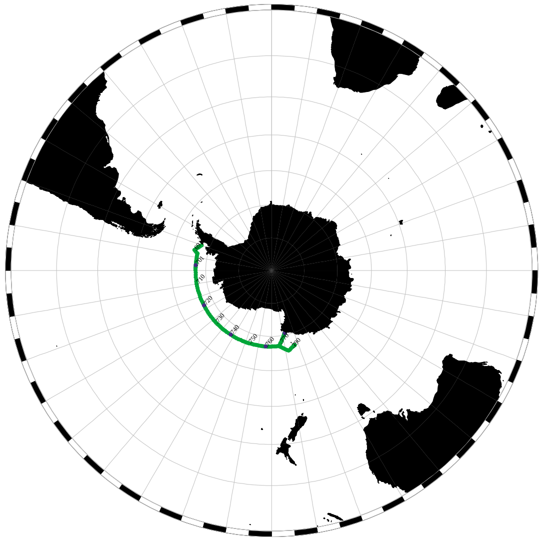
CRUISE REPORT - WOCE S04P

(Updated 2005.AUG.01)

HIGHLIGHTS



WHP Cruise Summary Information

WOCE section designation	**S04P**
Expedition designation (EXPOCODE)	**90KDIOFFE6_1**
Chief Scientists and their affiliations	**Mikhail H. Koshlyakov / Shirshov IO*** **James G. Richman / OSU****
Dates	1992.02.14 - 1992.04.06
Ship	R/V Akademik Ioffe
Ports of call	Montevideo, Uruguay; Wellington, New Zeland
Number of stations	113 CTD / rosette stations
Geographic boundaries of the stations	65° 19.12' S 70° 5.17' W 162° 39.91' E 70° 38.92' S
Floats and drifters deployed	none
Moorings deployed or recovered	none
Contributing Authors:	Marie-Claude Beaupré ODF/SIO J.C. Jennings Robert M. Key Eugene Morozov Peter Schlosser

Chief Scientist Contact Information

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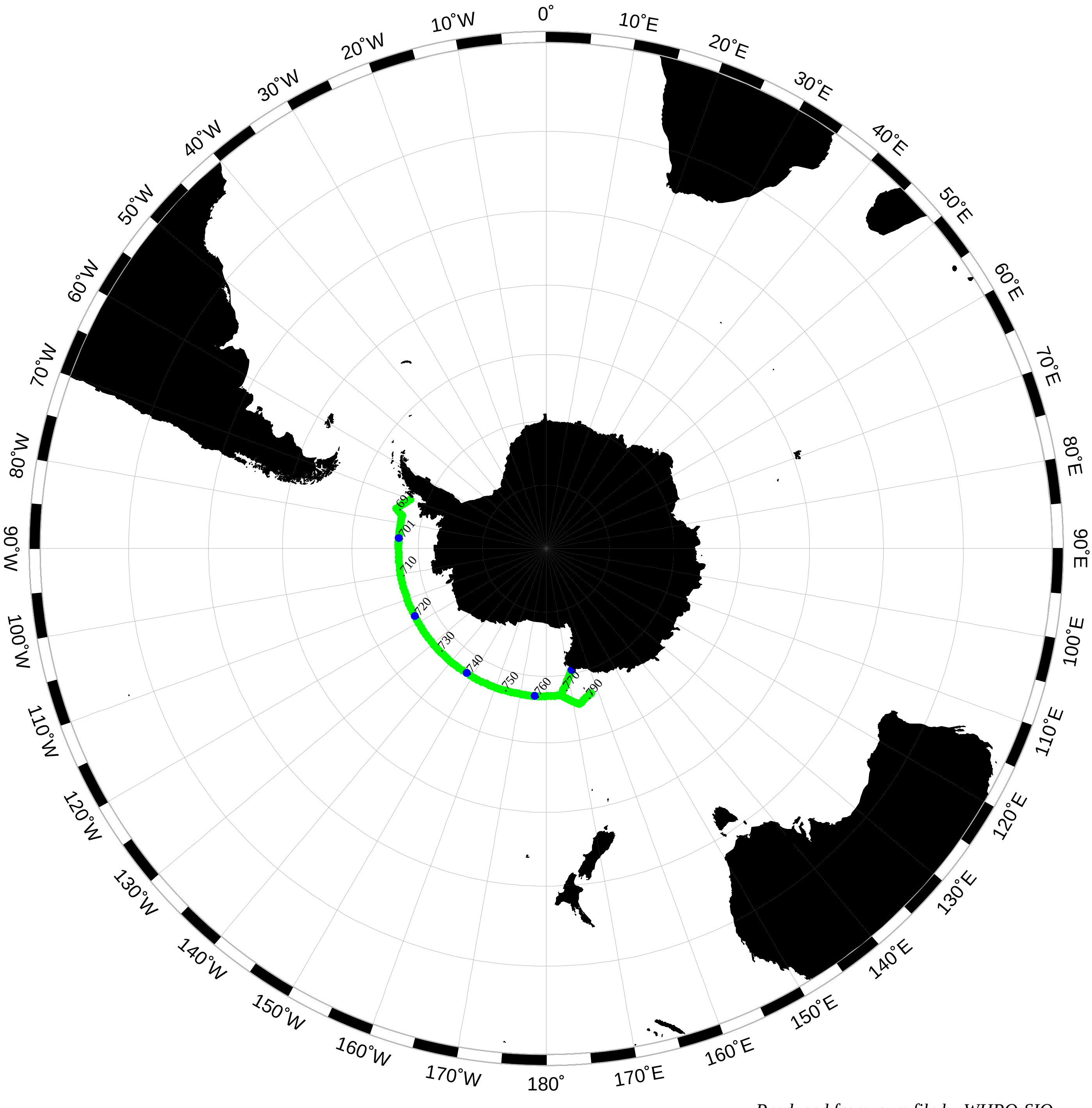
WHP Cruise and Data Information

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

Cruise Summary Information	**Hydrographic Measurements**
Description of scientific program	CTD - general
	CTD - pressure
Geographic boundaries of the survey	CTD - temperature
Cruise track (figure)	CTD - conductivity/salinity
Description of stations	CTD - dissolved oxygen
Description of parameters sampled	
Bottle depth distributions (figure)	Salinity
Floats and drifters deployed	Oxygen
Moorings deployed or recovered	Nutrients
	CFCs (report pending)
Principal Investigators for all measurements	Helium (report pending)
Cruise Participants	Tritium (report pending)
	Radiocarbon
Problems and goals not achieved	
Other incidents of note	
Underway Data Information	**References:** HYD/CTD 14C
Bathymetry	
Acoustic Doppler Current Profiler (ADCP)	**DQE Reports**
Thermosalinograph and related measurements	
XBT and/or XCTD	CTD
Meteorological observations	S/O_2/nutrients
Atmospheric chemistry da	CFCs (report pending)
	Data Processing Notes

Station locations for S04P • Koshlyakov • Richman • 1992 • R/V Akademik Ioffe



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CRUISE SUMMARY

Cruise track

The cruise track included WHP stations beginning on the continental shelf of the Antarctic Peninsula at 67° 28S 71° 5W on 22 February, 1992, continuing west along ca. 67°S (S04P Pacific) at nominally 30 nautical mile intervals. The first ten stations were made along a northwesterly line approximately perpendicular to the continental slope with stations over the shelf break and slope located on isobaths separated by approximately 800 m. Over the Bellingshausen Abyssal Plain between 91°34W and 130°41W and over the Amundsen Abyssal Plain between 142°11W and 157°41W, the station spacing was increased to nominally 40 nautical miles. At 174°15E, the track was turned southwestward to run perpendicular to the Antarctic continental shelf. The section was completed with a station in 200 m of water off Cap Daemon at 70°39S 168°04E. The section was restarted with a repeat station at 67°S 174°15E and continued east-northeast to end in 400 m of water off Young Island of the Balleny Islands at 66°25S 162°41E. The last station will be the eastern terminus for the continuation of WHP line S04P into the Indian Ocean.

Stations occupied

There were 113 CTD/rosette stations, in all but one case each close to the bottom. No large volume casts were made. There were 3 surface samples for Ge isotopes and one complete profile with 24 samples.

Floats and drifters deployed

No floats nor surface drifters were deployed.

Moorings deployed or recovered

No moorings were deployed or recovered.

List of Principal Investigators

Name	Measurement responsibility	Institution or affiliation
Berezutski & J. Richman	ADCP	Shirshov Inst .& OSU
Berezutski	MultiBeam Bathymetry	Shirshov Inst.
Bullister	CFCs	PMEL
Rau	carbon isotopes	NASA Ames Res Center
Schlosser	AMS ^{14}C	LDGO
Schlosser	helium, tritium	LDGO
Schlosser	^{18}O	LDGO
Swift	CTD/O_2/nutrients	SIO
Takahashi & D. Chipman	TCO_2, pCO_2	LDGO
Voronina	Biological sampling	Shirshov Inst.

SCIENTIFIC PROGRAM

Narrative

The R/V Akademik Ioffe Cruise 6 (WHP line S04P Pacific) left Montevideo, Uruguay on 14 February, 1992 and ended in Wellington, New Zealand on 6 April, 1992. The chief Scientists were Mikhail H. Koshlyakov (Shirshov Institute of Oceanology) and James G. Richman (Oregon State University). The purpose of this cruise was to determine the strength and extent of the cyclonic circulation in the Pacific Ocean south of the Polar Front as part of the WOCE Hydrographic Program.

The R/V Akademik Ioffe departed Montevideo at 2130 on 14 February 1992, and headed for deep water in the South Atlantic. On the morning of 17 February, the vessel stopped for training and station tests. No reportable data were collected. WHP stations began on the continental shelf of the Antarctic Peninsula 67°28.1S 70°05.4W on 22 February (station 682). The first six stations were over the continental shelf and slope along a northwesterly line. The stations over the slope were made on isobaths separated by approximately 800 m. Two more stations were made in deep water along this line and then the track was turned southwestward. Five stations were made along the southwesterly track until 67°S was reached. The section was then continued along 67°S at nominally 30 nautical mile spacing. Over the Bellingshausen Abyssal Plain between 91°34W and 130°41W and over the Amundsen Abyssal Plain between 142°11W and 157°41W, the station spacing was increased to nominally 40 nautical miles. At 174°15E (station 768), the track was turned southwestward to run perpendicular to the Antarctic continental shelf. The section was completed with a station in 200 m of water off Cap Daemon at 70°39S 168°04E on 23 March (station 780). The section was restarted with a repeat station at 67°S 174°15E on 25 March and continued east-northeast to end in 400 m of water off Young Island of the Balleny Islands at 66°25S 162°41E on 29 March (station 794). The last station will be the eastern terminus for the continuation of WHP line S04P into the Indian Ocean.

The principal sampling program consisted of full-depth CTD/O profiles with a maximum of 24 small-volume water samples per cast. Water samples were collected for salinity, dissolved oxygen, silicate, phosphate, nitrate, nitrite, CFC-11, and CFC-12 at all stations, and for 3He, tritium, AMS ^{14}C, CFC-113, ^{18}O, and CO_2 system parameters at selected stations.

Rosette water samples were collected by the Scripps Oceanographic Data Facility (ODF) from Niskin and ODF-constructed 10-liter sample bottles mounted on an ODF-constructed 24-bottle rosette sampler which used General Oceanics 24- place pylon. The rosette was equipped with ODF-modified NBIS Mark IIIb CTDs for in-situ measurement of conductivity, temperature, pressure, and dissolved oxygen. A transmissometer belonging to Dr. Wilf Gardner, TAMU, was installed on the rosette and used at several stations. A short-range (ca. 100 meter) altimeter was mounted on the rosette frame and its data fed into the CTD data stream. A pinger on the rosette frame gave height above bottom (via a PDR in the CTD console area) throughout the water column. In every case the bottles were closed at selected depths during the up cast, after the winch had stopped at that depth. There were 113 CTD/rosette stations, in all but one case each close to the bottom.

Two PRTs were used on most stations for temperature measurements. No reversing thermometers were used during the cruise. Conductivities were measured using ODF Autosal salinometer with an automated logging program. Oxygen samples were run using a Dosimat/UV automatic titration system. Nutrients were run with a Technicon AAII system.

While on station and underway a shipboard 75 kHz RDI ADCP system was operated. Underway surface measurements were also obtained: temperature, salinity, fluorescence and pCO_2. A multi-beam sonar system was operated between stations Routine weather observations were collected at ten minute intervals by the ship's automated meteorological station with visual observations every four hours by the ship's officers.

Along the section, the weather and sea conditions were moderate to very rough. The winds were generally 10-15 m/sec, with five days approaching or exceeding 20 m/sec. Icebergs were present during the entire section which necessitated slowing at night and some extra maneuvering before starting sections. The air temperature averaged slightly below freezing. Near Antarctica, at the end of the section, cold air and wind created problems with freezing in the bottle spigots (stations 773 and 778), but only three salinity samples were lost. No trouble with pack ice occurred during the section. The weather was extremely poor in the vicinity of the the Antarctic Circumpolar Current between the continent and New Zealand which prevented any work on the northward run after the completion of the main zonal section.

Bottle depth distributions

Vertical sections along the ship's track showing the depth distributions for small volume samples are shown in Figure 2.

