Bottle salinity is high compared with CTD. CTD Processor: "O2 -0.03 ml/l vs CTDO/down or up, nearby casts." No analytical problems for bottle O2. Pressure is 2278db.
109	CTD Processor: "Bottle O2 +0.02 ml/l vs duplicate bottle 163, +0.03 ml/l vs CTDO/nearby casts." Duplicate O2 samples, 109/163, may differ due to oxygen gradient. There may have been a problem with the loose stopper, Stations 038-053. See Station 038 O2 comment for details. Footnote O2 questionable. Pressure is 3147db.
101	Salt Log: "1 value bad?" Salt Data: "Sample low, 3 tries to get reading. Pressure is 4410db.
Station 054	
Cast 1	Deck Log: "Delay near surface up-cast, pylon problems." Console Log: "Pylon problems." Salt Log: "[standby] cond. ratio jumped from 6503 to 6511 at start"
136-130	CTD Processor: "Sacrificed surface CTDO fit to optimize deeper fit." Footnote CTDO bad. Pressure is 16-186db.
133	Console Log: "No-confirm from pylon at first trip attempt, reset; second trip confirm okay." Bottle trips appear to be correctly assigned. See 136-130 CTD Processor comment. Footnote CTDO bad. Pressure is 84db.
116	Sample Log: "tight spigot." Pressure is 1763db.
113	CTD Log: "Bottle tripped on the fly." Data appears acceptable. Pressure is 2548db.
110	CTD Processor: "O2 +0.04 ml/l vs CTDO/down or up, nearby casts." No analytical problems for bottle O2. Pressure is 3041db.
Station 055	
Cast 1	Deck Log: "Large swell during rosette recovery."
136-131	CTD Processor: "Sacrificed surface CTDO fit to optimize deeper fit." Footnote CTDO bad. Pressure is 17-127db.
116	Deck Log: "New baked O-rings in spigot." Pressure is 1270db.
101	High oxygen value, inconsistent with t-o2 & CTD. Bottle salinity is high compared with CTD. Within the precision of the measurement, salinity is acceptable. Footnote oxygen questionable. Pressure is 4187db.
Station 056	
102-101	CTD Processor: "Apparently (pre-?)tripped at unknown depths." CTD data eliminated from bottle files. Footnote bottle did not trip as scheduled. See Cast 1 bottle trip problems. No data.

Cast 1	Console Log: "Conductivity noise, spikes, ship roll and hysteresis. Kink in wire above rosette, cut off 50 meters wire, reterminate after cast. Bottles 3-36 apparently tripped at levels 1-34, 2 levels deeper than expected. All trip confirm values matched the pylon positions of the intended bottles. No explanation for the shift. Same thing happened Station 52." Bottle trips appear to be correctly assigned. Footnote bottle did not trip as scheduled.
136-135	Console Log: "Bottle tripped on the fly." Data appears acceptable. See Cast 1 bottle trip problems. See 134-133 CTDO comments. Footnote bottle did not trip as scheduled and CTDO bad. Pressure is 53-73db.
134-133	CTD Processor: "Sacrificed surface CTDO fit to optimize deeper fit." See Cast 1 bottle trip problems. Footnote bottle did not trip as scheduled and CTDO bad. Pressure is 99-129db.
132-111	See Cast 1 bottle trip problems. Footnote bottle did not trip as scheduled. Pressure is 187-2746db.
120-119	CTD Processor: "CTD conductivity/salinity okay after despiking." Footnote CTD salinity despiked.
117-115	CTD Processor: "CTD conductivity/salinity okay after despiking." Footnote CTD salinity despiked.
112-111	CTD Processor: "CTD conductivity/salinity okay after despiking." Footnote CTD salinity despiked.
110	Salt Log: "10 aborted, value climbed." Sample not run. See Cast 1 bottle trip problems. Footnote bottle did not trip as scheduled and salinity lost. Pressure is 2946db.
109	See Cast 1 bottle trip problems. Footnote bottle did not trip as scheduled. CTD Processor: "CTD conductivity/salinity okay after despiking." Footnote CTD salinity despiked. Pressure is 3148db.
163	See Cast 1 bottle trip problems. Footnote bottle did not trip as scheduled. Bottle salinity is low compared with CTD. Data are acceptable. CTD Processor: "CTD conductivity/salinity okay after despiking." Footnote CTD salinity despiked. Pressure is 3345db.
107	CTD Processor: "O2 +0.07 ml/l vs CTDO (up-cast), nearby casts." No analytical problems for bottle O2. See Cast 1 bottle trip problems. Footnote bottle did not trip as scheduled. Pressure is 3549db.
107-103	CTD Processor: "CTD conductivity/salinity okay after despiking." Footnote CTD salinity despiked.
106	See Cast 1 bottle trip problems. Footnote bottle did not trip as scheduled. Pressure is 3748db.
105	Oxy Data: "Analyst forgot acid, sample lost." See Cast 1 bottle trip problems. Footnote bottle did not trip as scheduled and O2 lost. Pressure is 3956db.
104-103	See Cast 1 bottle trip problems. Footnote bottle did not trip as scheduled. Pressure is 4054-4147db.

Station 057

Cast 1	New wire end termination. Console Log: "Large swell, lots of ship roll." Salt Data: "3 tries to get end Wormley reading."
136-131	CTD Processor: "Sacrificed surface CTDO fit to optimize deeper fit." Footnote CTDO bad. Pressure is 14-129db.
135	Bottle salinity is high compared with CTD. CTD Processor: "CTD conductivity/salinity okay after despiking." Footnote CTD salinity despiked. Pressure is 34db.
134	Console Log: "Reset pylon prior to this trip due to odd trip confirm on 133." Bottle trips appear to be correctly assigned. See 136-131 CTD Processor comment. Footnote CTDO bad. Pressure is 55db.

133 Deck Log: "Not closed, no water." Console Log: "Odd trip confirm from pylon; noticed at next bottle stop." Bottle trips appear to be correctly assigned. See 136-131 CTDO comment. Footnote samples were not drawn and CTDO bad. Pressure is 80db.

126 CTD Processor: "O2 +0.04 ml/l vs CTDO (up-cast), nearby casts." No analytical problems for bottle O2. Pressure is 302db.

118 CTD Processor: "O2 +0.04 ml/l vs CTDO (up-cast), nearby casts." No analytical problems for bottle O2. Pressure is 1101db.

118-109 CTD Processor: "CTD conductivity/salinity okay after despiking." Footnote CTD salinity despiked.

116 CTD Processor: "O2 +0.05 ml/l vs CTDO (up-cast), nearby casts." No analytical problems for bottle O2. Pressure is 1395db.

110 Sample Log: "New salt bottle 10, broke old Bottle salinity is low compared with CTD. Pressure is 2608db.

163 CTD Processor: "CTD conductivity/salinity okay after despiking." Footnote CTD salinity despiked. Bottle salinity is low compared with CTD. Pressure is 3012db.

107-102 CTD Processor: "CTD conductivity/salinity okay after despiking." Footnote CTD salinity despiked.

106 PI: "The SiO3 value of 132.8 um/l appears to be slightly low, by ca. 3.5 um/l." Nutrient analyst: "Peak looks ok, but may have had electrical jump." Bottle salinity is low compared with CTD. Within the precision of the measurement, salinity is acceptable. Footnote silicate questionable. Pressure is 3425db.

101 Bottle salinity is high compared with CTD. CTD Processor: "CTD trip data extracted 15.5 seconds later than actual trip due to large conductivity drift at time of trip; rawPress and rawTemp data nearly identical to original values." CTD Processor: "CTD conductivity/salinity okay after despiking." Footnote CTD salinity despiked. CTD Processor: "O2 -0.03 ml/l vs CTDO (up-cast), nearby casts - could be partly CTDO fit +0.01 ml/l high per theta-CTDO, up-casts often fit on the high side at bottom." No analytical problems for bottle O2. CTD Processor: "CTDO +0.03-4 ml/l compared to bottom bottle and down-cast CTDO." Footnote CTDO questionable. Pressure is 4096db.

Station 058

131-130 Sample Log: "bottles did not close." Console Log: "Odd trip confirm from pylon on two consecutive trip attempts at same pressure." Bottle trips appear to be correctly assigned.

136-132 CTD Processor: "Sacrificed surface CTDO fit to optimize deeper fit; 3 minutes at 176-180db, between bottle stops." Footnote CTDO bad. Pressure is 30-156db.

129-127 CTD Processor: "CTD conductivity/salinity okay after despiking." Footnote CTD salinity despiked.

125 Salt Data: "4 tries to get reading." High value, inconsistent with t-s, CTD. Footnote salinity bad. Pressure is 356db.

125-109 CTD Processor: "CTD conductivity/salinity okay after despiking." Footnote CTD salinity despiked.

122 Salt Data: "3 tries to get reading." High salinity value, inconsistent with t-s, CTD. Footnote salinity bad. Pressure is 510db.

118 CTD Processor: "O2 +0.06 ml/l vs CTDO (up-cast), nearby casts; matches next deeper bottle O2 for bottle 117 at 1110db - duplicate draw?" No analytical problems for bottle O2. Pressure is 1008db.

111 Bottle salinity is high compared with CTD. CTD Processor: "O2 -0.03 ml/l vs CTDO (up-cast), overlays nearby casts but all nearby O2s/CTDO do not line up with nearby casts." No analytical problems for bottle O2. Pressure is 2277db.

163 CTD Processor: "CTD conductivity/salinity okay after despiking." Footnote CTD salinity despiked.

107-102 CTD Processor: "CTD conductivity/salinity okay after despiking." Footnote CTD salinity despiked.

103 Salt Data: "9 tries to get reading, manual entry." Footnote CTD salinity despiked. Bottle salinity looks okay compared to CTD after despike." Pressure is 3861db.

102 Salt Data: "5 tries to get reading." High value, inconsistent with t-s, CTD. Footnote salinity bad. Pressure is 3963db.

101 Salt Data: "9 tries to get reading, manual entry." CTD Processor: "CTD trip data extracted 17.5 seconds later than actual trip due to large Conductivity drift at time of trip; rawPress 1 db shallower, rawTemp -0.0005 degree compared to original values. CTD Processor: "CTD conductivity/salinity okay after despiking." Footnote CTD salinity despiked. Bottle salinity looks okay compared to CTD after despike." CTD Processor: "O2 -0.05 ml/l vs CTDO (up-cast), nearby casts - could be partly CTDO fit +0.02 ml/l high per theta-CTDO, up-casts often fit on the high side at bottom." No analytical problems for bottle O2. CTD Processor: "CTDO +0.05 ml/l compared to bottom bottle, +0.01 ml/l compared to down-cast/nearby casts theta-CTDO; shape mirrors CTD salinity bottom bottle O2 looks lower than nearby casts bottom drops, down/up CTDO show same structure, but previous cast CTDO here coded questionable and this is only cast without a CTDO drop at bottom." Footnote CTDO questionable. Pressure is 4020db.