Problems

This cruise had few problems. The CTD operations were made from the stern A-frame. There were numerous cable problems, kinking and unlaying, associated with the pitching in rough weather conditions when the winds exceeded 15 m/sec or large swells were encountered. Many mire reterminations were made during the cruise. However, little data was lost from these problems. One station, 701, was terminated early on 27 February at 3700 m in 4340m of water during bad weather and excessive ship motion. The rosette hit the ship during recovery stations 705 and 763. The CTD signal was lost at 3650 dbars on station 702 and the cast was aborted. However, the signal returned as the CTD was being raised and the cast was restarted in the water at 3100 dbars. The CTD signal was lost on the upcast at 4337 dbars on station 709. The bottles were tripped based upon wire out for this station. The same CTD was used for the entire cruise. The CTD Sampler Controller and Data Logger was tested from station 781 through station 794. Using the controller, bottles were tripped at preset depths and the CTD data recorded internally. The casts were monitored and data recorded with normal CTD computer.

An oxygen sensor was used with the CTD. Problems with the sensor and its spare were encountered at the start of the section. The data are suspect for the first 11 stations (682-692). The sensor failed on station 773. No oxygen sensor was available for stations 773 through 782.

The transmissometers had inside lens fogging and temperature compensation problems. Many casts had no transmissometer mounted and the data are suspect for the stations where one was used.

South of the Polar Front, the acoustic backscatter sound levels for the 75 kHz ADCP were extremely low. The data from the upper 200 m appear to be contaminated by transducer ringing. The overall quality of the ADCP velocity data is poor.

Other Incidents of Note

Cruise Participants

Name	Responsibility on cruise	Institution
Barstow, Dennis	ADCP	Oregon State Univ.
Chipman, David	CO_2, underway systems	LDGO
Clark, Jordan	helium, tritium, ^{18}O, AMS ^{14}C	LDGO
Grabitz, Dorothea	helium, tritium, ^{18}O, AMS ^{14}C	LDGO
Hiller, Scott	electronics tech, salts	SIO/ODF
Low, Clarence	^{13}C	NASA Ames
Masten, Doug	nutrients, deck	SIO/ODF
Mattson, Carl	electronics tech, salts	SIO/ODF
Menzia, Fred	CFCs	NOAA/PMEL
Muus, David	deck, O_2, data	SIO/ODF
Richman, James	co-chief scientist physical oceanography	Oregon State Univ.
Rubin, Stephany	CO_2	LDGO
Swift, James	physical oceanography	SIO
Warner, Mark	CFCs	Univ. of Washington
Williams, Robert	deck, O_2, data	SIO/ODF

Leader Group (plus Richman, U.S.)		
Koshlyakov, Mikhail	Chief Scientist	Shirshov Institute
Sklyarov, Vladimir	Ch. Deputy	Shirshov Institute
Zaytsev, Alexandr	Ch. Deputy; CTD deck ops	Shirshov Institute
Sazhina, Tatyana	Sc. Secretary	Shirshov Institute
Zhukova, Veronika	secretary	Shirshov Institute

Sonde Group (CTD)		
Yemelyanov, Mikhail	CTD console ops	Shirshov Institute
Maslennikov, Vyacheslay	CTD console ops	VNIRO
Popkov, Valeriy	CTD console ops	VNIRO
Frolov, Mikhail	CTD deck ops	Shirshov Institute
Nesterenko, Yuriy	watch stander	Shirshov Institute
Savelyev, Vitaliy	CTD deck ops	Shirshov Institute
Yakovlev, Evgeniy	watch stander	Shirshov Institute

Mathematical Group (data processing, GFD, models)		
Yaremchuck, Maxim	data processing; interpolations	Shirshov Institute
Nechayev, Dmitriy	GFD, modelling	Shirshov Institute
Benenson, Mikhail	computer system manager	Shirshov Institute
Chesnokov, Andrey	software technician	Shirshov Institute
Mardashkina, Natalya	ocean modelling	MFTI

Hydrological Group (interpretative)		
Belkin, Igor	interpretative p.o.; fronts	Shirshov Institute
Burkov, Valentin	interpretative p.o.	Shirshov Institute
Chernyakova, Alla	O_2, nutrients, CO_2	Shirshov Institute
Stunzhas, Pavel	O_2, nutrients, CO_2	Shirshov Institute
Polyakova, Irina	technician	Shirshov Institute

Meteorological Group		
Romanov, Yuriy	Meteorology	Shirshov Institute
Lutsenko, Eduard	synoptics	AANII
Radikevich, Vitaliy	meteorology	LGMI
Rodionov, Vyacheslav	remote sensing	Shirshov Institute
Safronov, Alexey	actinometry	IFA
Romashova, Elena	actinometry	IFA

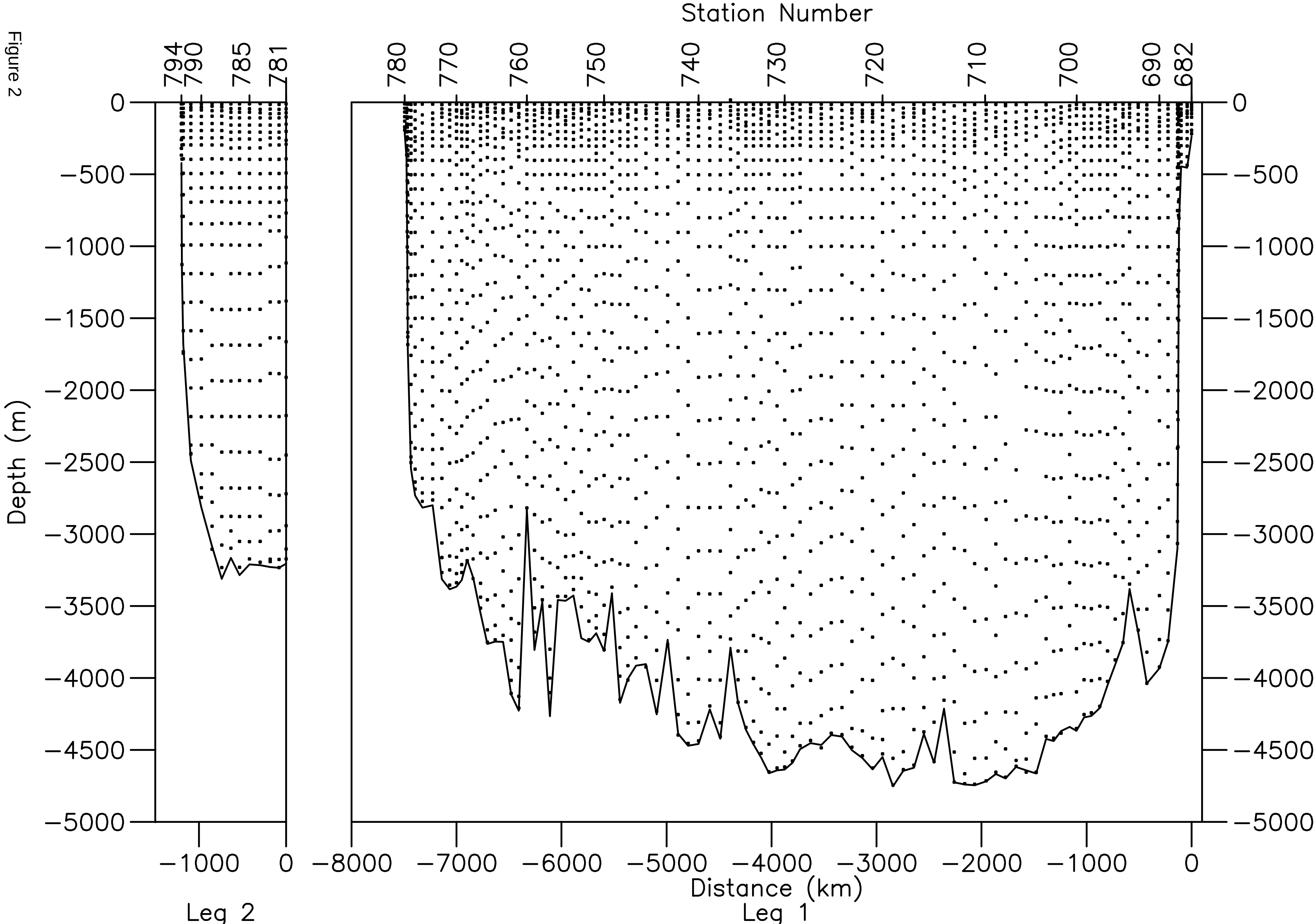
Acoustic Group (ADCP & sound scattering)		
Berezutski, Alexander	ADCP, MultiBeam bathymetry	Shirshov Institute
Timoshenko, Vladimir	MultiBeam bathymetry	TRTI
Nosov, Alexandr	MultiBeam bathymetry	Shirshov Institute
Shilov, Igor	ADCP	Shirshov Institute
Korolev, Alexander	ADCP	Shirshov Institute
Tikhonova, Natalya	MultiBeam bathymetry	Shirshov Institute

Biological Group		
Voronina, Natalya	zooplankton	Shirshov Institute
Levin, Lev	fluorescence	IBSO
Sazhin, Andrey	microplankton	Shirshov Institute
Sedelnikov, Sergey	bio. hardware technician	IBSO
Zadorina, Larisa	bio. Technician	Shirshov Institute

Definition of acromyms:

VNIRO: Research Institute of Marine Fisheries and Oceanography, Moscow
MFTI: Moscow Pysical-Technical Institute
AANII: Arctic and Antarctic Institute, Saint Petersburg
LGMI: Leningrad Hydro Meteorological Institute
IFA: Institute of Atmospheric Physics of Russian Academy of Sciences, Moscow
TRTI: Taganrog Radio Engineering Institute
IBSO: Institute of biophysics of Siberian Branch of Russian Academy of Sciences, Krasnojarsk

Figure 2



Bottle Sample Depths, R/V Akademik Ioffe
WHP line S4 Pacific, Feb−Mar 1992

IOFFE6

(WOCE S4-92)

Calibrated Pressure-Series CTD Data
Processing Summary and Comments

December 28, 1993

R/V *Akademik Ioffe* 90KDIOFFE6/1
920214 - 920406
Montevideo, Uruguay to Wellington, New Zealand

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Note: *Appendices A and B have bee omitted from this report by ODF request.*

1. Introduction

In this document we discuss CTDO data acquisition, calibration, corrections, and other processing for the IOFFE6 cruise on the R/V Akademik Ioffe. The final reported values were determined via careful examination and application of the pre- and post-cruise calibrations, and by comparison of CTD data with the water sample data collected during the CTD casts. Our techniques and calibration data are discussed below.

2. CTD Acquisition and Processing Summary

113 CTD casts plus 4 test casts were completed during IOFFE6. The rosette used was an ODF-designed 24-bottle system with a 24-place General Oceanics pylon nested inside a ring of twenty-four 10-liter bottles. A CTD, altimeter, pinger, and transmissometer were mounted on the bottom of the frame. ODF CTD #1 (a modified NBIS Mark III-B instrument) was used during the leg.

The ODF CTD acquired data at a maximum rate of 25 Hz. The data consisted of pressure, temperature, conductivity, dissolved oxygen, second temperature, four CTD voltages, trip confirmation, transmissometer, altimeter and elapsed time. Power to the CTD was optimized by applying the minimum current to attain the CTD voltages required to maintain sensor stability. These voltages were monitored throughout the cast.

An ODF-designed deck unit demodulated the FSK CTD signal to an RS-232 interface. The raw CTD data server allowed the data to be split into three different paths: to be logged in raw digitized form, to be monitored in real time as raw data, and to be processed and plotted. During the IOFFE6 expedition, an Integrated Solutions Inc. (ISI) Optimum V computer served as the real-time data acquisition processor. Additionally, Sun SPARC computers were used during post-cruise processing.

The raw CTD audio signal was recorded on VHS videotape as an ultimate back-up, and all raw binary data were logged on a hard disk and then backed up to magnetic cartridge tape. In addition, all intermediate versions of processed data were backed up to magnetic cartridge tape.

CTD data processing consists of a sequence of steps which is modified as needed. Data can be re-processed from any point in this sequence after the raw data are acquired from the sea cable and recorded on videotape and/or hard disk. Each CTD cast is assigned a correction file, and while the corrections are usually determined for groups of stations, it is possible to fine tune the parameters for even a single station. The acquisition and processing steps are as follows:

- Data are acquired from the CTD sea cable and assembled into consecutive .04-second frames containing all data channels. The data are converted to engineering units.
- The raw pressure, temperature and conductivity data are passed through broad absolute value and gradient filters to eliminate noisy data. The entire frame of raw data is omitted, as opposed to interpolating bad points, if any one of the filters is exceeded. The filters may be adjusted as needed for each cast.