Station 059

Cast 1 Deck Log: "Cleaned CTD conductivity cell."

136-129 CTD Processor: "Sacrificed surface CTDO fit to optimize deeper fit." Footnote CTDO bad. Pressure is 18-208db.

131 CTD Processor: "CTD conductivity/salinity okay after despiking." Footnote CTD salinity despiked.

128 CTD Processor: "Sacrificed surface CTDO fit to optimize deeper fit." Footnote CTDO questionable. Pressure is 240db.

124 High value, inconsistent with t-s & CTD. Possible dup draw of 123? Bottle salinity is high compared with CTD. Footnote salinity questionable. Pressure is 417db.

118 CTD Processor: "O2 +0.06 ml/l vs CTDO (up-cast), nearby casts." No analytical problems for bottle O2. Pressure is 953db.

114 Oxy Data: "Flask 840 with stopper 1180." Footnote oxygen bad. Pressure is 1658db.

113 Oxy Data: "Flask 1180 with stopper 840." Footnote oxygen bad. Pressure is 1865db.

110 CTD Processor: "O2 +0.04 ml/l vs CTDO (up-cast), only this and 163 bottle O2s overlay higher Station 58 here, rest of bottle O2s and CTDO in this area agree with Station 60." No analytical problems for bottle O2. Pressure is 2472db.

163 CTD Processor: "O2 +0.03 ml/l vs CTDO (up-cast), only this and 110 bottle O2s overlay higher Station 58 here, rest of bottle O2s and CTDO in this area agree with Station 60." No analytical problems for bottle O2. Pressure is 2871db.

105 CTD Processor: "O2 +0.04 ml/l vs CTDO (up-cast), Station 58 (Station 60 too shallow to compare)." No analytical problems for bottle O2. Pressure is 3490db.

102-101 CTD Processor: "CTDO +0.02 ml/l compared to deepest bottles; +0.02 ml/l compared to down-cast at bottom, no bottle O2 at bottom to check; ±0.01 ml/l compared to nearby casts theta-CTDO

	up CTDO diverges from down CTDO here, cannot be sure without bottom bottle." Footnote CTDO questionable. Pressure is 3950-4008db.
101	High oxygen value, inconsistent with t-o2, CTD. See 102-101 CTDO comment. Footnote CTDO questionable and O2 questionable. CTD Processor: "CTD conductivity/salinity okay after despiking." Footnote CTD salinity despiked. Pressure is 4008db.

Station 060

136-126	CTD Processor: "Sacrificed surface CTDO fit to optimize deeper fit." Footnote CTDO bad.
128	Console Log: "2 duplicate/odd trip confirms." Bottle trips appear to be correctly assigned. Pressure is 54db.
125-130	Sample Log: "Salt bottles empty with residue, before draw." Pressure is 140-15db.
101	Salt Data: "3 tries for reading." Data are acceptable. CTD Processor: "CTDO +0.02-4 ml/l compared to bottom bottle; diverges high compared to down-cast here." Footnote CTDO questionable. CTD Processor: "O2 -0.02 ml/l vs CTDO (up-cast), Station 59 (Station 61 too shallow to compare); other nearby-cast bottle O2s low at bottom, this cast is much shallower." No analytical problems for bottle O2. Bottle salinity is high compared with CTD. Pressure is 2986db.

Station 061

Cast 1	Deck Log: "Hooked sea-cable during recovery, no damage. Tag line was close to bottle tops. Big swell, lots of ship roll."
130-125	CTD Processor: "Sacrificed surface CTDO fit to optimize deeper fit." Footnote CTDO bad. Pressure is 13-154db.
114	Salt Data: "3 tries to get reading." High value, inconsistent with t-s, CTD. Footnote salinity bad. Pressure is 834db.
112	CTD Processor: "CTD conductivity/salinity okay after despiking." Footnote CTD salinity despiked. Pressure is 1060db.
102-101	CTD Processor: "CTDO +0.04-5 ml/l compared to bottom bottles and down CTDO, does not match nearby casts theta-CTDO." Footnote CTDO questionable. Pressure is 2628-2736db.
101	CTD Processor: "O2 -0.02 ml/l vs CTDO (up-cast), Station 60 (Station 62 too shallow to compare); other nearby-cast bottle O2s low at bottom." No analytical problems for bottle O2. See 102-101 comment. Footnote CTDO questionable. Pressure is 2736db.

Station 062

Cast 1	Console Log: "new CTD conductivity sensor (O17 replaces E55)." Console Log: "replaced CTD PRT2/FSI OTM 1320 with OTM 1322."
128	Console Log: "Bottle tripped on the fly." Pressure is 14db.
128-124	CTD Processor: "Sacrificed surface CTDO fit to optimize deeper fit." Footnote CTDO bad. Pressure is 14-103db.
123	CTD Processor: "CTDO -0.25 ml/l compared to bottle O2, mirrors CTD salinity structure down/up CTDO differ, but fit quality uncertain with large down/up difference." Footnote CTDO questionable. Pressure is 134db.
163	Salt Data: "3 tries for reading." High value, inconsistent with t-s, CTD. Footnote salinity bad. Pressure is 1453db.
106-102	Salt Log: "2 - 6 problematic, cell dirty ?" Pressure is 1857-2425db.
101	Salt Data: "3 tries for reading." High value, inconsistent with t-s, CTD. Footnote salinity bad. Pressure is 2464db.

Station 063

124-120	CTD Processor: "Sacrificed surface CTDO fit to optimize deeper fit." Footnote CTDO bad. Pressure is 14-101db.

Station 064

Cast 1	Deck Log: "Big swell, lots of rolling."
122	Salt Log: " Salt Data: "3 tries to get reading." Console Log: "tripped on the fly." Data are acceptable. Pressure is 12db.
122-120	CTD Processor: "Sacrificed surface CTDO fit to optimize deeper fit." Footnote CTDO bad. Pressure is 12-62db.
104	Salt Data: "3 tries to get reading." High value, inconsistent with t-s, CTD. Footnote salinity bad. Pressure is 1149db.
101	Sample Log: "Low water level for salt sample." Pressure is 1526db.

Station 065

122-120	CTD Processor: "Sacrificed surface CTDO fit to optimize deeper fit." Footnote CTDO bad. Pressure is 11-52db.
114	CTD Processor: "O2 +0.04 ml/l vs CTDO/down or up; nearby casts not comparable." No analytical problems for bottle O2. Pressure is 252db.
113	Sample Log: "Tight spigot." Pressure is 302db.
107	CTD Processor: "O2 +0.03 ml/l vs CTDO/down or up; only this bottle O2 overlays higher Stations 64/66 here, CTDO and other bottle O2s not comparable to nearby casts." No analytical problems for bottle O2. Pressure is 855db.
103	CTD Processor: "O2 -0.03 ml/l vs CTDO/down; matches up-cast well, minimum feature is 40db shallower on up-cast." No analytical problems for bottle O2. Pressure is 1464db.

Station 066

136-129	CTD Processor: "Sacrificed surface CTDO fit to optimize deeper fit." Footnote CTDO bad. Pressure is 14-118db.
135	See 136-129 CTDO comment. Footnote CTDO bad and salinity, silicate, nitrate, nitrite and phosphate not drawn per sampling schedule. Pressure is 14db.
133	See 136-129 CTDO comment. Footnote CTDO bad and salinity, silicate, nitrate, nitrite and phosphate not drawn per sampling schedule. Pressure is 28db.
131	See 136-129 CTDO comment. Footnote CTDO bad and salinity, silicate, nitrate, nitrite and phosphate not drawn per sampling schedule. Pressure is 82db.
127	Footnote salinity, silicate, nitrate, nitrite and phosphate not drawn per sampling schedule. Pressure is 150db.
125	Oxy Data: "Low sloped titration curve; t-o2 okay." Footnote salinity, silicate, nitrate, nitrite and phosphate not drawn per sampling schedule. Pressure is 209db.
123	Footnote salinity, silicate, nitrate, nitrite and phosphate not drawn per sampling schedule. Pressure is 237db.
121	Footnote salinity, silicate, nitrate, nitrite and phosphate not drawn per sampling schedule. Pressure is 267db.
119	Oxy Data: "Pause analysis here for Ros. recovery." oxy sample 120 okay also. Pressure is 290db.
117	Footnote salinity, silicate, nitrate, nitrite and phosphate not drawn per sampling schedule. Pressure is 419db.

115	Footnote salinity, silicate, nitrate, nitrite and phosphate not drawn per sampling schedule. Pressure is 545db.
111	Footnote salinity, silicate, nitrate, nitrite and phosphate not drawn per sampling schedule. Pressure is 733db.
109	Footnote salinity, silicate, nitrate, nitrite and phosphate not drawn per sampling schedule. Pressure is 934db.
107	Footnote salinity not drawn per sampling schedule. Pressure is 1238db.

Station 067

Cast 1	Console Log: "Drift west during cast. Up-cast more "inshore" character than down-cast."
136-134	CTD Processor: "Sacrificed surface CTDO fit to optimize deeper fit." Footnote CTDO bad. Pressure is 7-32db.
135-136	Console Log: "tripped on the fly." Data are acceptable. Pressure is 14-7db.
132	Console Log: "No-confirm from pylon at first trip attempt, reset; second trip confirm okay." Bottle trips appear to be correctly assigned. See 133-131 CTDO comment. Footnote CTDO questionable. Pressure is 60db.
133-131	CTD Processor: "Sacrificed surface CTDO fit to optimize deeper fit." Footnote CTDO questionable. Pressure is 62-90db.
130	Oxy Data: "Pause analysis here for Ros. recovery." oxy sample 131 okay also. Pressure is 118db.
128-123	CTD Processor: "O2s -0.40 to +0.15 ml/l vs CTDO/down - okay, matches up-cast." No analytical problems for bottle O2. Pressure is 177-465db.
114-101	Sample Log: "Oxygen sampling went before Helium." Pressure is 3669-1496db.
102	Salt Analysis: "3 attempts." High value, inconsistent with t-s, CTD. Footnote salinity bad. Pressure is 3668db.

Station 068

Cast 1	Console Log: "Slowed to 20 m/min at 750 m. on down cast. Unusual transmissometer readings looked like bottom layer. Checked bottom depth and then resumed 60 m/min down." Console Log: "Drift west during cast. Up-cast more "inshore" character than down-cast."
136	Console Log: "Bottle tripped on the fly." Pressure is 15db.
136-131	Sample Log: "Before sampling salt bottles were empty and had salt crystals visible in them." Data are acceptable. See 136-132 CTD Processor comment. Footnote CTDO bad. Pressure is 15-136db.
136-132	CTD Processor: "Sacrificed surface CTDO fit to optimize deeper fit." Footnote CTDO bad. Pressure is 15-108db.
132-118	CTD Processor: "O2s maximum +0.40 ml/l vs CTDO/down - okay, down/up very different, similar down-CTD/bottle salinity differences." No analytical problems for bottle O2. Pressure is 108-935db.
131-118	CTD Processor: "CTDO max -0.40 ml/l compared to bottles, mirrors CTD salinity structure down/up CTDO differ, but fit quality uncertain with large down/up difference." Footnote CTDO questionable. Pressure is 136-935db.
130	Salt Data: "3 tries for reading." See 131-118 CTDO comment. Footnote CTDO questionable. Pressure is 160db.
127	Salt Data: "3 tries for reading." See 131-118 CTDO comment. Footnote CTDO questionable. Pressure is 268db.
125	Salt Data: "3 tries for reading." See 131-118 CTDO comment. Footnote CTDO questionable. Pressure is 350db.

123	Salt Data: "Suspect salt crystals, 4 attempts." See 131-118 CTDO comment. Footnote CTDO questionable. Pressure is 470db.
122-120	Salt Data: "3 tries for reading." See 131-118 CTDO comment. Footnote CTDO questionable.
118	Salt Data: "3 tries for reading." See 131-118 CTDO comment. Footnote CTDO questionable. Pressure is 935db.
107	CTD Processor: "O2 +0.04 ml/l vs CTDO/down or up, nearby casts." No analytical problems for bottle O2. Pressure is 3490db.
106	CTD Processor: "O2 +0.04 ml/l vs CTDO/down or up, nearby casts." No analytical problems for bottle O2. Pressure is 3708db.
Station 069	
Cast 1	Salt Log: "Cleaned cell before run."
136-127	CTD Processor: "Sacrificed surface CTDO fit to optimize deeper fit." Footnote CTDO bad. Pressure is 14-277db.
123-122	CTD Processor: "O2s max. +0.25 ml/l vs CTDO/down - okay, down/up very different, similar down-CTD/bottle salinity differences." No analytical problems for bottle O2. Pressure is 486-548db.
Station 070	
136-132	CTD Processor: "Sacrificed surface CTDO fit to optimize deeper fit." Footnote CTDO bad. Pressure is 16-157db.
130-120	CTD Processor: "O2s -0.05 to +0.25 ml/l vs CTDO/down - okay, down/up very different, similar down-CTD/bottles salinity differences." No analytical problems for bottle O2. Pressure is 245-862db.
125-121	CTD Processor: "CTDO max -0.20 ml/l compared to bottles, -0.10 ml/l compared to nearby casts; mirrors CTD salinity structure down/up CTDO differ, but fit quality uncertain with large down/up difference." Footnote CTDO questionable. Pressure is 450-726db.
124	Salt Data: "3 tries to get reading." High salinity value, inconsistent with t-s, CTD. Footnote salinity bad. See 125-121 comment. Footnote CTDO questionable. Pressure is 495db.
163	Salt Data: "3 tries to get reading." High salinity value, inconsistent with t-s, CTD." Footnote salinity bad. Pressure is 3105db.
105	CTD Processor: "O2 -0.03 ml/l vs CTDO/down or up, nearby casts." No analytical problems for bottle O2. Pressure is 3706db.
102	Sample Log: "Bottom cap not seated." Pressure is 4252db.
Station 071	
Cast 1	Salt Log: "1st std was bad", re-try okay." Salt Log: "1st end std bad"
136	Console Log: "Bottle tripped on the fly." Data are acceptable. Pressure is 18db.
136-132	CTD Processor: "Sacrificed surface CTDO fit to optimize deeper fit." Footnote CTDO bad. Pressure is 18-136db.
129-128	Salt Log: "trouble with analysis." Pressure is 348-290db.
128-127	CTD Processor: "O2s max. -0.06 ml/l vs CTDO/down - okay, up drop is shallower through this area." No analytical problems for bottle O2. Pressure is 348-387db.
119	Oxy Data: "Pause analysis here for rosette recovery." oxy sample 120 okay also. Pressure is 1263db.
105	Low salinity value, inconsistent with t-s, CTD. Bottle salinity is low compared with CTD. Footnote salinity questionable. Pressure is 4025db.

Station 072

Cast 1 Deck Log: "After cast, rinse rosette with fresh water. Begin run to Mirnyy, Russian antarctic base, to supply them with food."

136-124 Nutrient analyst: "Silicate baseline jumped 0.017 units at sample 24, data for 36-24 was hand edited." Pressure is 15-565db.

136-130 CTD Processor: "Sacrificed surface CTDO fit to optimize deeper fit." Footnote CTDO bad. Pressure is 15-215db.

129-128 CTD Processor: "CTDO noisy and max +0.08 ml/l compared to bottles, somewhat mirrors CTD salinity structure down/up CTDO differ, but fit quality uncertain due to noisier signal that blends into shallower high CTDO section." Footnote CTDO questionable. Pressure is 263-303db.

128-127 CTD Processor: "O2s maximum -0.08 ml/l vs CTDO/down - okay, down/up different, similar down-CTD/bottle salinity differences." No analytical problems for bottle O2. Pressure is 303-345db.

122 CTD Processor: "O2 -0.05 ml/l vs CTDO/down - okay, up drop is shallower through this area." No analytical problems for bottle O2. Pressure is 708db.

114 Sample Log: "Duplicate salt, loose insert in 1st bottle" Salt Data: "3 tries for reading." High value, inconsistent with t-s, CTD. Footnote salinity bad. Pressure is 2067db.

107 Salt Data: "4 tries for reading." High value, inconsistent with t-s, CTD. Footnote salinity bad. Pressure is 3752db.

104 Salt Data: "3 tries for reading." High value, inconsistent with t-s, CTD. Footnote salinity bad. Pressure is 4365db.

103 High value, inconsistent with t-s, CTD. Bottle salinity is high compared with CTD. Footnote salinity questionable. Pressure is 4518db.

101 Salt Data: "3 tries for reading." High value, inconsistent with t-s, CTD. Footnote salinity bad. Pressure is 4663db.

Station 073

107-105 CTD Processor: "O2s max. -0.15 ml/l vs CTDO/down - okay, down/up different." No analytical problems for bottle O2. CTD Processor: "CTDO max +0.15 ml/l compared to bottles." Footnote CTDO questionable. Pressure is 250-351db.

101 CTD Processor: "CTD conductivity/salinity okay after despiking." Footnote CTD salinity despiked.

Station 074

Cast 1 Console Log: "At start, down 30 m., up to 0 then down again, due to frozen sensors." Console Log: "Transmissometer cleaned and checked." Deck Log: "Jelly-fish on frame at cast end. " Salt Log: "End Worm low water, okay at first/2nd high."

163 Salt Log: "Readings ’a little wacky’" Salt Data: "3 tries to get reading." Pressure is 223db.

107-106 CTD Processor: "CTD conductivity/salinity okay after despiking." Footnote CTD salinity despiked.

104-102 CTD Processor: "CTD conductivity/salinity okay after despiking." Footnote CTD salinity despiked.

103 Salt Log: "Readings ’a little wacky’" Salt Data: "3 tries to get reading." Pressure is 545db.

Station 075

Cast 1 Salt Log: "wrong salt bottle Salt Log: "[Large drift at end of salinity run, lab temperature changed by 3.3 degrees. Salinities appear to be acceptable.

122-116	CTD Processor: "Frozen sensors at start of cast/high CTDO signal; CTDO max ±0.10 ml/l extrapolated top 100db." Footnote CTDO bad. Pressure is 12-183db.
104	Sample Log: "possible contamination of O2 by spraying freon sampler" Pressure is 1060db.
Station 076	
Cast 1	Deck Log: "Sensors "frozen", down 30, up to 0, then dn." Console Log: "7 duplicate/odd trip confirms: 3,7,9,12,15,18,26." Bottle trips appear to be correctly assigned.
112-109	CTD Processor: "O2s max. ±0.10 ml/l vs CTDO/down - okay, down/up different." No analytical problems for bottle O2. Pressure is 632-783db.
110	Salt Log: "Sample 10 run out of order, at end of run" Pressure is 783db.
163	CTD Processor: "see 112-109 comment." No analytical problems for bottle O2. Pressure is 889db.
107-106	CTD Processor: "see 112-109 comment." No analytical problems for bottle O2. Pressure is 1000-1112db.
101	Console Log: "Problems initializing pylon at cast start, tripped in air - reset pylon/bottle before cast entered water." Bottle trips appear to be correctly assigned. Pressure is 1770db.
Station 077	
131	Sample Log: "Bottle closed, but wasn't tripped by console operator." Pressure is db.
Cast 1	Console Log: "7 duplicate/odd trip confirms: 6,7,9,10,15,16,22." Bottle trips appear to be correctly assigned.
120-118	CTD Processor: "O2s max. +0.20 ml/l vs CTDO/down - okay, down/up different." No analytical problems for bottle O2. Pressure is 354-445db.
106	Sample Log: "Lanyards caught in top endcap. Leaked. Bottle salinity is low compared with CTD. Footnote bottle leaking and samples bad. Pressure is 1871db.
104	Sample Log: "Missing from rosette (imploded); replaced by 39 on subsequent casts." Footnote samples were not drawn. Pressure is 2277db.
102	Salt Data: "Manual Entry, 3 tries, Low water." Low Value. Footnote salinity bad. Pressure is 2379db.
Station 078	
Cast 1	Console Log: "1 odd trip confirm: bottle 2; multiple No-confirms during a half-hour at 3008db (bottle 3 stop), while sorting out pylon communication problems. Re-initialized CTD data acquisition at 3008db stop after 2 trips at bottom. Pylon reset to position 3 after re-initialization." 3 duplicate/odd trip confirms: btls 3,7,22." Bottle trips appear to be correctly assigned. Bottle numbering from shallow to deep, 36-9, 63, 7-5, 39, 3-1.
136-128	CTD Processor: "Frozen sensors at start of cast/high CTDO signal; sacrificed surface CTDO fit to optimize deeper fit extrapolated top 32db." Footnote CTDO bad. Pressure is 14-195db.
127-126	CTD Processor: "CTDO max ±0.06 ml/l compared to bottles down/up CTDO differ, but fit quality uncertain: blends into shallower high CTDO section." Footnote CTDO questionable. Pressure is 235-285db.
123-114	CTD Processor: "O2s -0.40 to +0.30 ml/l vs CTDO/down - okay, down/up very different, similar down-CTD/bottle salinity differences." No analytical problems for bottle O2. Pressure is 416-1265db.
105	CTD Processor: "Deepest 5 bottle O2s maximum ±0.02 ml/l vs CTDO/down - CTDO fit runs down the middle, agrees okay with Station 79." No analytical problems for bottle O2. Pressure is 2738db.