TYPICAL IOFFE6 RAW DATA FILTERS

Raw Data Channel	Minimum	Maximum	Frame-to-Frame Gradient
Pressure	-40	6400	2.0 dbar
Temperature	-8	32.7	.2 °C
Conductivity	0	64.355	.3 mmho

- Pressure and conductivity are phase-adjusted to match the temperature response, since the temperature sensor responds more slowly to change. This lag time is determined using raw CTD data from the cruise. Conductivity data are corrected for ceramic compressibility in accordance with the NBIS Mark III-B Reference Manual.
- The data are averaged into 0.5-second blocks. During this step, data falling outside four standard deviations from the mean are rejected and the average is recalculated. Then data falling outside two standard deviations from the new mean are rejected, and the data are re-averaged. The resulting averages, excepting second temperature and CTD voltages, are reported as the 0.5-second time series. Secondary temperature data are used to verify the stability of the primary temperature channel calibration. Secondary temperature data are only filtered, averaged and reported with the time-series data when they are used in place of the primary temperature data due to a sensor malfunction.
- Corrections are applied to the data. The pressure data are corrected using laboratory calibration data. Temperature corrections, typically a quadratic correction as a function of temperature, are based on laboratory calibrations. Conductivity and oxygen corrections are derived from water sample data. Conductivity corrections are typically a linear fit of bottle minus CTD differences as a function of conductivity. Oxygen data are corrected on an individual cast basis. Uncorrected time-series transmissometer data are

forwarded to TAMU for final processing and reporting.

The averaged data are recorded on hard disk and sent to the real-time display system, where the averaged data can be reported and plotted during a cast. The averaging system also communicates with the CTD acquisition computer for detection of bottle trips, almost always occurring during the up casts. A 3- to 4-second average of the CTD data is stored for each detected bottle trip.

A down-cast pressure-series data set is created from the time series by applying a ship-roll filter to the down-cast time-series data, then averaging the data within 2-dbar pressure intervals centered on the reported pressure. The first few seconds of data for each cast are generally excluded from the averages due to sensor adjustment or bubbles during the in-water transition. Pressure intervals with no time-series data can optionally be filled by double-parabolic interpolation. When the down-cast CTD data have excessive noise, gaps or offsets, the up-cast data are used instead. CTD data from down and up casts are not mixed together in the pressure-series data because they do not represent identical water columns (due to ship movement, wire angles, etc.).

The CTD time series is always the primary CTD data record for the pressure, conductivity and temperature channels. The final corrections to the CTD oxygen data are made by correcting pressure-series CTD oxygen data to match the up-cast oxygen water samples at common isopycnals. The final CTDO pressure-series data are the data reported to the principal investigator and to the WHP Office.

Subsequent sections of this document discuss the laboratory calibrations, data processing and corrections for the CTD used during IOFFE6.

3. CTD Laboratory Calibrations

3.1. Pressure Transducer Calibration

The CTD pressure transducer was calibrated in a temperature-controlled bath to the ODF Ruska deadweight-tester (DWT) pressure standards. The mechanical hysteresis loading and unloading curves were measured both pre- and post-cruise at cold temperature (-1.5 degrees C bath) to a maximum of 8830 psi, and at warmer temperature (15.2 and 6.1 degrees C baths pre-/post-cruise) to a maximum of 2030 psi. The post-cruise deep 8830 psi calibration was done a total of 3 times (in -1.5, -1.4, and -0.7 degrees C baths).

CTD pre- and post-cruise pressure calibrations are summarized in Figure 1.

3.2. PRT Temperature Calibration

All CTD PRT temperature transducers were calibrated in a temperature-controlled bath. CTD temperatures were compared with temperatures calculated from the resistance of a standard platinum resistance thermometer (SPRT) as measured by a NBIS ATB-1250 resistance bridge. The ultimate temperature standards at ODF are water and diphenyl ether triple-point cells and a gallium cell. Seven or more calibration temperatures, spaced across the range of -2.0 to 20.0 degrees C, were measured both pre- and post-cruise.

CTD pre- and post-cruise temperature calibrations are summarized in Figures 2 and 3. It should be noted that ODF CTD PRT temperature transducers are offset approximately +1.5 degrees C in order to avoid a temperature response discontinuity that occurs at 0 degrees C; this offset is taken into account when correcting the data.

4. CTD Data Processing

4.1. Pressure, Temperature, Conductivity/Salinity, and Oxygen Corrections

A maximum of 24 salinity and oxygen check samples were collected during each CTD cast. No thermometric pressure or temperature data were collected during this cruise.

A 3- to 4-second average of the CTD time-series data was calculated for each sample. The resulting data were then used to derive CTD conductivity/salinity and oxygen corrections. The severe weather conditions encountered during this cruise dictated that shallow bottle stops (in the top 125 meters or so) be very short or omitted altogether, thus leading to smeared bottle-trip data for shallow bottles. Typically the winch does not move during a trip.

4.1.1. CTD Pressure Corrections

4.1.1.1. CTD #1

CTD #1 pre- and post-cruise pressure calibrations, Figures 1a and 1b were compared. The warm/shallow and cold/deep calibration curves both shifted by about 1 to 1.5 decibars from pre- to post-cruise. The slopes of the warm/shallow pressure calibration curves were nearly identical. The slopes of the cold/deep curves were slightly different: shallower points were nearly identical and the deepest points from the two calibrations were about 1.5 decibars apart. Thermometric pressures were not measured during the leg.

The pre-cruise pressure calibration was left in place for the pressure data since the pre- and post-cruise pressure calibrations had slope differences well within the sensor accuracy. Any residual offset was compensated for automatically at each station: as the CTD enters the water, the corrected pressure is adjusted to 0 decibars.

4.1.2. CTD Temperature Corrections

4.1.2.1. CTD #1

CTD #1 had two temperature sensors: both PRT-1 and PRT-2 were calibrated pre- and post-cruise. PRT-1 was the main temperature sensor and was used exclusively in all data processing. PRT-2 was used to check for PRT-1 drift during the cruise. A comparison of the pre- and post-cruise laboratory CTD #1 PRT-1 temperature transducer calibrations, Figures 2a and 2b, showed two curves with nearly identical slopes and a -.0008 degrees C temperature shift in the range of -1 to 7 degrees C. For PRT-2, the secondary sensor, a comparison of the two calibrations, Figures 3a and 3b, also showed curves with nearly identical slopes and a +.0006 degrees C temperature shift in the range of -1 to 6 degrees C. The pre-cruise PRT-1 temperature calibration, Figure 2a, remained in effect for the CTD data since any differences between pre- and post-cruise temperature calibrations were negligible and well within the sensor accuracy.

No thermometric temperatures were measured during this cruise. The PRT-1 minus PRT-2 differences were monitored during the cruise to check for possible temperature shifts. None were detected, and as expected, the pre- and post-cruise PRT-1 minus PRT-2 differences were consistent.

4.1.3. CTD Conductivity Corrections

In order to calibrate CTD conductivity, check-sample conductivities were calculated from the bottle salinities using CTD pressures and temperatures. For each cast, the differences between sample and CTD conductivities at all pressures were fit to CTD conductivity using a linear least-squares fit. Values greater than 2 standard deviations from the fits were rejected. The resulting conductivity correction slopes were plotted as a function of station number. The conductivity slopes were then fit as a function of station number to generate smoothed slopes. These smoothed slopes were an average of the slopes for the cruise (0-order). Since the range of conductivities in this part of the ocean is very narrow, the conductivity slope correction does not have a great effect on the data.

Conductivity differences were then calculated for each cast after applying the preliminary conductivity slope corrections. Residual conductivity offsets were computed for each cast and fit to station number. Smoothed offsets were determined by groups, based on common conditions (i.e. such factors as pre- and post-conductivity-sensor cleaning). The resulting smoothed offsets were then applied to the data. Then conductivity slope as a function of conductivity was re-checked: no changes were warranted.

Some offsets were manually adjusted to account for discontinuous shifts in the conductivity transducer response, or to insure a consistent deep T-S relationship from station to station.

Station 711 was the only station showing any discontinuity with surrounding stations in the conductivity transducer response, and it was adjusted to match its own bottle salinities, which also matched the deep Theta-S data of surrounding stations. This cast exhibited strange results which were noted at sea during the cast. The top 340 decibars of this cast are offset, but it was impossible to use the upcast due to multiple offsets. Probably this entire cast is still suspect. We are surmising that the sensor became coated with protoplasmic slime early in the cast, some of which came off around 340 decibars, and which kept gradually washing off during the down and up casts.

Plots of the final conductivity slopes and offsets can be found in Figures 4 and 5.

Conductivity Correction Summary

Stations	CTD#	Cond.Slopes	Cond.Offsets†
682-686	1	-1.5079e-3	+4.0999e-2
687-690	1	-1.5079e-3	+4.5252e-2
691-710	1	-1.5079e-3	+4.3439e-2
711-761	1	-1.5079e-3	+4.0357e-2
762-769	1	-1.5079e-3	+3.8297e-2
770-794	1	-1.5079e-3	+3.6655e-2

†individual stations were adjusted after this for conductivity sensor shifting or to insure a consistent deep T-S relationship from cast to cast.

4.1.3.1. Bottle vs. CTD Conductivity Statistical Summary

The IOFFE6 calibrated bottle-minus-CTD conductivity statistics include bottle salinity values with quality 3 or 4. There is approximately a 1:1 correspondence between conductivity and salinity residual differences. The following statistical results were generated from the final bottle data set and the final corrected CTD data:

IOFFE6 Final Bottle-CTD Conductivity Statistics

cruise	pressure range(dbars)	mean conductivity difference (bottle-CTD mmho/cm)	standard deviation	#values in mean
IOFFE6	all pressures	-.00025††	.01758	2543
	allp (4,2rej) †	-.00009	.00162	2437
	press < 1500	.00022	.01446	1559
	p<1500(4,2rej)†	-.00011	.00219	1477
	press > 1500	-.00100†††	.02161	984
	p>1500(4,2rej)†	-.00008	.00075	964

† "4,2rej" means a 4,2 standard-deviation rejection filter was applied to the differences before generating the results.
†† A plot of these differences can be found in Figure 6a.
††† A plot of these differences can be found in Figure 6b.

4.2. CTD Dissolved Oxygen Data

4.2.1. CTD Oxygen Corrections

Dissolved oxygen data were acquired using Sensormedics dissolved oxygen sensors. The ocean area in which this cruise occurred provided harsh conditions for CTD oxygen sensors, especially the freezing temperatures. Due to the severe conditions, only the larger features in the CTD oxygen profiles should be considered realistic. Many profiles are very noisy and/or have extraneous oscillations.

CTD oxygen data are corrected after pressure, temperature and conductivity corrections have been determined. CTD raw oxygen currents were extracted from the pressure-series data at isopycnals corresponding to the up-cast check samples. Most pressure-series data were from the down casts, where oxygen data are usually smoother than up-cast data because of the more constant lowering rate, avoiding the flow-dependence problems occurring at up-cast bottle stops. However, the IOFFE6 CTD oxygen data were affected with flow-dependence problems, down or up cast, each time a cast was stopped. There can also be flow-dependence problems if a cast is slowed down, as often happens during bottom approaches.

The CTD oxygen correction coefficients were determined by applying a modified Levenberg-Marquardt nonlinear least squares fitting procedure to residual differences between CTD and bottle oxygen values. Bottle oxygen values were weighted as required to optimize the fitting of CTD oxygen to discrete bottle samples. Some bottle levels were omitted from a fit because of large pressure differences between down- and up-cast CTD data at isopycnals. Deep data points were often weighted more heavily than shallower data due to the higher density of shallow sampling on a typical 24-bottle sampling scheme.

The IOFFE6 surface oxygen data fitting was adversely affected by the extreme cold conditions. Freezing sensors, combined with the typical going-in-water bubbles/noise, made it difficult to fit CTD oxygens to the bottle data in the surface mixed layer of many casts. The value of data above the second check sample should be very carefully considered. Sometimes, due to freezing of the oxygen sensor, the CTD oxygen data may be suspect for as much as the top 100 decibars. Any station where questionable data goes deeper than about 10 decibars is noted in the "CTD Shipboard and Processing Comments" in Appendix D.

4.2.2. Bottle vs. CTD Oxygen Statistical Summary

The CTD oxygens are generated by fitting up cast oxygen bottle data to down cast CTD raw oxygen (μamps) measurements along isopycnals. Residual oxygen differences are not generated from these comparisons, so no comparison statistics are shown in this report.

4.3. Additional Processing

A software filter was used on 35 casts to remove conductivity or temperature spiking problems in about .066% of the time-series data frames. Pressure did not require filtering.

Oxygen spikes were filtered out of 6 casts. The filtered oxygen levels affected approximately .008% of the time-series data frames. 58.3% of the filtered oxygen data were shallower than 100 dbars and could possibly be directly related to bubbles trapped during the going-in-water transition or freezing of the sensor.

The remaining density inversions in high-gradient regions cannot be accounted for by a mis-match of pressure, temperature and conductivity sensor response. Detailed examination of the raw data shows significant mixing occurring in these areas because of ship roll. The ship-roll filter resulted in a reduction in the amount and size of density inversions.

After filtering, the down cast (or up cast - see table below) portion of each time-series was pressure-sequenced into 2-decibar pressure intervals. A ship-roll filter was applied to each cast during pressure sequencing to disallow pressure reversals.

5. General Comments/Problems

There is one pressure-sequenced CTD data set, to near the ocean floor, for each of 113 casts at 112 station locations. There was a reoccupation of station 768 (as station 781). There was additionally a 3-cast shakedown station, a freon bottle check station, plus one cast aborted to avoid an iceberg; these were neither processed nor reported. Another CTD cast was done after the aborted cast at the same location.