139	CTD Processor: "See 105 comment" No analytical problems for bottle O2. Pressure is 2891db.
103	Sample Log: "Bottom endcap needed to be reseated." CTD Processor: "See 1all comment; last trip confirm okay." Pressure is 2993db.
103-101	CTD Processor: "See 105 comment; duplicate bottle O2s at bottom disagree by 0.03 ml/l." No analytical problems for bottle O2. Pressure is 2993-3044db.

Station 079

Cast 1	Sample Log: "only 21 bottles (of 31 trips) closed." Console Log: "2 duplicate/odd trip confirms: 1, 5; then 1 odd trip confirm at 11th trip attempt (1534db). Bottle 1 tripped at expected level, bottles 2-11 tripped one level deeper than expected, and bottle 12 apparently tripped at same level as bottle 11 (although only 11 trips attempted). Cast re-initialized after this, at 1534db stop, but pylon not repositioned to first un-tripped position: 12 bottles were already closed and "re-tripped" with only one duplicate/odd trip confirm. Bottles 13-21 had normal trip confirms when the lack of pylon repositioning was considered. Bottle trips appear to be correctly assigned. CTD Processor: "12 attempted bottle trips failed: pylon not reset to first un-tripped bottle after re-initialization at 1516db stop (after bottle 12 closed); tried to close already-tripped bottles in positions 1-12."
121-118	CTD Processor: "Sacrificed surface CTDO fit to optimize deeper fit." Footnote CTDO bad. Pressure is 11-78db.
112-109	CTD Processor: "Pressures for deepest 12 trips were one level too deep, as assigned on ship; problems with pylon/tripping. Deepest 12 bottle pressures reassigned one trip-level shallower based on trip-confirm values, bottle/CTD comparisons for oxygen and salinity, and deep overlays of salinity, oxygen, phosphate and silicate vs potential temperature for Stations 78/79/80." Bottle trips appear to be correctly assigned. Footnote bottle did not trip as scheduled. Pressure is 1516-1921db.
163	CTD Processor: "See 112-109 comment." Pressure is 2123db.
107-105	CTD Processor: "See 112-109 comment." Pressure is 2326-2732db.
139	CTD Processor: "See 112-109 comment." Pressure is 2935db.
103-101	CTD Processor: "See 112-109 comment." Pressure is 3139-3257db.
102	Salt Log: " Bottle salinity is high compared with CTD. Pressure is 3210db.
102-101	Salt Data: "Aborted salt program [op error] and restarted." Pressure is 3210-3257db.

Station 080

Cast 1	Console Log: "Frozen sensors, down 30, up to 0, then dn" Deck Log: "Water immediately froze on bottles when came out of water at cast end." Console Log: "17 odd trip confirms: 1-3,5,6,63,9-18,22. reset pylon after btls 2,3 trips and before btl 13 trip." Bottle trips appear to be correctly assigned.
134-101	Sample Log: "New O2 draw therm. box M93004412, correction to 02 draw temp. = -1.5." Pressure is 3634-10db.
134-129	CTD Processor: "Sacrificed surface CTDO fit to optimize deeper fit." Footnote CTDO bad. Pressure is 10-146db.
128-126	CTD Processor: "CTDO max ±0.05 ml/l compared to bottles, mirrors CTD salinity structure down/up CTDO differ, but fit quality uncertain: blends into shallower high CTDO section." Footnote CTDO questionable. Pressure is 180-250db.
125	Deck Log: "New baked spigot O-rings." Pressure is 285db.
120	O2 Analyst: "Lost oxygen sample." Footnote oxygen lost. Pressure is 598db.

118	Sample Log: "Leak at spigot before venting [air leak]." Pressure is 848db.
115	CTD Processor: "O2 +0.04 ml/l vs CTDO/down or up, Station 79; +0.02 vs Station 81." No analytical problems for bottle O2. Pressure is 1302db.
114	Salt Data: "3 tries to get reading." High value, inconsistent with t-s, CTD. Footnote salinity bad. Pressure is 1505db.
113	Deck Log: "New baked spigot O-rings." Pressure is 1709db.
112	CTD Processor: "O2 +0.04-5 ml/l vs CTDO/down or up, nearby casts." Pressure is 1908db.
110-109	Salt Log: "bottle 10 on autosal, rinsed cell, realized wrong bottle removed, replaced with 9, flushed put 10 bottle on too quickly; [bottles 9 and 10 analyses in correct order during run.]" Pressure is 2311-2516db.
107	Console Log: "No-confirm from pylon at first trip attempt, not reset; second trip confirm okay." Bottle trips appear to be correctly assigned. Pressure is 2919db.
106	Deck Log: "New baked spigot O-rings." Pressure is 3123db.
139	Console Log: "Reset pylon prior to this trip because so many odd trip confirms." Bottle trips appear to be correctly assigned. Pressure is 3433db.

Station 081

Cast 1	Console Log: "11 odd trip confirms: 1,3,5,6,10,15,18-20,22,34." Bottle trips appear to be correctly assigned.
134-129	CTD Processor: "Sacrificed surface CTDO fit to optimize deeper fit." Footnote CTDO bad. Pressure is 6-99db.
126-120	CTD Processor: "O2s ±0.05 ml/l vs CTDO/down - okay, down/up different, similar down-CTD/bottle salinity differences." No analytical problems for bottle O2. Pressure is 242-576db.
119	Oxy Data: "Flask 1023 with stopper 1309." Footnote oxygen bad. Pressure is 677db.
118	Oxy Data: "Flask 1309 with stopper 1023." Footnote oxygen bad. Pressure is 879db.
103	Salt Data: "3 tries to get reading. High value, inconsistent with t-s & CTD. Footnote salinity bad. Pressure is 3722db.
102	Footnote low salinity value, inconsistent with t-s & CTD. Bottle salinity is low compared with CTD. Footnote salinity questionable. Pressure is 3824db.

Station 082

Cast 1	Console Log: "Down to 30 m., up to surface, re-lower." Console Log: "7 odd trip confirms: btls 1,62,63,10,16,17,19." Bottle trips appear to be correctly assigned. Bottle numbering from shallow to deep, 36-9, 63, 7, 62, 5, 39, 3-1.
136-129	CTD Processor: "Sacrificed surface CTDO fit to optimize deeper fit." Footnote CTDO bad. Pressure is 15-206db.
119	Impossibly low oxygen value. Bad raw titer value. Footnote oxygen bad. Pressure is 862db.
114	Salt Log: "14, screwed up" Salt Data: "3 tries for reading." Pressure is 1723db.
114-111	Possible salinity drawing problem. Looks like 111-113 are really 112-114. No 111. All other properties are consistent. Pressure is 1723-2332db.
113	Console Log: "No-confirm from pylon at first trip attempt, not reset; second trip confirm odd. Bottle trips appear to be correctly assigned. Pressure is 1926db.
111	Salinity not drawn/run. See 114-111 salinity comments. Footnote salinity lost. Pressure is 2332db.
109	Console Log: "No-confirm from pylon at first trip attempt, not reset; second trip confirm odd." Bottle trips appear to be correctly assigned. Pressure is 2740db.

162 Console Log: "external spring GO bottle 62 replaces 6." Sample Log: "leaks like a sieve, no samples." Footnote samples were not drawn. Pressure is 3352db.

139 CTD Processor: "CTD conductivity values/differences okay after despiking (spike plus small offset just after trip)." Footnote CTD salinity despiked. Pressure is 3556db.

101 Salt Log: "Btl Salt Data: "Duplicate samples, 0.0004 psu diff." Pressure is 3889db.

Station 083

Cast 1 Console Log: "14 odd trip confirms: 3,39,5,62,7,63,9,10,13,14,16-18,36." Bottle trips appear to be correctly assigned.

136-128 CTD Processor: "Sacrificed surface CTDO fit to optimize deeper fit." Footnote CTDO bad. Pressure is 15-230db.

127-118 CTD Processor: "O2s -0.70 to +0.25 ml/l vs CTDO/down - okay, down/up very different, similar down-CTD/bottle salinity differences." No analytical problems for bottle O2. Pressure is 280-801db.

127-125 CTD Processor: "CTDO max ±0.70 ml/l compared to bottles, mirrors CTD salinity structure down/up CTDO differ, but fit quality uncertain: blends into shallower high CTDO section." Footnote CTDO questionable. Pressure is 280-380db.

162 Deck Log: "Increased spring tension before cast." Sample Log: "Test bottle. Bottom cap open; didn’t close." Footnote samples were not drawn. Pressure is 3274db.

Station 084

Cast 1 Deck Log: "No sensor freeze, warm enough for light rain" Console Log: "6 odd trip confirms: 1,3,39,6,63,20." Bottle trips appear to be correctly assigned. Bottle numbering from shallow to deep, 36-9, 63, 7-5, 39, 3-1. Sample Log: "O2 thermometer seems to give elevated readings occasionally; remeasurements were better."

136-120 CTD Processor: "Sacrificed surface CTDO fit to optimize deeper fit." Footnote CTDO bad. Pressure is 16-851db.

123-116 CTD Processor: "O2s ±0.05 ml/l vs CTDO/down - okay, down/up different, similar down-CTD/bottle salinity differences." No analytical problems for bottle O2. See 136-120 CTD Processor comment. Footnote CTDO bad. Pressure is 556-1257db.

121 CTD Processor: "O2 -0.03 ml/l vs CTDO/down, nearby casts not comparable." No analytical problems for bottle O2. Pressure is 736db.

118 CTD Processor: "O2 +0.03 ml/l vs CTDO/down, nearby casts not comparable." Sample log indicates a problem with the O2 draw therm reading high, but the draw temperature is not significantly different than surrounding ones. Pressure is 1056db.

107 Sample Log: "re-drawn, rain water dripped into 1st try." Looks okay on theta-O2 plot. CTD Processor: "O2 +0.02 ml/l vs CTDO/down, nearby casts." No analytical problems for bottle O2. Pressure is 2927db.

Station 085

Cast 1 Console Log: "3 odd trip confirms: 3,9,31." Bottle trips appear to be correctly assigned.

131-121 CTD Processor: "Sacrificed surface CTDO fit to optimize deeper fit." Footnote CTDO bad. Pressure is 15-300db.

111-110 Salt Log: "11 analyzed before 10." Bottle-CTD salt diffs okay. Pressure is 1082-1250db.

110 CTD Processor: "O2 +0.03 ml/l vs CTDO/down or up, nearby casts not comparable." No analytical problems for bottle O2. Pressure is 1250db.

103 CTD Processor: "O2 -0.03 ml/l vs CTDO/down - okay?, down/up different, sharper gradient on up CTDO 2900-2650db." No analytical problems for bottle O2. Pressure is 2777db.

Station 086

Cast 1	Console Log: "8 odd trip confirms: 1,3,39,6,14,18,30,33." Bottle trips appear to be correctly assigned.
132-126	CTD Processor: "Sacrificed surface CTDO fit to optimize deeper fit." Footnote CTDO bad. Pressure is 14-128db.
133	Sample Log: "Spigot is tight." Pressure is 14db.
125	Sample Log: "Spigot is tight." Pressure is 178db.
125-116	CTD Processor: "O2s ±0.05 ml/l vs CTDO/down - okay, down/up different, similar down-CTD/bottle salinity differences." No analytical problems for bottle O2. Pressure is 178-572db.
124	Salt data: "3 attempts." High value. Footnote salinity bad. Pressure is 202db.
123	Console Log: "No-confirm from pylon at first trip attempt, not reset; second trip confirm okay." Bottle trips appear to be correctly assigned. Pressure is 202db.
118	Sample Log: "Leaked before venting [top cap air leak]." bottle 17 and 18 at same depth, O2 values match. Pressure is 481db.
112-101	Sample Log: "Duplicate salts to check ASA Autosal." Pressure is 927-2582db.
106	Salt Log: "6 ?" Salt data: "3 attempts." Theta-S okay. Pressure is 1929db.
103	High value, inconsistent with t-s, CTD & replicates. Footnote salinity questionable. Pressure is 2501db.
101	Salt data: "3 attempts." High value. Footnote salinity bad. Pressure is 2582db.

Station 087

Cast 1	Console Log: "8 odd trip confirms: 2,3,7,63,9,15,18,20." Bottle trips appear to be correctly assigned. Salt/O2 okay versus CTD. Salt Log: "Ran std a 2nd time as reading very high". Bottle minus CTD salt differences okay.
136	Console Log: "tripped on the fly." Bad draw or bad run. Value way low." Footnote bottle and CTD oxygen questionable. Pressure is 14db.
136-130	CTD Processor: "Sacrificed surface CTDO fit to optimize deeper fit." Footnote CTDO bad. Pressure is 14-174db.
134	Salt Log: " Salt Data: "[sample] water level low, manual data entry" Bottle salt matches up-cast CTD. Pressure is 57db.
133	Sample Log: "Oxygen reagent dispenser above 1.0 ml." Theta-O2 okay. Pressure is 87db.
128-123	CTD Processor: "O2s ±0.05 ml/l vs CTDO/down - okay, down/up different, similar down-CTD/bottle salinity differences." No analytical problems for bottle O2. Pressure is 246-509db.
125	Deck Log: "New spigot O-rings (baked)." Pressure is 373db.

Station 088

Cast 1	Console Log: "Conductivity Sensor frozen to 40 m down." Console Log: "13 odd trip confirms: 1-3,5,9-14,19,21,36." Bottle trips appear to be correctly assigned. Salts and O2 look okay versus CTD.
135-129	CTD Processor: "Sacrificed surface CTDO fit to optimize deeper fit." Footnote CTDO bad. Pressure is 14-159db.
127-122	CTD Processor: "O2s ±0.05 ml/l vs CTDO/down - okay, down/up different, similar down-CTD/bottle salinity differences." No analytical problems for bottle O2. Pressure is 264-476db.
101	CTD Processor: "CTD hit bottom, conductivity/salinity at trip ok after despike." Footnote CTD salinity despiked.

Station 089

Cast 1	Console Log: "5 odd trip confirms: 1,3,6,10,14." Bottle trips appear to be correctly assigned. Salts and O2 look okay versus CTD Deck Log: "Bio-slime on rosette frame after cast." Console Log: "Large wire angle at cast bottom."
136	Console Log: "Bottle tripped on the fly." Theta-S and Theta-O2 look okay. Data are acceptable. Pressure is 15db.
136-133	CTD Processor: "Sacrificed surface CTDO fit to optimize deeper fit." Footnote CTDO bad. Pressure is 15-70db.
128	Salt Log: "reset back to 1?" Salt looks odd but matches up-cast Theta-S. Pressure is 214db.
124	Sample Log: "Salt cap dropped and rinsed." Okay on Theta-S. Pressure is 427db.
112	Console Log: "No-confirm from pylon at first trip attempt, not reset; second trip confirm okay." Bottle trips appear to be correctly assigned. Salt Log: "bad run" Salt data: "ME, low water." Okay on Theta-S. Pressure is 1854db.

Station 090

Cast 1	Console Log: "10 odd trip confirms: 2,39,5,6,9,11-14,36." Bottle trips appear to be correctly assigned. Salts/O2 okay versus CTD.
136-132	CTD Processor: "Sacrificed surface CTDO fit to optimize deeper fit." Footnote CTDO bad. Pressure is 16-85db.
129	Salt Log: "29 bad." Okay versus Theta-S and CTD. Salt data: "3 attempts." Okay versus Theta-S and CTD. CTD Processor: "CTDO max +0.30 ml/l compared to bottle, mirrors CTD salinity structure down/up CTDO differ, but fit quality uncertain: blends into shallower high CTDO section." Footnote CTDO questionable. Pressure is 175db.
128	Salt Log: "28 bad." Okay versus Theta-S and CTD. Pressure is 209db.
128-124	CTD Processor: "O2s ±0.10 ml/l vs CTDO/down - okay, down/up different, similar down-CTD/bottle salinity differences." No analytical problems for bottle O2. Pressure is 209-456db.
101	PO4 value seems too high, possible contamination. Ran sample twice, same value, not an analytical error. Footnote PO4 questionable. Pressure is 3855db.

Station 091

Cast 1	Console Log: "10 odd trip confirms: 1,39,5,6,63,9-12,22." Bottle trips appear to be correctly assigned. Salt & O2 okay versus CTD.
136-131	CTD Processor: "Sacrificed surface CTDO fit to optimize deeper fit." Footnote CTDO bad. Pressure is 15-129db.
130	Salt Data: "Manual entry, 31 on for second draw." Okay vs CTD. CTD Processor: "CTDO max +0.30 ml/l compared to bottle, mirrors CTD salinity structure down/up CTDO differ, but fit quality uncertain: blends into shallower high CTDO section." Footnote CTDO questionable. Pressure is 178db.
127-124	CTD Processor: "O2s ±0.05 ml/l vs CTDO/down - okay, down/up different, similar down-CTD/bottle salinity differences." No analytical problems for bottle O2, except 126 and 124. Pressure is 324-412db.
126	O2 high on Pressure versus O2. Footnote oxygen questionable.
124	Salt Log: "Bottle 24 cracked, ran sample anyway." Okay vs CTD. High value, inconsistent with t-o2, CTD. Footnote oxygen questionable. Pressure is 412db.
118	Sample Log: "Top endcap not seated." Salt & O2 okay versus CTD. Pressure is 1135db.

Station 092

Cast 1	Console Log: "8 odd trip confirms: 1,5,7,11,12,14,15,19." Bottle trips appear to be correctly assigned. Okay on Theta-S. Console Log: "CTD on 15-20 minutes before cast, ship moved to more opened water."
136-132	CTD Processor: "Sacrificed surface CTDO fit to optimize deeper fit." Footnote CTDO bad. Pressure is 16-107db.
131-128	CTD Processor: "CTDO max +0.10 ml/l compared to bottles, mirrors CTD salinity structure down/up CTDO differ, but fit quality uncertain: blends into shallower high CTDO section." Footnote CTDO questionable. Pressure is 148-242db.
127-121	CTD Processor: "O2s -0.05 to +0.13 ml/l vs CTDO/down - okay, down/up different, similar down-CTD/bottle salinity differences." No analytical problems for bottle O2.
124	Sample Log: "Oxygen got little less than 1ml NaOH/NaI." Okay on Theta-O2. Pressure is 484db.
119	Low value, inconsistent with t-o2 & CTD. Footnote oxygen questionable. Pressure is 981db.

Station 093

Cast 1	Console Log: "6 odd trip confirms: 2,39,9,10,14,22." Bottle trips appear to be correctly assigned. Bottles versus CTD look okay.
136-130	CTD Processor: "Sacrificed surface CTDO fit to optimize deeper fit." Footnote CTDO bad. Pressure is 15-206db.
136-135	Sample Log: "Sampled in reverse order by Freon/Helium." Pressure is 15-29db.
127-119	CTD Processor: "O2s ±0.03 ml/l vs CTDO/down - okay, down/up different, similar down-CTD/bottle salinity differences." No analytical problems for bottle O2. Pressure is 356-846db.
125	Salt data: "5 attempts, numbers climbing, water low." Bottle minus CTD difference slightly high, 0.0026 Footnote salinity questionable. Pressure is 430db.
118	Salt data: "Water low." Okay on Theta-S. Pressure is 943db.
114	Salt Log: "Air bubble" Salt data: "ME, bubbles in cell, water low." Okay on Theta-S. Pressure is 1717db.
112	Salt data: "3 attempts." Bottle salinity is high compared with CTD. Footnote salinity bad. Pressure is 2108db.
139	Sample Log: "Spigot loose." Bottle O2 looks okay. Salt data: "3 attempts." Bottle salinity is high compared with CTD. Footnote salinity bad. Pressure is 3924db.
102	CTD Processor: "-0.02 ml/l CTDO drop at 4212db/bottom slowdown; small-scale yoyos 4304-4310db cause +0.03 ml/l in CTDO." Footnote CTDO questionable. Pressure is 4289db.