The data reported is from down casts, excepting the stations listed below:

UP-CAST PRESSURE-SERIES DATA REPORTED

Station(s)	Problem with Down Cast Data
687,769	Salinity offset(s); up ok
702	CTD signal lost at approximately 3655 db down (cast 1); signal came back on way up. Went back down (called cast 2) to get a complete upcast and trip bottles. Only complete cast is cast 2 (upcast).

The top level(s) (0 or 0-2 decibar(s) usually, but up to 16 decibars for a few stations with serious freezing problems) of some casts were extrapolated using a quadratic fit through the next three deeper levels. Recorded surface values were rejected only when it appeared that the drift was caused by sensors adjusting to the in-water transition or freezing/thawing; if there was any question that the that the surface values might be real, the original data were reported. Extrapolated surface levels are identified by a count of "1" in the "Number of Raw Frames in Average" reported with each data record in the files. The pressures for these extrapolated data frames, as well as other cast-by-cast shipboard or processing comments, are listed in the "CTD Shipboard and Processing Comments" in Appendix D.

Harsh weather during this cruise combined with working off the stern of the ship led to numerous wire problems. These resulted in many stops, pauses, or yoyos during casts, the most severe of which are documented in Appendix D.

In addition, missing data values, such as CTD oxygens in casts where the sensor failed or was not present on the rosette package, are represented as "-9" in the data files. There are 20 such casts in this data set:

687/02,688/01,689/01,690/01,692/01,719/01,720/01,721/01,723/01,724/01,773/01, 774/01,775/01,776/01,777/01,778/01,779/01,780/01,781/01 and 782/01.

There were 35 casts where the oxygen signal seemed to fail only during the top 80 or so decibars (probably due to extreme cold and/or sensor freezing); these are not reported as "-9", but the affected pressure levels are listed in Appendix D for the following stations:

684,686,696,699,702,703,704,705,708,709,710,711,712,713,714,717,718,722,730, 733,734,739,740,743,751,752,759,761,768,770,771,772,783,784 and 792 (all cast 1).

The CTD oxygen sensor often requires several seconds in the water before being wet enough to respond properly; this is manifested as low or high CTD oxygen values at the start of some casts. Flow-dependence problems occur when the lowering rate varies, or when the CTD is stopped, as at the cast bottom or bottle trips, where depletion of oxygen at the sensor can cause lower oxygen readings.

Appendix C:

IOFFE6 Calibration Figures

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NOTE: some differences fall outside of the plotted limits.
Please refer to the bottle data quality codes.