Station 094

Cast 1	Salt Log: "[Air] temperature fluctuates during run." Bottle minus CTD salt differences typical. Console Log: "4 odd trip confirms: 1,3,63,11." Bottle trips appear to be correctly assigned. Okay on Theta-S.
136-133	CTD Processor: "Sacrificed surface CTDO fit to optimize deeper fit." Footnote CTDO bad. Pressure is 14-78db.
129	Sample Log: "slight leak [spigot] before venting." O2 looks okay. Pressure is 194db.
124	Sample Log: "leaks [at spigot] before venting." O2 looks okay. Pressure is 406db.
111	CTD Processor: "See CTD Conductivity note for bottle 102." Footnote CTD salinity despiked. Pressure is 2629db.

109	Bottle O2 looks high on Theta-O2. Footnote oxygen questionable. Bottle salinity is low compared with CTD. CTD Processor: "See CTD Conductivity note for bottle 102." Footnote CTD salinity despiked. Pressure is 3028db.
107	Bottle salinity is low compared with CTD. CTD Processor: "See CTD Conductivity note for bottle 102." Footnote CTD salinity despiked. Pressure is 3426db.
106	Bottle salinity is low compared with CTD. CTD Processor: "See CTD Conductivity note for bottle 102." Footnote CTD salinity despiked. Pressure is 3685db.
139	CTD Processor: "See CTD Conductivity note for bottle 102." Footnote CTD salinity despiked. Pressure is 4151db.
103	CTD Processor: "See CTD Conductivity note for bottle 102." Footnote CTD salinity despiked. Pressure is 4369db.
102	CTD Processor: "CTD conductivity values/differences okay after despiking (whole cast had major conductivity dropout/spiking problems; many bottle stops affected by spiking, most didn't show much change from before despiking)." Footnote CTD salinity despiked. Pressure is 4469db.
101	CTD Processor: "CTDO -0.03 ml/l below bottom slowdown compared to bottle O2 and rest of CTDO at bottom." Footnote CTDO questionable. Pressure is 4504db.

Station 095

Cast 1	Sample Log: "Filled oxygen reagents before sampling." Console Log: "3 odd trip confirms: 39,14,20." Bottle trips appear to be correctly assigned.
136-132	CTD Processor: "Sacrificed surface CTDO fit to optimize deeper fit." Footnote CTDO bad. Pressure is 16-117db.
131-128	CTD Processor: "O2s max. -0.50 ml/l vs CTDO/down - okay, down/up different, similar down-CTD/bottle salinity differences." No analytical problems for bottle O2. Pressure is 150-257db.
139	Salt data: "Low water." Theta-S okay. Pressure is 4169db.

Station 096

Cast 1	Console Log: "Winch not zeroed, 4 m deeper than readout." Console Log: "7 odd trip confirms: 1,2,5,6,10,12,22." Bottle trips appear to be correctly assigned.
136-131	CTD Processor: "Sacrificed surface CTDO fit to optimize deeper fit." Footnote CTDO bad. Pressure is 21-150db.
133	Salinity probably dup of 131. Bottle salinity is high compared with CTD. Footnote salinity questionable. Pressure is 80db.
130-120	CTD Processor: "O2s ±0.05 ml/l vs CTDO/down (bottle 126 is -0.22 ml/l) - okay, down/up different, similar down-CTD/bottle salinity differences." No analytical problems for bottle O2. Pressure is 180-812db.

Station 097

Cast 1	Console Log: "7 odd trip confirms: 3,5,6,63,10,11,13." Bottle trips appear to be correctly assigned. Console Log: "Transmissometer fouled 1300db down-cast to 4250db up-cast" PI: "possibly a real feature."
136-131	CTD Processor: "Sacrificed surface CTDO fit to optimize deeper fit." Footnote CTDO bad. Pressure is 15-160db.
130-124	CTD Processor: "O2s ±0.10 ml/l vs CTDO/down - okay, down/up different, similar down-CTD/bottle salinity differences." No analytical problems for bottle O2. Pressure is 212-458db.
111	Salts were apparently drawn/run from the next adjacent lower bottle and bottle 11 was not drawn. After correction, salts overlay CTD Theta-S. Not drawn/run. Footnote salinity lost. Pressure is 2582db.

105	Looks high, not in line with other O2's on theta-O2 plot. Bottle salinity is high compared with CTD. Within the precision of the measurement, salinity is acceptable. Footnote oxygen questionable. Pressure is 3787db.

Station 098

Cast 1	Console Log: "12 odd trip confirms: 1-3,39,5,7,9-11,13,14,18." Bottle trips appear to be correctly assigned.
136-132	CTD Processor: "Sacrificed surface CTDO fit to optimize deeper fit." Footnote CTDO bad. Pressure is 15-106db.
131-122	CTD Processor: "O2s ±0.10 ml/l vs CTDO/down - okay, down/up different, similar down-CTD/bottle salinity differences." No analytical problems for bottle O2. Pressure is 135-609db.
111	Salt data: "Low water level." Theta-S okay. Pressure is 2584db.
106-105	CTD Processor: "See CTD Conductivity note for bottles 103-101." Footnote CTD salinity despiked.
139	CTD Processor: "See CTD Conductivity note for bottles 103-101." Footnote CTD salinity despiked.
103-101	CTD Processor: "CTD conductivity values/differences okay after despiking (small offset to up-cast from bottom to 3520db - affected first 6 bottles) Footnote CTD salinity despiked.
101	Oxy Data: "Computer problem, sample lost." See 102-101 CTD comments. Footnote CTD salinity despiked, and bottle oxygen lost. Pressure is 4332db.

Station 099

Cast 1	Console Log: "5 odd trip confirms: 1,5,9,17,23." Bottle trips appear to be correctly assigned. Deck Log: "Cleaned Transmissometer windows before cast."
136-131	CTD Processor: "Sacrificed surface CTDO fit to optimize deeper fit." Footnote CTDO bad. Pressure is 16-126db.
131	High salt gradient Pressure is 126db.
115	Salt Log: "1 strange reading" Averages look okay. Theta-S okay. Pressure is 1823db.
107	Deck Log: "New baked spigot O-rings." Pressure is 3454db.
101	CTD Processor: "CTDO -0.02 ml/l below bottom slowdown vs nearby CTDO casts, odd on theta-CTDO problem caused by slowdown and likely not real." Footnote CTDO questionable. Pressure is 4339db.

Station 100

Cast 1	Console Log: "3 odd trip confirms: 1,39,11." Bottle trips appear to be correctly assigned. Console Log: "Some wire angle" Deck Log: "Stray chunks of ice during launch."
136	Console Log: "Bottle tripped on the fly." Small surface mixed layer, O2 and salt may not be good for calibration. But O2 and salt agree with surrounding stations. Data are acceptable. See 136-130 CTD Processor comment. Footnote CTDO bad. Pressure is 14db.
136-130	CTD Processor: "Sacrificed surface CTDO fit to optimize deeper fit." Footnote CTDO bad. Pressure is 14-143db.
129-117	CTD Processor: "O2s ±0.07 ml/l vs CTDO/down - okay, down/up different, similar down-CTD/bottle salinity differences." No analytical problems for bottle O2. Pressure is 179-1207db.
113	Salt Log: "[op.error] - aborted at bottle 13, restarted, repeated standard before reading 13; Restarted program." Theta-S okay. Pressure is 2020db.
112	Deck Log: "New baked spigot O-rings." Pressure is 2213db.

101	Salt Log: "New salt bottle, 1, (old ,1, broke sampling)." Theta-S okay. CTD Processor: "CTDO max +0.03-4 ml/l compared to bottle at bottom of cast." Footnote CTDO questionable. Pressure is 4137db.

Station 101

Cast 1	Deck Log: "Replaced FSI OTM 1322 with OTM 1321." Console Log: "10 odd trip confirms: 1-3,39,6,63,10-13." Bottle trips appear to be correctly assigned.
133-130	Footnote CTDO bad. Pressure is 14-84db.
129-117	CTD Processor: "O2s ±0.03 ml/l vs CTDO/down - okay, down/up different, similar down-CTD/bottle salinity differences." No analytical problems for bottle O2. Pressure is 108-882db.
111	Oxy Data: "Flask 1164 with 641 stopper." Footnote oxygen bad. Pressure is 1953db.
110	Oxy Data: "Flask 641 with 1164 stopper." Footnote oxygen bad. Pressure is 2152db.
109	Salt Data: "ME, water level low." Theta-S okay. Pressure is 2352db.

Station 102

Cast 1	Deck Log: "Rosette swung a lot during recovery." Console Log: "Transmissometer bad readings P > 2450 down cast" Console Log: "6 odd trip confirms: 1,2,6,63,10,36." Bottle trips appear to be correctly assigned.
136-132	CTD Processor: "Sacrificed surface CTDO fit to optimize deeper fit." Footnote CTDO bad. Pressure is 12-82db.
131	CTD Processor: "CTDO compares well to bottles, but looks artificially low in between; should mirror CTD salinity shape better, like time-series does." Footnote CTDO questionable. Pressure is 103db.
130	Sample Log: "air vent not closed." Theta-O2 looks okay . Pressure is 133db.
109	Salt Data: "4 attempts." Bottle salinity is high compared with CTD. Footnote salinity bad. Pressure is 2737db.
105	CTD Processor: "O2 +0.05 ml/l vs CTDO/down or up, nearby casts." No analytical problems for bottle O2. Pressure is 3546db.
101	High value, inconsistent with t-o2 and CTD. Footnote oxygen questionable. Pressure is 4001db.

Station 103

Cast 1	Deck Log: "Replaced FSI OTM 1321 with OPM 1326." Console Log: "7 odd trip confirms: 1-3,39,5-7 (first 7 trips)." Bottle trips appear to be correctly assigned.
136-131	CTD Processor: "Sacrificed surface CTDO fit to optimize deeper fit." Footnote CTDO bad. Pressure is 15-126db.
133	Salt Log: "Bottle 33 broken before analysis." See 136-131 CTDO comment. Footnote CTDO bad and salinity lost. Pressure is 86db.
130-128	CTD Processor: "CTDO max -0.05 ml/l compared to bottles, somewhat mirrors CTD salinity structure down/up CTDO differ, but fit quality uncertain: blends into shallower high CTDO section." Footnote CTDO questionable. Pressure is 141-204db.
127-122	CTD Processor: "O2s ±0.06 ml/l vs CTDO/down - okay, down/up different, similar down-CTD/bottle salinity differences." No analytical problems for bottle O2. Pressure is 256-574db.
109	CTD Processor: "O2 +0.06 ml/l vs CTDO/down or up, nearby casts." No analytical problems for bottle O2. Pressure is 2803db.