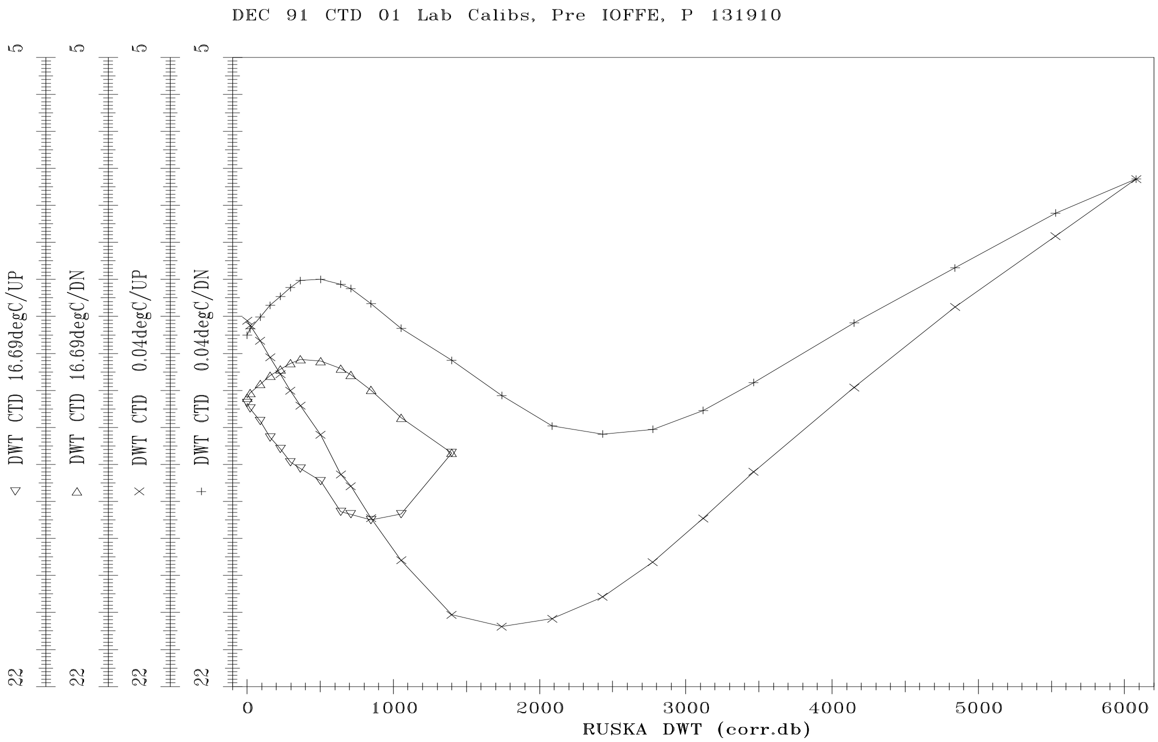

Figure 1a: CTD #1 Pre-cruise Pressure Calibration

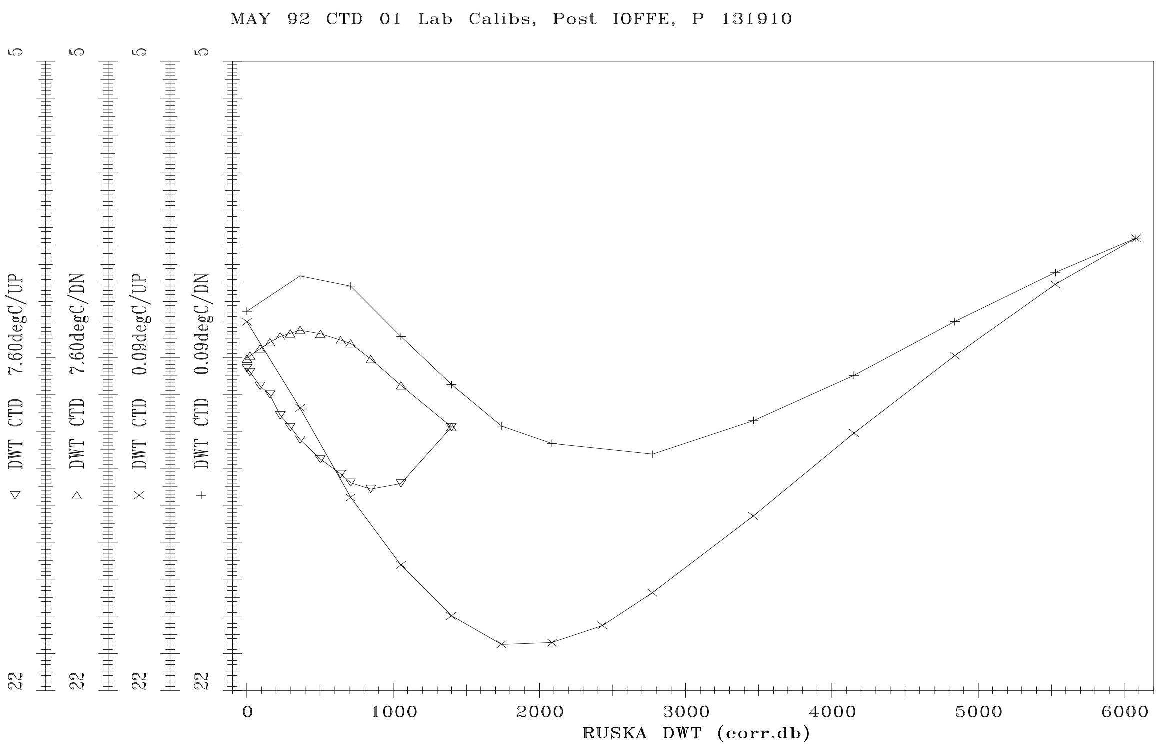

Figure 1b: CTD #1 Post-cruise Pressure Calibration

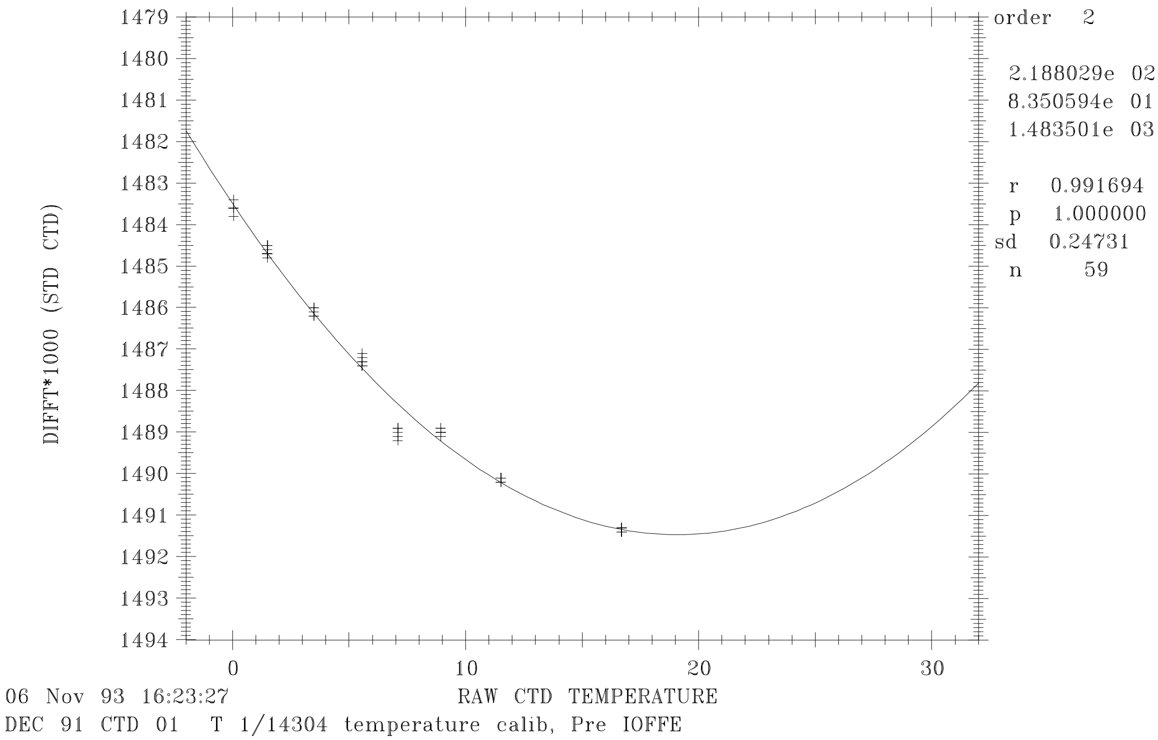

Figure 2a: CTD #1 Pre-cruise PRT-1 Temperature Calibration

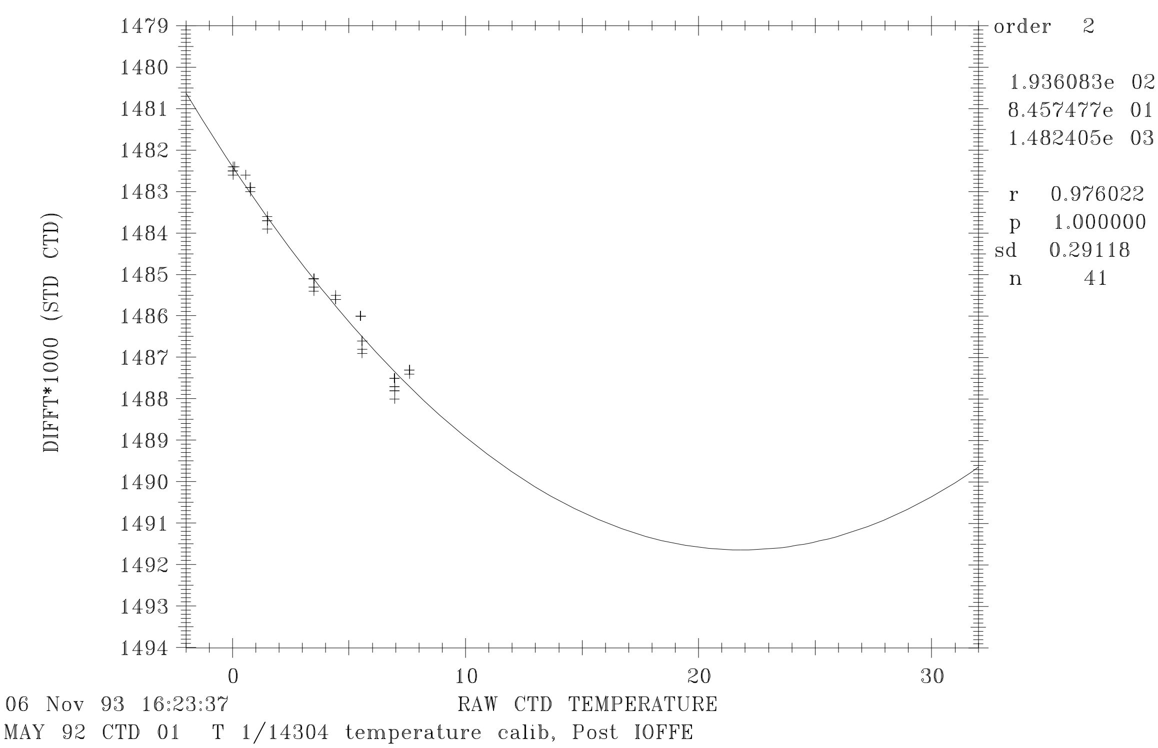

Figure 2b: CTD #1 Post-cruise PRT-1 Temperature Calibration

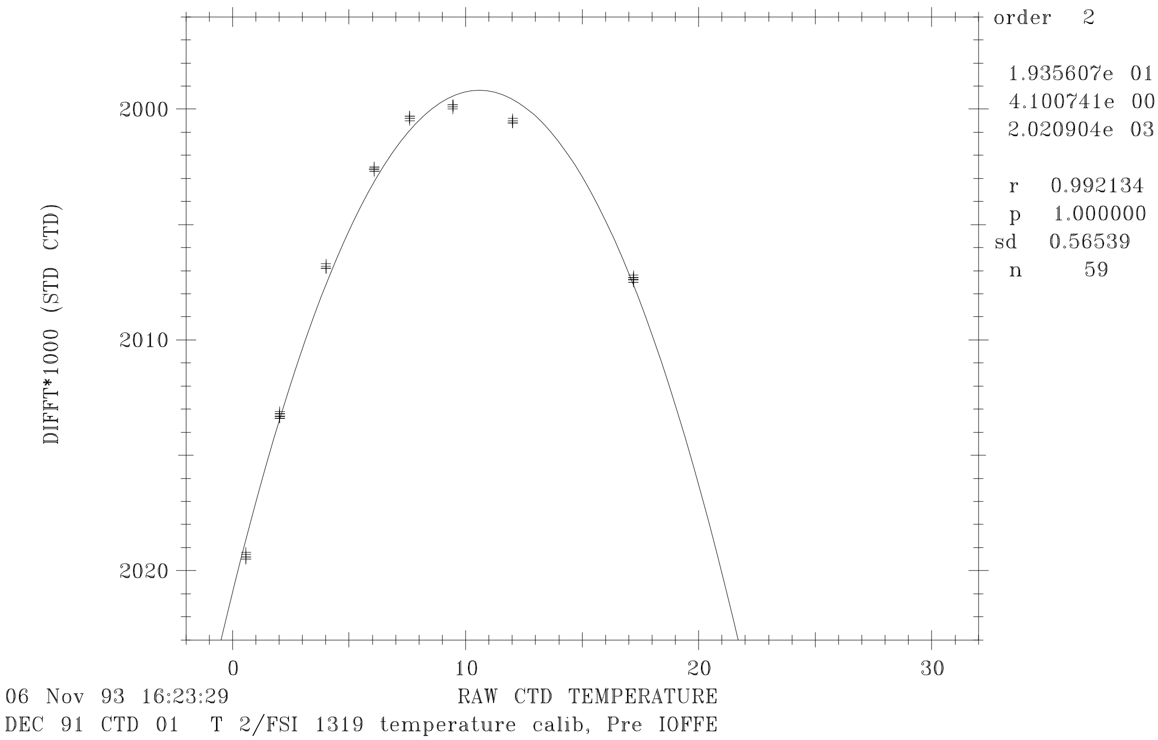

Figure 3a: CTD #1 Pre-cruise PRT-2 Temperature Calibration

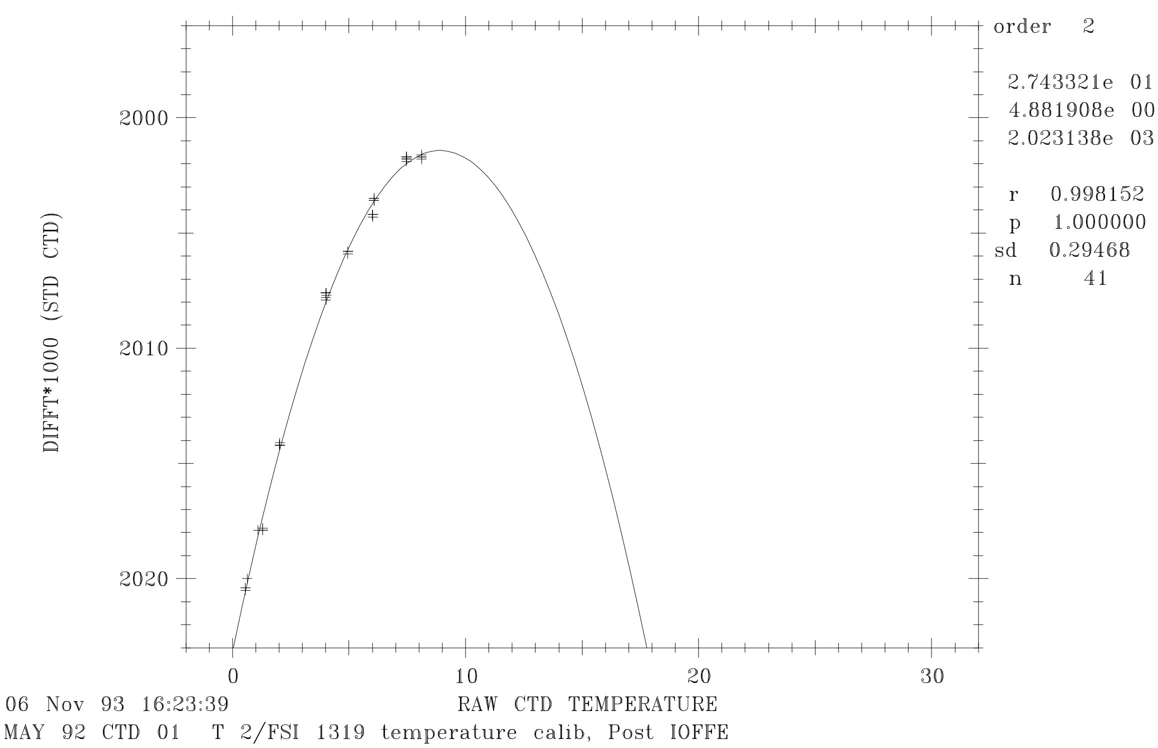

Figure 3b: CTD #1 Post-cruise PRT-2 Temperature Calibration

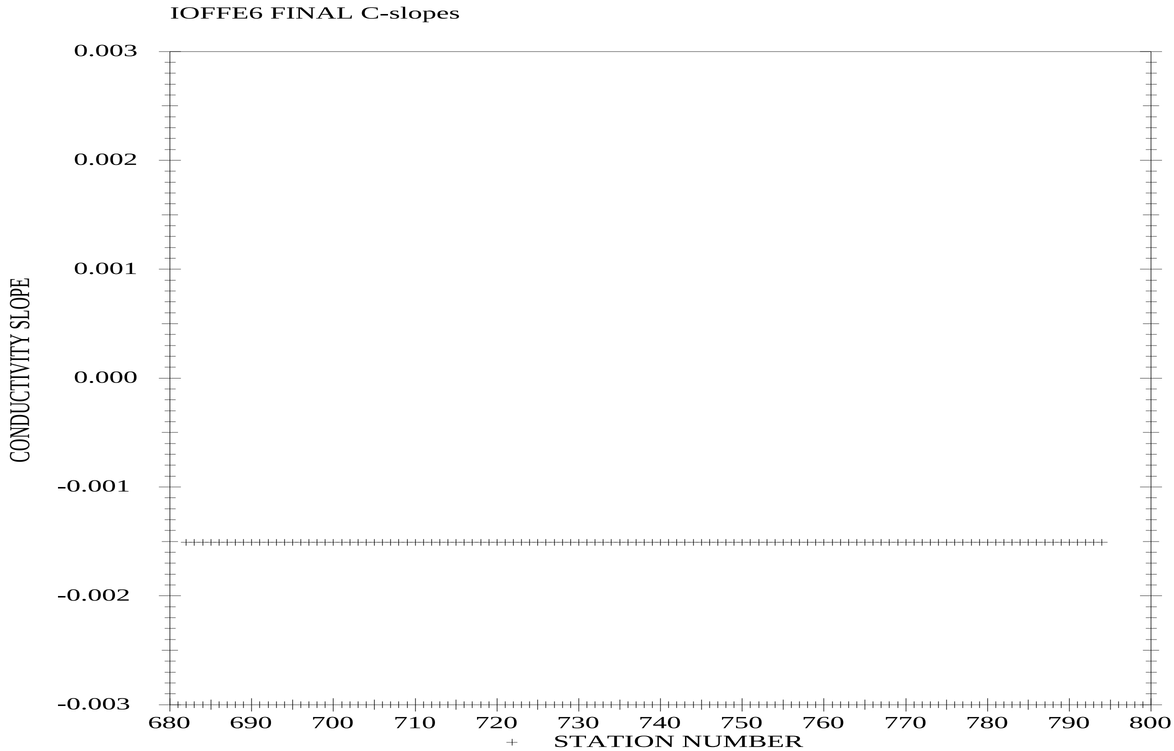

Figure 4: IOFFE6 Conductivity Slopes

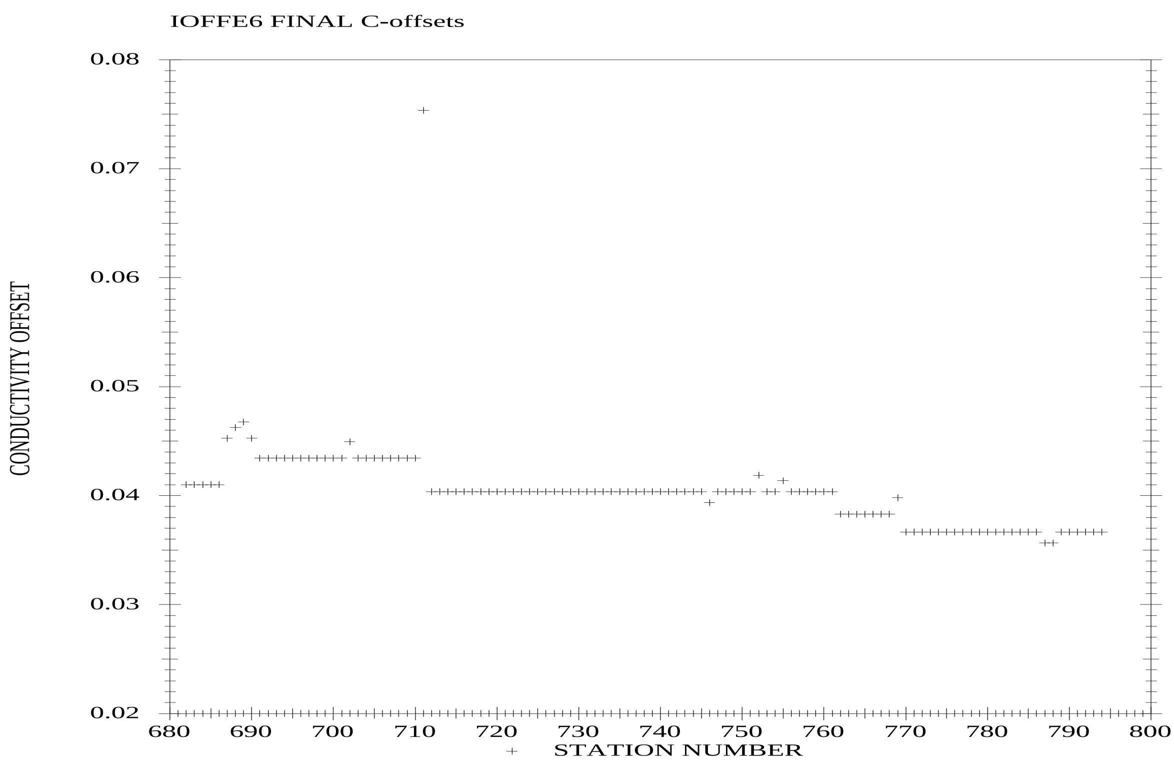

Figure 5: IOFFE6 Conductivity Offsets

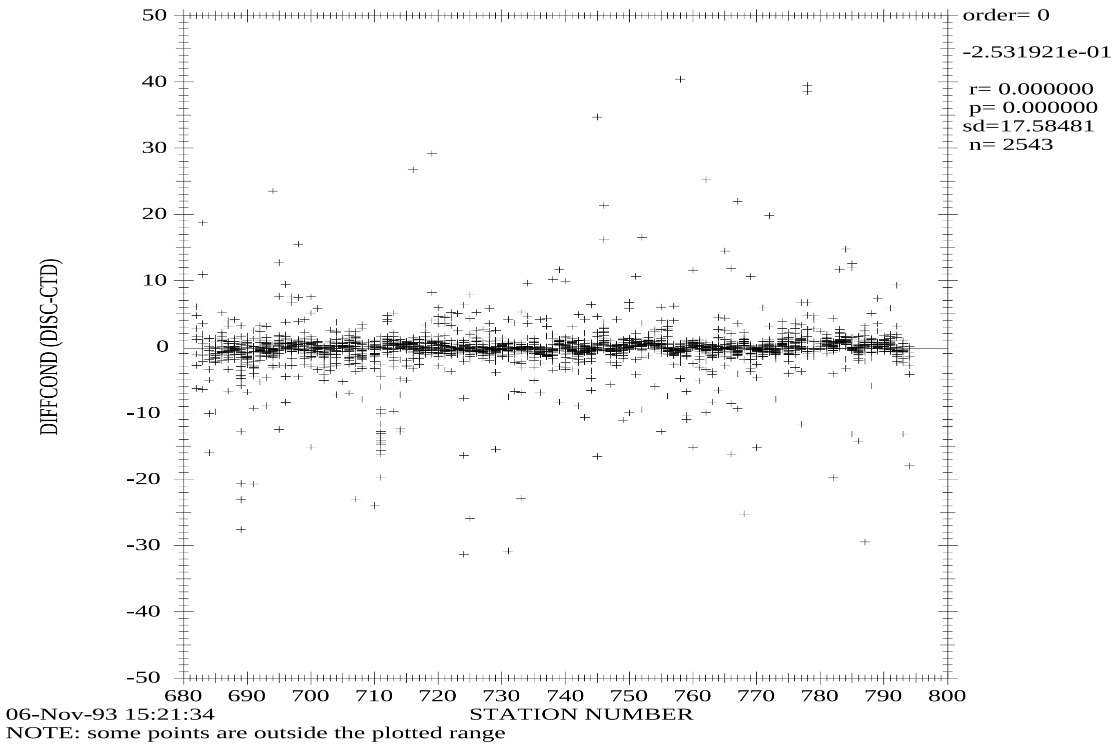

Figure 6a: IOFFE6 Residual Conductivity Bottle-CTD Differences - All Pressures

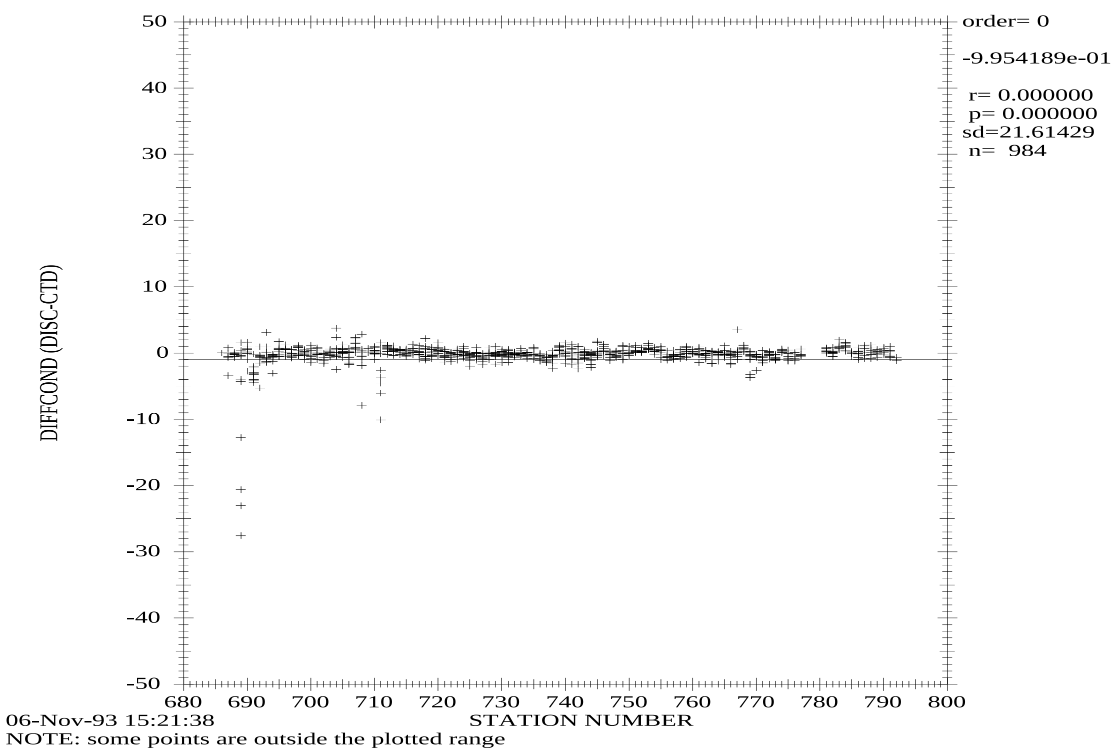

Figure 6b: IOFFE6 Residual Conductivity Bottle-CTD Differences - Prs>1500dbar

Appendix D:

IOFFE6 Processing Notes (WOCE-S4)

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IOFFE6 / WOCE-S4 CTD Shipboard and Processing Comments

sta/cast	Comments
681/01	shakedown cast, no samples - not part of final data distribution
681/02	shakedown cast, no samples - not part of final data distribution
681/03	shakedown cast, freon & SSW samples - not part of final data distribution; new end termination after cast due to PRT2 problem
682/01	
683/01	
684/01	delay before cast start (approx 30 min) due to ice "growlers" near ship; top 20 db CTD oxygen questionable
685/01	"steaming on wire on upcast"
686/01	new xmiss; problems with oxygen signal noted during cast; top 15 db CTD oxygen questionable
687/01	delay before cast start to avoid iceberg; cast ABORTED
687/02	UP cast (salinity offset on down cast); no CTD oxygen data (sensor not working properly)
688/01	no CTD oxygen data (sensor not working properly)
689/01	no CTD oxygen data (sensor not working properly); 0-db level extrapolated
690/01	no CTD oxygen data (sensor not working properly)
691/01	new CTD oxygen sensor
692/01	new CTD oxygen sensor; no CTD oxygen data (sensor not working properly)
693/01	new CTD oxygen sensor
694/01	after cast: cut off 50 m CTD cable due to kink & unlays - new end termination and added more weight to rosette
694/03	shallow IOAN biology cast - not part of final data distribution
695/01	
696/01	xmiss not working properly?; top 18 db CTD oxygen questionable
697/01	0-db level extrapolated
698/01	need to clean xmiss windows: uptrace very different from down
699/01	top 40 db CTD oxygen questionable
700/01	
701/01	swell causing slack wire on deployment; by 3600 m down, wind up to 40 knots & decided to head back up to surface; wire very slack at 10 m stop: kinks in wire - after cast, cut wire & reterminated; approx 3-min pause at 72 db down: data affected in all channels
702/01	hove to and waited 6 1/2 hrs to start due to wind (35 knots) & swell; added 150 lbs more lead pre-cast; lost CTD signal at 3655 db down but kept going deeper, so incomplete cast - not part of final data distribution
702/02	UP cast: continuation of 702/01 after CTD signal recovered & cast already on its way back up (3240 mwo) - after CTD signal recovery, cast taken back down to bottom before bringing up to have a complete up cast for this station; slack wire at 60 m stop: kink; top 70 db CTD oxygen questionable
703/01	kink in same place as station 702: new end termination after cast; top 120 db CTD oxygen questionable
704/01	strong winds but seas not bad; 20 deg wire angle: no slack wire, no kinks; top 100 db CTD oxygen questionable
705/01	rosette hit A-frame twice on recovery, breaking some bottles; top 100 db CTD oxygen questionable
706/01	little slack but not bad - towing at approx 20 deg angle; kink in wire at same place as before: new end termination after cast
707/01	PRT2 repairs made pre-cast: PRT2 board fixed inside CTD; 0-db level extrapolated
708/01	top 12 db CTD oxygen questionable
709/01	lost CTD signal at 4339 db up: problem in CTD/xmiss bulkhead connector; top 80 db CTD oxygen questionable; 0-db level extrapolated
710/01	no xmiss; top 100 db CTD oxygen questionable

sta/cast	Comments
711/01	no xmiss; entire station's data questionable due to salinity/ conductivity shift at 343 db - upcast not usable due to multiple offsets; as noted at sea, this station's CTD data was totally different from surrounding stations and needed a large conductivity offset adjustment to match surrounding stations' deep T/S; top 110 db CTD oxygen questionable
712/01	no xmiss; top 100 db CTD oxygen questionable; 0-db level extrapolated
713/01	no xmiss; top 100 db CTD oxygen questionable; 0-db level extrapolated
714/01	no xmiss; top 70 db CTD oxygen questionable; 0-db level extrapolated
715/01	0-db level extrapolated
716/01	
717/01	xmiss ??; top 70 db CTD oxygen questionable (noted at sea that oxygen sensor probably frozen through mixed layer); 0-db level extrapolated
718/01	no xmiss; top 40 db CTD oxygen questionable; 0-db level extrapolated
719/01	no xmiss; no CTD oxygen data (sensor not working properly)
720/01	no xmiss; no CTD oxygen data (sensor not working properly); 0-db level extrapolated
721/01	no xmiss; no CTD oxygen data (sensor not working properly)