Station 104

136-130	CTD Processor: "Sacrificed surface CTDO fit to optimize deeper fit." Footnote CTDO bad. Pressure is 15-180db.
134	Oxy Data: "Inferred draw temperature from other samples." Pressure is 54db.
130	Sample Log: "Tight air vent." Pressure is 180db.
129-121	CTD Processor: "O2s ±0.03 ml/l vs CTDO/down - okay, down/up different, similar down-CTD/bottle salinity differences." No analytical problems for bottle O2. Pressure is 230-707db.
102-101	Console Log: "2 odd trip confirms: 1,2 (first 2 trips)." Bottle trips appear to be correctly assigned. Pressure is 4182-4233db.

Station 105

Cast 1	Console Log: "7 odd trip confirms: 1,3,7,11,14,15,24." Bottle trips appear to be correctly assigned.
136-132	CTD Processor: "Sacrificed surface CTDO fit to optimize deeper fit." Footnote CTDO bad. Pressure is 16-87db.
131-120	CTD Processor: "O2s ±0.03 ml/l vs CTDO/down - okay, down/up different, similar down-CTD/bottle salinity differences." No analytical problems for bottle O2. Pressure is 116-808db.
130	Deck Log: "New air vent, used same O-ring." Pressure is 147db.
122	Oxy data: "OT due to analyst error; Theta-o2 okay." CTD Processor: "+0.04 ml/l vs CTDO/down or up, +0.02 ml/l vs nearby casts." O2 noisy point, low EP. Footnote O2 bad. Pressure is 557db.
118	Oxy data: "Possible mis-trip." Theta-O2 and Theta-S look okay. Pressure is 1115db.
115	Sample Log: "Draw temperature taken after sampling." Pressure is 1721db.
111	O2 high compared to CTD on Theta-O2. Footnote oxygen questionable. Pressure is 2528db.

Station 106

Cast 1	Console Log: "Reset deck unit @ 150 m. down." Console Log: "4 odd trip confirms: 3,5,9,10." Bottle trips appear to be correctly assigned.
136	Salt Log: "Removed bottle too soon" Salt Data: "Removed bottle early, values climbing." Theta-S looks okay. Pressure is 14db.
136-132	CTD Processor: "Sacrificed surface CTDO fit to optimize deeper fit." Footnote CTDO bad. Pressure is 14-129db.
125	Salt Data: "3 attempts, value bad?, kept climbing." High CTD-bottle salt diff, bottle salt high. Footnote salinity bad. Pressure is 386db.
122	CTD Processor: "O2 +0.05 ml/l vs CTDO/down or up, nearby casts." No analytical problems for bottle O2. Pressure is 607db.
107	CTD Processor: "O2 +0.03 ml/l vs CTDO/down or up, nearby casts." No analytical problems for bottle O2. Pressure is 3450db.

Station 107

Cast 1	Deck Log: "Replaced FSI OPM 1326 with OTM 1320." Console Log: "6 odd trip confirms: 2,5,9,14,16,18." Bottle trips appear to be correctly assigned. Excessive drift. Corrected. salts for stas 106,107,108 compare well.
136-133	CTD Processor: "Sacrificed surface CTDO fit to optimize deeper fit." Footnote CTDO bad. Pressure is 15-109db.
132-121	CTD Processor: "O2s ±0.03 ml/l vs CTDO/down - okay, down/up different, similar down-CTD/bottle salinity differences." No analytical problems for bottle O2. Pressure is 155-810db.

115-114	Salt Log: "switched 14/15" Salt Data: "15 analyzed before 14." Theta-S looks okay. Pressure is 2069-1867db.
163	Salinity high, inconsistent with t-s, CTD. Footnote salinity questionable. Pressure is 3295db.
139	Salinity high, inconsistent with t-s, CTD. Bottle salinity is high compared with CTD. Footnote salinity questionable. Pressure is 4065db.
102	Salinity high, inconsistent with t-s, CTD. Bottle salinity is high compared with CTD. Footnote salinity questionable. Pressure is 4229db.
101	Salinity high, inconsistent with t-s, CTD. Bottle salinity is high compared with CTD. Footnote salinity questionable. Pressure is 4271db.

Station 108

Cast 1	Salt Log: "Algae in most salt bottles (box O). Need cleaned." Salt Data: "4 attempts for end Wormley." Station 107 and 108 salts match well. Console Log: "Last S4I station." Console Log: "4 odd trip confirms: 1,5,6,15." Bottle trips appear to be correctly assigned.
136-130	CTD Processor: "Sacrificed surface CTDO fit to optimize deeper fit." Footnote CTDO bad. Pressure is 17-132db.
112	Console Log: "No-confirm from pylon at first trip attempt, not reset; second trip confirm okay." Bottle trips appear to be correctly assigned. Bottle salinity is high compared with CTD. Pressure is 2323db.
102	Sample Log: "Bottom end cap not seated." theta-O2 looks okay. Salinity low value, inconsistent with t-s, CTD. Bottle salinity is low compared with CTD. Footnote salinity questionable. Pressure is 4162db.

WHPO-SIO Data Processing Notes

Date	Contact	Data Type	Data Status Summary
01/23/98	Rutz	BTL/CTD	Data are NonPublic
01/23/98	Whitworth	SUM/BTL	Submitted
07/29/98	Johnson	DOC	S04I is next on ODF CTD report agenda
05/05/99	Swift	Cruise ID	Confirming Whitworth as Chi. Sci.
	Regarding S4I, Nowlin had foot surgery shortly before the cruise and cancelled. All my interactions since have been with Tom Whitworth. So, yes, he is Chief Scientist and chief contact for the R/V Palmer S4I cruise. Jim		
03/24/00	Schlosser	He/Tr	Data are Public
	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.		
05/05/00	Key	DELC14	Data are NonPublic
	Thank you for the notice regarding S4I C14 and the new CD-ROM. The proprietary period for this data (2 years after measurement) ends 2/16/2001 or later (I'm not sure that the measurements for this cruise are even finished). I do not want these data made public yet.		
05/09/00	Whitworth	CTD/BTL	Data are Public
	The 1996 Palmer S4I data may be made public. I am almost certain that my co-Chief Scientist will agree.		
06/08/00	Bartolacci	CTD/BTL/CFCs	Website Updated data unencrypted
09/13/00	Kozyr	CO2	Final Data Submitted
	TCARBN, ALKALI, PCO2, PCO2TMP I have just put the final and public CO2-related data for the WOCE Section S4I (EXPOCODE 320696_2) in your INCOMING ftp area. The data consist of TCARBN, ALKALI, PCO2, PCO2TMP, and quality flags. The data were submitted to CDIAC by Taro Takahashi of LDEO and Frank Millero of RSMAS.		
06/20/01	Johnson	CTD	Data Update; Processing error corrected
	revised data available by ftp ODF has discovered a small error in the algorithm used to convert ITS90 temperature calibration data to IPTS68. This error affects reported Mark III CTD temperature data for most cruises that occurred in 1992-1999. A complete list of affected data sets appears below. ODF temperature calibrations are reported on the ITS90 temperature scale. ODF internally maintains these calibrations for CTD data processing on the IPTS68 scale. The error involved converting ITS90 calibrations to IPTS68. The amount of error is close to linear with temperature: approximately -0.00024 degC/degC, with a -0.00036 degC offset at 0 degC. Previously reported data were low by 0.00756 degC at 30 degC, decreasing to 0.00036 degC low at 0 degC. Data reported as ITS90 were also affected by a similar amount. CTD conductivity calibrations have been recalculated to account for the temperature change.		

06/20/01	Johnson	CTD	Data Update; Processing error corrected (continued)

Reported CTD salinity and oxygen data were not significantly affected.

Revised final data sets have been prepared and will be available soon from ODF (ftp://odf.ucsd.edu/pub/HydroData). The data will eventually be updated on the whpo.ucsd.edu website as well. IPTS68 temperatures are reported for PCM11 and Antarktis X/5, as originally submitted to their chief scientists. ITS90 temperatures are reported for all other cruises.

Changes in the final data vs. previous release (other than temperature and negligible differences in salinity/oxygen):

S04P: 694/03 CTD data were not reported, but CTD values were reported with the bottle data. No conductivity correction was applied to these values in the original .sea file. This release uses the same conductivity correction as the two nearest casts to correct salinity.

AO94: Eight CTD casts were fit for ctdoxy (previously uncalibrated) and resubmitted to the P.I. since the original release. The WHP- format bottle file was not regenerated. The CTDOXY for the following stations should be significantly different than the original .sea file values:

009/01	026/04
013/02	033/01
017/01	036/01
018/01	036/02

I09N: The 243/01 original CTD data file was not rewritten after updating the ctdoxy fit. This release uses the correct ctdoxy data for the .ctd file. The original .sea file was written after the update occurred, so the ctdoxy values reported with bottle data should be minimally different.

DATA SETS AFFECTED:

WOCE Final Data - NEW RELEASE AVAILABLE:

WOCE Section ID	***P.I.***	***Cruise Dates***
S04P	(Koshlyakov/Richman)	Feb.-Apr. 1992
P14C	(Roemmich)	Sept. 1992
PCM11	(Rudnick)	Sept. 1992
P16A/P17A (JUNO1)	(Reid)	Oct.-Nov. 1992
P17E/P19S (JUNO2)	(Swift)	Dec. 1992 - Jan. 1993
P19C	(Talley)	Feb.-Apr. 1993
P17N	(Musgrave)	May-June 1993
P14N	(Roden)	July-Aug. 1993
P31	(Roemmich)	Jan.-Feb. 1994
A15/AR15	(Smethie)	Apr.-May 1994
I09N	(Gordon)	Jan.-Mar. 1995
I08N/I05E	(Talley)	Mar.-Apr. 1995
I03	(Nowlin)	Apr.-June 1995
I04/I05W/I07C	(Toole)	June-July 1995
I07N	(Olson)	July-Aug. 1995
I10	(Bray/Sprintall)	Nov. 1995
ICM03	(Whitworth)	Jan.-Feb. 1997

06/20/01	Johnson	CTD	Data Update; Processing error corrected (continued)	

non-WOCE Final Data - NEW RELEASE AVAILABLE:

Cruise Name	***P.I.***	***Cruise Dates***
Antarktis X/5	(Peterson)	Aug.-Sept. 1992
Arctic Ocean 94	(Swift)	July-Sept. 1994

Preliminary Data - WILL BE CORRECTED FOR FINAL RELEASE ONLY

NOT YET AVAILABLE:

Cruise Name	***P.I.***	***Cruise Dates***
WOCE-S04I	(Whitworth)	May-July 1996
Arctic Ocean 97	(Swift)	Sept.-Oct. 1997
HNRO7	(Talley)	June-July 1999
KH36	(Talley)	July-Sept. 1999

"Final" Data from cruise dates prior to 1992, or cruises which did not use NBIS CTDs, are NOT AFFECTED.