722/01	no xmiss; top 80 db CTD oxygen questionable
723/01	no xmiss; new CTD oxygen sensor; no CTD oxygen data (sensor not working properly); during post-cast rosette recovery too much wire paid out too quickly, resulting in kink: new end termination
724/01	no xmiss; no CTD oxygen data (sensor not working properly); 0-db level extrapolated
725/01	0-db level extrapolated
726/01	0-db level extrapolated
727/01	0,2-db levels extrapolated; -.001 salinity offset area 4174-4222 db
728/01	
729/01	after cast in, noticed outer lay of armor looks loose
730/01	top 100 db CTD oxygen questionable; 0-db level extrapolated
731/01	0,2-db levels extrapolated
732/01	0-db level extrapolated
733/01	new end termination after cast; top 70 db CTD oxygen questionable
734/01	recovery ok, but some oil on water surface as rosette came out; top 40 db CTD oxygen questionable; 0-db level extrapolated
735/01	
736/01	recovery ok, but outer lay of armor unlaying again - either spin or slack???; some big swells on this station
737/01	
738/01	towing, seas up; loose strands to about 60 mwo; 0-db level extrapolated
739/01	voltage problem - "meg" cable: ok; xmiss not working well; after cast, new end termination with guy grip; top 80 db CTD oxygen questionable; 0-db level extrapolated
740/01	ok - wire shows signs of unlaying - block still seems a little skewed with shackles - needs swivel?; top 80 db CTD oxygen questionable; 0-db level extrapolated
741/01	xmiss off-scale & may not be working; 0-db level extrapolated
742/01	surge during recovery: wire kinked - new end termination after cast; 0-db level extrapolated
743/01	towing; wind 35 knots; xmiss off-scale and may not be working properly; top 70 db CTD oxygen questionable; 0-db level extrapolated
744/01	xmiss off-scale & may not be working properly; supposed to be towing cast but slight forward angle as rosette entered water & some slack wire - wire dropped to deck before bridge got ship moving 3-4 min later; recovery ok but large kink/very loose strand approx 10 m from rosette - new end termination; 0-db level extrapolated
745/01	towing at 2 knots - good-size swell but launch ok; after recovery found 2 kinks - big swell; xmiss not working; 0-db level extrapolated

sta/cast	Comments
746/01	waiting on weather - high seas & 39-43 knot winds; trawl wire block rigged in place of CTD block; wind to 29-31 knots & big swell but smoother at cast start - some problem with slack wire - towing at 2 knots; when cast up weather better, but 2 kinks; xmiss not working; 0-db level extrapolated
747/01	no xmiss; pre-cast added weight & found another kink in CTD cable near winch
748/01	no xmiss
749/01	no xmiss
750/01	no xmiss; pinger batteries died during cast (2500 m down); 0-db level extrapolated
751/01	no xmiss; new pinger batteries; top 40 db CTD oxygen questionable
752/01	no xmiss; top 20 db CTD oxygen questionable; 0-db level extrapolated
753/01	no xmiss; 0-db level extrapolated
754/01	no xmiss; bottom depth changing by 400 m at beginning of station from 3300 to 3700 m; 0-db level extrapolated
755/01	xmiss on rosette; towing speed a little slow: block bounced a few times until angle increased, but when cast in, wire ok; 0-db level extrapolated
756/01	
757/01	
758/01	0-db level extrapolated
759/01	top 80 db CTD oxygen questionable; 0-db level extrapolated
760/01	
761/01	top 80 db CTD oxygen questionable; multiple salinity offsets in bottom 150 db caused by temperature and conductivity offsets: .001 to .003 salinity offset from 4132-4154 db, approximately .004 from 4172-4196 db, and .001 to .002 from 4210-4250 db
762/01	0-db level extrapolated
763/01	on recovery, rosette hit A-frame 3 ft off deck, damaging some bottles
764/01	
765/01	good tow
766/01	after in found 1 bad kink - reterminated
767/01	big swell - towing at 2 knots; after in found 4 kinks, probably from slack during launch - new end termination after cast; temperature, conductivity, salinity and oxygen look strange in area between 530 and 800 db, but sigma theta stays smooth - down/up casts very different in this area; 0-db level extrapolated
768/01	towed at 2+ knots - several slack wire surges 50-150 mwo; pinger not working; top 40 db CTD oxygen questionable; 0-db level extrapolated
769/01	UP cast (salinity offset on down cast); wind approx 23 knots & seas about same as station 768 - slack wire to deck about 25 mwo - wire looks ok: no kinks/ strands a little loose; 0-db level extrapolated
770/01	weather better: no slack wire; conductivity sensor cleaned before this station; top 60 db CTD oxygen questionable (noted at sea that oxygen sensor probably frozen as air temp -4.6 deg); 0-db level extrapolated
771/01	good weather; top 60 db CTD oxygen questionable (noted at sea that oxygen sensor probably frozen); 0-6-db levels extrapolated
772/01	top 50 db CTD oxygen questionable; 0-10-db levels extrapolated
773/01	freezing weather on deck; no CTD oxygen data (CTD oxygen sensor failed at 10 m); 0-12-db levels extrapolated
774/01	freezing weather on deck; no CTD oxygen data (no CTD oxygen sensor); 0-8-db levels extrapolated
775/01	freezing weather; no CTD oxygen data (no CTD oxygen sensor); 0,2-db levels extrapolated
776/01	freezing weather; stopped at 10 m to allow sensors to equilibrate; no CTD oxygen data (no CTD oxygen sensor); 0-12-db levels extrapolated

sta/cast	Comments
777/01	loose fresh sea ice (pancake ice) - rosette entered in clear water of prop wash/recovery in clear water; no CTD oxygen data (no CTD oxygen sensor); 0-16-db levels extrapolated
778/01	CTD cold-soaked or had ice on sensors - waited 4 min at 10 m to warm up/ thaw sensors; no CTD oxygen data (no CTD oxygen sensor); 0-8-db levels extrapolated
779/01	warmed CTD at 10 m for 3 min - top 10 m of down cast no good - sensors frozen; no CTD oxygen data (no CTD oxygen sensor); 0-8-db levels extrapolated
780/01	held at 10 m down to warm up CTD; no CTD oxygen data (no CTD oxygen sensor); 0-8-db levels extrapolated
781/01	no CTD oxygen data (no CTD oxygen sensor); 0-db level extrapolated
782/01	no CTD oxygen data (no CTD oxygen sensor); 0-db level extrapolated
783/01	CTD oxygen sensor back on; top 80 db CTD oxygen questionable; 0-db level extrapolated
784/01	top 50 db CTD oxygen questionable; 0-db level extrapolated
785/01	0,2-db levels extrapolated
786/01	0-db level extrapolated
787/01	sampled during blizzard; 0-db level extrapolated
788/01	big swell - tow at 2.5 knots - no slack during launch; slack wire on recovery approx 50 mwo even though no stop - wind 25 knots - rough seas - several bad kinks: new end termination; large wire angle
789/01	wind 21 knots - seas still rough - waiting for seas to die down; launch ok; on recovery, kink in level wind when paying out wire during recovery; 0-db level extrapolated
790/01	0-db level extrapolated
791/01	towing at 2 knots - ok; 0-db level extrapolated
792/01	towing at 1.5 knots, then increasing to 2 knots; top 80 db CTD oxygen questionable; 0-db level extrapolated
793/01	
794/01	final S4 station; 0-db level extrapolated
795/01	freon cast - not part of final data distribution; after recovery found 1 bad kink

IOFFE6: CAST STOPS LONGER THAN 1-MINUTE

station /cast	down /up	#minutes stopped	avg.pressure (decibars)	pressure range
682/01	DOWN	3.3	12	(10 - 14)
		5.5	34	(32 - 36)
		7.1	74	(72 - 76)
683/01	DOWN	3.4	12	(10 - 14)
		1.9	74	(72 - 76)
684/01	DOWN	3.6	11	(8 - 14)
		2.1	72	(70 - 74)
685/01	DOWN	2.1	12	(10 - 14)
		3.3	73	(70 - 76)
686/01	DOWN	1.5	12	(10 - 14)
		2.9	74	(72 - 76)
687/02	UP	2.6	11	(8 - 14)
		1.0	32	(30 - 34)
688/01	DOWN	4.0	9	(2 - 16)
689/01	DOWN	1.6	12	(10 - 14)
		2.0	72	(70 - 74)
690/01	DOWN	2.6	11	(8 - 14)
		2.1	71	(68 - 74)
691/01	DOWN	1.5	10	(8 - 12)
		4.7	74	(72 - 76)
		1.2	3998	(3996 - 4000)
692/01	DOWN	3.3	7	(2 - 12)
693/01	DOWN	1.3	11	(8 - 14)
694/01	DOWN	3.2	7	(2 - 12)
		2.6	70	(68 - 72)
697/01	DOWN	1.7	72	(70 - 74)
698/01	DOWN	3.9	103	(100 - 106)
		1.7	203	(202 - 204)
		1.3	4221	(4218 - 4224)
701/01	DOWN	3.2	72	(70 - 74)
702/02	UP	1.6	70	(68 - 72)
703/01	DOWN	1.2	149	(148 - 150)
704/01	DOWN	3.1	196	(194 - 198)
		2.4	495	(490 - 500)
711/01	DOWN	4.4	4251	(4248 - 4254)
712/01	DOWN	1.4	4145	(4144 - 4146)
768/01	DOWN	1.5	1257	(1252 - 1262)
		1.5	1297	(1294 - 1300)
787/01	DOWN	1.0	2350	(2348 - 2352)
		1.2	2784	(2782 - 2786)

IOFFE6: CTD Temperature and Conductivity Corrections Summary

Sta/ Cast	PRT Response Time (secs)	Temperature Coefficients corT = $t2*T^2 + t1*T + t0$ t2	t1	t0	Conductivity Coefficients corC = $c1*C + c0$ c1	c0
682/01	.325	2.18853e-05	-8.35260e-04	-1.4839	-1.50792e-03	0.0410
683/01	.325	2.18853e-05	-8.35260e-04	-1.4839	-1.50792e-03	0.0410
684/01	.325	2.18853e-05	-8.35260e-04	-1.4839	-1.50792e-03	0.0410
685/01	.325	2.18853e-05	-8.35260e-04	-1.4839	-1.50792e-03	0.0410
686/01	.325	2.18853e-05	-8.35260e-04	-1.4839	-1.50792e-03	0.0410
687/02	.325	2.18853e-05	-8.35260e-04	-1.4839	-1.50792e-03	0.0453
688/01	.325	2.18853e-05	-8.35260e-04	-1.4839	-1.50792e-03	0.0463
689/01	.325	2.18853e-05	-8.35260e-04	-1.4839	-1.50792e-03	0.0468
690/01	.325	2.18853e-05	-8.35260e-04	-1.4839	-1.50792e-03	0.0453
691/01	.325	2.18853e-05	-8.35260e-04	-1.4839	-1.50792e-03	0.0434
692/01	.325	2.18853e-05	-8.35260e-04	-1.4839	-1.50792e-03	0.0434
693/01	.325	2.18853e-05	-8.35260e-04	-1.4839	-1.50792e-03	0.0434
694/01	.325	2.18853e-05	-8.35260e-04	-1.4839	-1.50792e-03	0.0434
695/01	.325	2.18853e-05	-8.35260e-04	-1.4839	-1.50792e-03	0.0434
696/01	.325	2.18853e-05	-8.35260e-04	-1.4839	-1.50792e-03	0.0434
697/01	.325	2.18853e-05	-8.35260e-04	-1.4839	-1.50792e-03	0.0434
698/01	.325	2.18853e-05	-8.35260e-04	-1.4839	-1.50792e-03	0.0434
699/01	.325	2.18853e-05	-8.35260e-04	-1.4839	-1.50792e-03	0.0434
700/01	.325	2.18853e-05	-8.35260e-04	-1.4839	-1.50792e-03	0.0434
701/01	.325	2.18853e-05	-8.35260e-04	-1.4839	-1.50792e-03	0.0434
702/02	.325	2.18853e-05	-8.35260e-04	-1.4839	-1.50792e-03	0.0449
703/01	.325	2.18853e-05	-8.35260e-04	-1.4839	-1.50792e-03	0.0434
704/01	.325	2.18853e-05	-8.35260e-04	-1.4839	-1.50792e-03	0.0434
705/01	.325	2.18853e-05	-8.35260e-04	-1.4839	-1.50792e-03	0.0434
706/01	.325	2.18853e-05	-8.35260e-04	-1.4839	-1.50792e-03	0.0434
707/01	.325	2.18853e-05	-8.35260e-04	-1.4839	-1.50792e-03	0.0434
708/01	.325	2.18853e-05	-8.35260e-04	-1.4839	-1.50792e-03	0.0434
709/01	.325	2.18853e-05	-8.35260e-04	-1.4839	-1.50792e-03	0.0434
710/01	.325	2.18853e-05	-8.35260e-04	-1.4839	-1.50792e-03	0.0434
711/01	.325	2.18853e-05	-8.35260e-04	-1.4839	-1.50792e-03	0.0754
712/01	.325	2.18853e-05	-8.35260e-04	-1.4839	-1.50792e-03	0.0404
713/01	.325	2.18853e-05	-8.35260e-04	-1.4839	-1.50792e-03	0.0404
714/01	.325	2.18853e-05	-8.35260e-04	-1.4839	-1.50792e-03	0.0404
715/01	.325	2.18853e-05	-8.35260e-04	-1.4839	-1.50792e-03	0.0404
716/01	.325	2.18853e-05	-8.35260e-04	-1.4839	-1.50792e-03	0.0404
717/01	.325	2.18853e-05	-8.35260e-04	-1.4839	-1.50792e-03	0.0404
718/01	.325	2.18853e-05	-8.35260e-04	-1.4839	-1.50792e-03	0.0404
719/01	.325	2.18853e-05	-8.35260e-04	-1.4839	-1.50792e-03	0.0404
720/01	.325	2.18853e-05	-8.35260e-04	-1.4839	-1.50792e-03	0.0404
721/01	.325	2.18853e-05	-8.35260e-04	-1.4839	-1.50792e-03	0.0404
722/01	.325	2.18853e-05	-8.35260e-04	-1.4839	-1.50792e-03	0.0404
723/01	.325	2.18853e-05	-8.35260e-04	-1.4839	-1.50792e-03	0.0404
724/01	.325	2.18853e-05	-8.35260e-04	-1.4839	-1.50792e-03	0.0404
725/01	.325	2.18853e-05	-8.35260e-04	-1.4839	-1.50792e-03	0.0404
726/01	.325	2.18853e-05	-8.35260e-04	-1.4839	-1.50792e-03	0.0404
727/01	.325	2.18853e-05	-8.35260e-04	-1.4839	-1.50792e-03	0.0404
728/01	.325	2.18853e-05	-8.35260e-04	-1.4839	-1.50792e-03	0.0404
729/01	.325	2.18853e-05	-8.35260e-04	-1.4839	-1.50792e-03	0.0404