Post-1991 Preliminary Data NOT AFFECTED:

Cruise Name	***P.I.***	***Cruise Dates***
Arctic Ocean 96	(Swift)	July-Sept. 1996
WOCE-A24 (ACCE)	(Talley)	May-July 1997
XP99	(Talley)	Aug.-Sept. 1999
KH38	(Talley)	Feb.-Mar. 2000
XP00	(Talley)	June-July 2000

09/13/00	Kozyr	CO2	Final Data submitted	

I have just put thefinal and public CO2-related data for the WOCE Section S4I (EXPOCODE 320696_2) in your INCOMING ftp area. The data consist of TCARBN, ALKALI, PCO2, PCO2TMP, and quality flags. The data were submitted to CDIAC by Taro Takahashi of LDEO and Frank Millero of RSMAS.

12/11/00	Uribe	DOC	Submitted	

2000.12.11 KJU

File contained here is a CRUISE SUMMARY and NOT sumfile. Documentation is online.

2000.10.11 KJU

Files were found in incoming directory under whp_reports. This directory was zipped, files were separated and placed under proper cruise. All of them are sum files. Received 1997 August 15th.

06/21/01	Uribe	CTD/BTL	EXCHANGE File put online.	
10/02/01	Diggs	SUM	Data Update	SUM file format corrected

At Mary Johnson's request I have corrected line 23-24 (Cast 1, Station 1 EN) which needed a formatting correction. That line needed a line feed and an expocode. Old file moved to original and all documentation updated.

10/12/01	Key	C14, C13	Submitted; reformatting needed	

To save time the S4I file is attached. I included c13 as well as c14. Note that my software isn't aware of the "official" number of decimal places. If too many are listed the values can be rounded, if too few just add the appropriate number of "0"'s.

Date	Contact	Data Type	Data Status Summary
12/11/01	Key	DELC14	DQE Report Submitted to WHPO
12/26/01	Uribe	CTD	Website Updated, EXCHANGE File Added
	CTD has been converted to exchange using the new code and put online.		
01/03/02	Hajrasuliha	CTD	Internal DQE completed
	created .ps files. created *check.txt files.		
04/01/02	Buck	DELC13	Data moved from incoming
	Moved data from: /usr/export/html-public/cgi/SUBMIT/INCOMING/20020401.102545_GERLACH_SO4I to: /usr/export/html-public/data/onetime/southern/s04/s04I/original/20020401.102545_GERLACH_SO4I. Directory contains a readme file from teh data submission page and a data file with delc13.		
04/12/02	Buck	C14	Data moved from incoming; Header added
	Moved S4I.C14 data from /usr/export/ftp-incoming to s04/s04i/original/20020410_KEY_S4I_C14. Data is a EXCHANGE file and contains C14 data. Added this line to header # S04I, 320696_3, Key		
05/08/02	Anderson	C14/C13/CO2/He	Website Updated, Data merged into online file
	helium, delhe3, delc14, delc13, tcarbn, alkali, pco2, delher, c14err Merged DELC13, TCARBN, ALKALI, DELC14, C14ERR, PC02, HELIUM, DELHE3, and DELHER into the .sea file and put online. Merged DELC14 and C14ERR from S4I.C14 found in web site: ...southern/s04/s04i/original/20002010_KEY_S4I_C14 into the online file. Merged DELC13 from 20020401.102545_GERLACH_S04I_whpo_s04i.txt found in web site: ...southern/s04/s04i/original/20020401.102545_GERLACH_S04I into the online file. Merged TCARBN, ALKALI, and PCO2 from s4icarb.txt found in web site: ...southern/s04/s04i/original/2000.09.13_S4I_CARB_BARTOLACCI into the online file. NOTE: Except for the above merged data the designation for missing values is -9 there is no decimal or decimal places. Merged HELIUM, DELHE3, and DELHER. Received data from Bob Newton on April 30, 2002. file in: .../southern/s04/s04i/20020430_S04I_HELIUM_BNEWTON Some of the DELHE3 values are very strange ie 9367.3822, but they are flagged as 4 There was no tritium in this file.		

Date	Contact	Data Type	Data Status Summary
05/09/02	Anderson	DELHE3	Update Needed; Some values out of range

Bob,

I have been merging the helium data you sent in April and have a question. In some cases the delhe3 values are very out of line with the rest of the data. Granted they are flagged 4, but since they exceed in both directions the range listed in the WOCE manual, our programs choke on them. What should we do with these samples (see sta. 2, samp. 34, 25, 24, 22, and 20)?

Also, occasionally (see sta. 40, samp. 7) there is a delher value when there is no delhe3 value. What should be done with these?

Date	Contact	Data Type	Data Status Summary
05/09/02	Newton	DELHE3	Answer to Sarilee's query

These far-out-of-range values are typically from samples where something has gone drastically wrong in the extraction process (loss of vacuum, cracked ampule, etc.). I've reported them as "4" rather than "5" just in case you guys wanted to keep track of where samples were taken; and where they were not. But since, for reasons such as those cited above, we were not able to make a legitimate measurement, I don't see any problem in changing their status to "5" (no value reported) and changing the measurement values to "-999".

Peter: does that seem right to you?

Where there is no delhe3 value reported, the delhe3_err value should be "-999".

Date	Contact	Data Type	Data Status Summary
05/09/02	Anderson	DELHE3/DELHER	Website Updated

Reformatted data online, new exchange file online. Made some changes to the DELHE3 and DELHER re Bob Newton's response to my e-mail.

Made new exchange file.

Date	Contact	Data Type	Data Status Summary
12/10/02	Kappa	DOC	cruise report updated

Added:

- Discussion and table of ALACE deployments
- Discussion and table of current meter deployments
- Section on underway measurements including
  - Navigation and Bathymetry
  - Meteorological Observations
  - Adcp
  - Atmospheric Chemistry
    - CO2 Analysis
    - CFC Analysis
  - Thermosalinograph and underway pCO2
    - Underway pCO2
- Section on Hydrographic Measurements including
  - Water Sampling Package (Rosette and CTD)
  - CTD Measurements
    - CTD Data Processing
  - Bottle Measurements
    - Bottle Data Processing
  - Salinity Analysis
  - Oxygen Analysis
  - Nutrient Analysis

12/10/02	Kappa	DOC	cruise report updated (continued)

Chloroflourocarbon Analysis
- Sample collection
- Sample analysis
- Calibration
- Preliminary results
- CFC intercomparison samples

Helium, Tritium and 18O Sampling
Radiocarbon Sampling
CO2 Sampling and Analysis
- Sampling
- Total CO2 analysis
- pCO2 analysis

Total Alkalinity
Current meter deployments
References
Final Report for S04I AMS 14C Samples
These Data Processing Notes

02/11/03	Diggs	He/Tr	Data Ready to be Merged

(Same as A24 he/tr data)
Data files (xls and csv) were sent to ODF email account. Once found, these data were place in the holding directory under 20020522_S04I_HE-TR_NEWTON and are ready to merge into the bottle

03/12/03	Muus	DELC13	Data online corrected

Decimal-1 data replaced with decimal-2 data
Replaced DELC13 decimal-1-data with decimal-2-data from same original data files.

Notes on S04I Mar 12, 2003 D. Muus

1. Replaced 1-decimal-place DELC13 in s04ihy.txt (20020509WHPOSIOSA) with 2-decimal-place DELC13 from: /usr/export/html-public/data/onetime/southern/s04/s04i/original20020401.102545_GERLACH_SO4I/20020401.102545_GERLACH_SO4I_whpo_so4i.txt
2. Both QUALT1 and QUALT2 set to QF value given in original data file.
3. Replaced all "1"s in QUALT2 with QUALT1 flags. Checked that non-1 values in QUALT2 are equal to the corresponding QUALT1 flags in the original bottle file. Only dicrepancy was Station 2, Cast 2, Sample 24 where original DELHE3 QUALT1 flag was 5 whereas original QUALT2 flag was 9. Changed new bottle file to correspond with with original.
4. Made new exchange file for Bottle data.
5. Checked new bottle file with Java Ocean Atlas.

Date	Contact	Data Type	Data Status Summary
08/28/03	Anderson	CTD/BTL/SUM	Merged final data files into online hyd file

S04I event log by Sarilee Anderson (132.239.114.244 / xebec.ucsd.edu)

Expocode: 320696_3

SUM, CTD, Bottle: (ctdprs, ctdtmp, ctdsal, ctdoxy, theta, salnty, oxygen, silcat, nitrat, nitrit, phspht, cfc-11, cfc-12, helium, delhe3, delc14, delc13, tcarbn, alkali, pco2, delher, c14err, qualt1, qualt2)

ODF submitted final data files for the bottle, ctd, and .sum data.

- I merged values and QUALT flags from the online file into the new final bottle file.
- Made new exchange and netcdf files.
- Put all files online and sent notes to Jerry.

Notes on the s04i remerge: Aug. 27, 2003

- Copied the QUALT1 flags to the QUALT2 flags in the ODF final data file 320696_3.sea found in s04/s04i/original/ODF_FINAL_2003_S04I/s4ihyd.
- Merged CFC-11, CFC-12, HELIUMN, DELHE3, DELHER, DELC14, 14ERR, DELC13, TACRBN, ALKALI, and PCO2 and their corresponding QUALT1 and QUALT2 flags from the online file 20030312WHPOSIODM into the ODF final data file 320696_3.sea.
- I did not merge REVPRS and REVTMP because the values were all -9.0.
- Checked the .sum file and made some minor column adjustments.
- The ctd files (s4ictd.zip) found in the ODF_FINAL_2003_S04I directory were formatted correctly, renamed them from 00101.ctd to s04i0001.wct, ect., and made a new zip file, s04ict.zip.

Date	Contact	Data Type	Data Status Summary
09/02/03	Kappa	DOC	Cruise Documentation Updated

Added ODF "Final Cruise Report"
Expanded these Data Processing Notes