Sta/ Cast	PRT Response Time (secs)	Temperature Coefficients $corT = t2*T^2 + t1*T + t0$			Conductivity Coefficients $corC = c1*C + c0$	
		t2	t1	t0	c1	c0
730/01	.325	2.18853e-05	-8.35260e-04	-1.4839	-1.50792e-03	0.0404
731/01	.325	2.18853e-05	-8.35260e-04	-1.4839	-1.50792e-03	0.0404
732/01	.325	2.18853e-05	-8.35260e-04	-1.4839	-1.50792e-03	0.0404
733/01	.325	2.18853e-05	-8.35260e-04	-1.4839	-1.50792e-03	0.0404
734/01	.325	2.18853e-05	-8.35260e-04	-1.4839	-1.50792e-03	0.0404
735/01	.325	2.18853e-05	-8.35260e-04	-1.4839	-1.50792e-03	0.0404
736/01	.325	2.18853e-05	-8.35260e-04	-1.4839	-1.50792e-03	0.0404
737/01	.325	2.18853e-05	-8.35260e-04	-1.4839	-1.50792e-03	0.0404
738/01	.325	2.18853e-05	-8.35260e-04	-1.4839	-1.50792e-03	0.0404
739/01	.325	2.18853e-05	-8.35260e-04	-1.4839	-1.50792e-03	0.0404
740/01	.325	2.18853e-05	-8.35260e-04	-1.4839	-1.50792e-03	0.0404
741/01	.325	2.18853e-05	-8.35260e-04	-1.4839	-1.50792e-03	0.0404
742/01	.325	2.18853e-05	-8.35260e-04	-1.4839	-1.50792e-03	0.0404
743/01	.325	2.18853e-05	-8.35260e-04	-1.4839	-1.50792e-03	0.0404
744/01	.325	2.18853e-05	-8.35260e-04	-1.4839	-1.50792e-03	0.0404
745/01	.325	2.18853e-05	-8.35260e-04	-1.4839	-1.50792e-03	0.0404
746/01	.325	2.18853e-05	-8.35260e-04	-1.4839	-1.50792e-03	0.0394
747/01	.325	2.18853e-05	-8.35260e-04	-1.4839	-1.50792e-03	0.0404
748/01	.325	2.18853e-05	-8.35260e-04	-1.4839	-1.50792e-03	0.0404
749/01	.325	2.18853e-05	-8.35260e-04	-1.4839	-1.50792e-03	0.0404
750/01	.325	2.18853e-05	-8.35260e-04	-1.4839	-1.50792e-03	0.0404
751/01	.325	2.18853e-05	-8.35260e-04	-1.4839	-1.50792e-03	0.0404
752/01	.325	2.18853e-05	-8.35260e-04	-1.4839	-1.50792e-03	0.0419
753/01	.325	2.18853e-05	-8.35260e-04	-1.4839	-1.50792e-03	0.0404
754/01	.325	2.18853e-05	-8.35260e-04	-1.4839	-1.50792e-03	0.0404
755/01	.325	2.18853e-05	-8.35260e-04	-1.4839	-1.50792e-03	0.0414
756/01	.325	2.18853e-05	-8.35260e-04	-1.4839	-1.50792e-03	0.0404
757/01	.325	2.18853e-05	-8.35260e-04	-1.4839	-1.50792e-03	0.0404
758/01	.325	2.18853e-05	-8.35260e-04	-1.4839	-1.50792e-03	0.0404
759/01	.325	2.18853e-05	-8.35260e-04	-1.4839	-1.50792e-03	0.0404
760/01	.325	2.18853e-05	-8.35260e-04	-1.4839	-1.50792e-03	0.0404
761/01	.325	2.18853e-05	-8.35260e-04	-1.4839	-1.50792e-03	0.0404
762/01	.325	2.18853e-05	-8.35260e-04	-1.4839	-1.50792e-03	0.0383
763/01	.325	2.18853e-05	-8.35260e-04	-1.4839	-1.50792e-03	0.0383
764/01	.325	2.18853e-05	-8.35260e-04	-1.4839	-1.50792e-03	0.0383
765/01	.325	2.18853e-05	-8.35260e-04	-1.4839	-1.50792e-03	0.0383
766/01	.325	2.18853e-05	-8.35260e-04	-1.4839	-1.50792e-03	0.0383
767/01	.325	2.18853e-05	-8.35260e-04	-1.4839	-1.50792e-03	0.0383
768/01	.325	2.18853e-05	-8.35260e-04	-1.4839	-1.50792e-03	0.0383
769/01	.325	2.18853e-05	-8.35260e-04	-1.4839	-1.50792e-03	0.0398
770/01	.325	2.18853e-05	-8.35260e-04	-1.4839	-1.50792e-03	0.0367
771/01	.325	2.18853e-05	-8.35260e-04	-1.4839	-1.50792e-03	0.0367
772/01	.325	2.18853e-05	-8.35260e-04	-1.4839	-1.50792e-03	0.0367
773/01	.325	2.18853e-05	-8.35260e-04	-1.4839	-1.50792e-03	0.0367
774/01	.325	2.18853e-05	-8.35260e-04	-1.4839	-1.50792e-03	0.0367
775/01	.325	2.18853e-05	-8.35260e-04	-1.4839	-1.50792e-03	0.0367
776/01	.325	2.18853e-05	-8.35260e-04	-1.4839	-1.50792e-03	0.0367
777/01	.325	2.18853e-05	-8.35260e-04	-1.4839	-1.50792e-03	0.0367
778/01	.325	2.18853e-05	-8.35260e-04	-1.4839	-1.50792e-03	0.0367

Sta/ Cast	PRT Response Time (secs)	Temperature Coefficients $corT = t2*T^2 + t1*T + t0$			Conductivity Coefficients $corC = c1*C + c0$	
		t2	t1	t0	c1	c0
779/01	.325	2.18853e-05	-8.35260e-04	-1.4839	-1.50792e-03	0.0367
780/01	.325	2.18853e-05	-8.35260e-04	-1.4839	-1.50792e-03	0.0367
781/01	.325	2.18853e-05	-8.35260e-04	-1.4839	-1.50792e-03	0.0367
782/01	.325	2.18853e-05	-8.35260e-04	-1.4839	-1.50792e-03	0.0367
783/01	.325	2.18853e-05	-8.35260e-04	-1.4839	-1.50792e-03	0.0367
784/01	.325	2.18853e-05	-8.35260e-04	-1.4839	-1.50792e-03	0.0367
785/01	.325	2.18853e-05	-8.35260e-04	-1.4839	-1.50792e-03	0.0367
786/01	.325	2.18853e-05	-8.35260e-04	-1.4839	-1.50792e-03	0.0367
787/01	.325	2.18853e-05	-8.35260e-04	-1.4839	-1.50792e-03	0.0357
788/01	.325	2.18853e-05	-8.35260e-04	-1.4839	-1.50792e-03	0.0357
789/01	.325	2.18853e-05	-8.35260e-04	-1.4839	-1.50792e-03	0.0367
790/01	.325	2.18853e-05	-8.35260e-04	-1.4839	-1.50792e-03	0.0367
791/01	.325	2.18853e-05	-8.35260e-04	-1.4839	-1.50792e-03	0.0367
792/01	.325	2.18853e-05	-8.35260e-04	-1.4839	-1.50792e-03	0.0367
793/01	.325	2.18853e-05	-8.35260e-04	-1.4839	-1.50792e-03	0.0367
794/01	.325	2.18853e-05	-8.35260e-04	-1.4839	-1.50792e-03	0.0367

Summary of IOFFE6 CTD Oxygen Time Constants

Temperature		Press.	O2 Grad.
Fast(tauTF)	Slow(tauTS)	(tauP)	(tauOG)
32.0	363.0	19.4	60.0

IOFFE6 CTD Oxygen: Levenberg-Marquardt Non-linear Least-Squares-Fit Coefficients

Sta/ Cast	Slope (c1)	Offset (c2)	Pcoeff (c3)	TFcoeff (c4/fast)	TScoeff (c5/slow)	OGcoeff (c6)
682/01	4.41656e-04	2.81506e-01	2.59066e-04	-1.18066e-01	8.75760e-02	-5.92099e-05
683/01	1.12553e-03	-3.49833e-01	-8.22970e-05	3.68271e-02	-3.19311e-03	-5.34368e-03
684/01	6.16649e-04	1.61790e-01	-4.60659e-04	-5.03203e-02	2.24278e-02	1.04247e-02
685/01	7.08322e-04	-7.98769e-02	-5.66257e-05	-3.27601e-02	9.56105e-02	-2.11736e-03
686/01	6.81419e-04	-1.51064e-01	1.80425e-04	-2.71929e-02	-1.50646e-02	1.83377e-05
691/01	1.06698e-03	-2.53905e-02	1.63225e-04	-1.37322e-02	-7.67522e-03	-4.78056e-04
693/01	1.24055e-03	-8.53240e-02	1.75683e-04	1.35587e-02	-6.06646e-02	3.96825e-03
694/01	1.13914e-03	-4.54231e-02	1.67281e-04	1.90263e-02	-3.38050e-02	-2.89906e-03
695/01	1.25086e-03	-1.49895e-01	2.24898e-04	4.22672e-02	-2.73415e-02	-1.12904e-02
696/01	1.15387e-03	2.69581e-02	1.19573e-04	-3.07104e-02	-4.85211e-02	2.10160e-02
697/01	1.25846e-03	-8.04296e-02	1.69573e-04	1.06062e-02	-5.16751e-02	7.56906e-03
698/01	9.97905e-04	2.12734e-02	1.50025e-04	-1.26084e-02	2.83711e-03	-5.24004e-04
699/01	1.13006e-03	-4.24718e-02	1.68862e-04	-5.55727e-04	-1.61875e-02	4.39058e-03
700/01	1.09283e-03	-2.81896e-03	1.51030e-04	9.62159e-03	-3.68770e-02	2.03188e-03
701/01	1.20881e-03	-1.13564e-01	2.04570e-04	1.35117e-02	-7.07136e-03	7.47335e-04
702/02	1.13335e-03	-4.48679e-02	1.66911e-04	-1.47351e-02	2.48849e-02	-4.93871e-03
703/01	4.95642e-04	3.41654e-01	5.72309e-05	-1.30936e-01	8.31153e-02	-1.47493e-02
704/01	1.08428e-03	-4.90157e-02	1.81499e-04	-2.35185e-03	9.69122e-03	-3.51149e-03
705/01	9.51020e-04	1.23543e-01	9.83544e-05	-8.45067e-02	2.29196e-02	1.99789e-02
706/01	1.12179e-03	-7.51298e-02	1.95906e-04	-5.71601e-04	1.78119e-02	-3.25526e-03
707/01	1.13968e-03	-3.36107e-02	1.61342e-04	-1.24755e-02	-1.05295e-02	4.88687e-03
708/01	1.09264e-03	2.40151e-02	1.32699e-04	-3.40506e-02	-1.43238e-02	1.33208e-02
709/01	1.17928e-03	-8.47251e-02	1.89398e-04	2.05195e-02	-2.48384e-02	1.17111e-02
710/01	9.80998e-04	1.20630e-01	1.00686e-04	-5.23040e-02	-1.81247e-02	2.19228e-02
711/01	9.96184e-04	1.34570e-01	9.13930e-05	-6.80733e-02	-1.92439e-02	2.94639e-02
712/01	1.15907e-03	-5.53703e-03	1.43922e-04	-2.32606e-02	-1.47306e-02	-1.78617e-04
713/01	1.21997e-03	-6.29919e-02	1.73581e-04	-1.66829e-02	-5.79670e-03	-3.99356e-03
714/01	1.31936e-03	-1.47018e-01	2.10924e-04	-2.05979e-02	3.30750e-02	1.19064e-03
715/01	1.33844e-03	-1.31428e-01	1.91589e-04	3.60549e-02	-3.88092e-02	-4.04108e-04
716/01	1.29558e-03	-1.21359e-01	1.95892e-04	2.69460e-02	-3.68500e-02	5.28753e-03
717/01	6.17421e-04	3.18335e-01	5.54860e-05	-7.22565e-02	-1.39745e-03	-5.12861e-03
718/01	1.25441e-03	-1.27688e-01	2.11262e-04	3.90072e-02	-2.30022e-02	-2.28054e-02
722/01	1.02297e-03	4.00209e-02	1.37768e-04	-2.67640e-02	8.86520e-03	-3.32302e-03
725/01	1.01728e-03	1.24892e-02	1.51013e-04	-4.12244e-02	-1.07148e-02	1.59435e-02
726/01	9.22823e-04	8.80208e-02	1.25605e-04	-1.34292e-02	-2.12598e-02	4.10653e-03
727/01	9.43562e-04	9.17664e-02	1.18396e-04	-3.85186e-02	-1.00319e-02	6.38133e-03

Sta/ Cast	Slope (c1)	Offset (c2)	Pcoeff (c3)	TFcoeff (c4/fast)	TScoeff (c5/slow)	OGcoeff (c6)
728/01	1.02918e-03	1.84145e-02	1.48880e-04	-1.35024e-02	-1.25400e-02	4.99005e-03
729/01	1.04585e-03	4.14905e-02	1.32547e-04	-2.11893e-02	-2.34922e-02	7.62123e-03
730/01	9.30988e-04	9.30923e-02	1.20562e-04	-3.05369e-02	6.00394e-03	-8.30193e-03
731/01	9.87435e-04	5.70260e-02	1.32424e-04	-2.90472e-02	-2.43773e-03	3.13893e-03
732/01	9.66307e-04	8.32789e-02	1.23135e-04	-2.28400e-02	-1.56844e-02	3.33191e-03
733/01	1.00736e-03	5.15322e-02	1.34336e-04	-2.11251e-02	-8.56873e-03	1.91424e-03
734/01	1.06679e-03	9.28361e-04	1.55277e-04	-1.09244e-02	-2.94109e-03	3.02109e-03
735/01	1.07422e-03	1.63055e-02	1.43831e-04	-1.60743e-02	-1.17162e-02	5.20765e-03
736/01	1.06161e-03	3.51262e-02	1.36107e-04	-1.49699e-02	-2.47393e-02	4.63908e-03
737/01	9.43655e-04	9.54865e-02	1.22031e-04	-2.35100e-02	-1.29253e-02	1.03330e-03
738/01	1.01605e-03	4.69968e-02	1.36045e-04	-2.45487e-02	-4.42285e-03	6.98044e-03
739/01	1.04500e-03	4.12862e-02	1.34994e-04	-2.21867e-02	-2.67270e-02	6.59985e-03
740/01	1.00722e-03	4.68610e-02	1.37644e-04	-2.82343e-02	-1.27683e-02	9.70662e-03
741/01	1.07689e-03	6.21134e-03	1.51098e-04	-2.14836e-02	-2.29251e-03	1.66719e-03
742/01	1.11749e-03	-1.99199e-02	1.59652e-04	-2.32734e-02	-2.91259e-03	5.71045e-03
743/01	1.08062e-03	2.41658e-03	1.54384e-04	-5.48815e-04	-1.51616e-02	2.73304e-03
744/01	7.92861e-04	2.03175e-01	8.83111e-05	-7.48440e-02	-6.32590e-03	1.05644e-02
745/01	9.78509e-04	1.29462e-01	9.39197e-05	-8.56711e-02	-2.68440e-02	1.76821e-02
746/01	1.06157e-03	3.33899e-02	1.34159e-04	-4.94038e-02	-3.17785e-02	1.07234e-02
747/01	1.03218e-03	4.64828e-02	1.33465e-04	-3.57133e-02	-2.10449e-02	1.25009e-02
748/01	1.00945e-03	5.05572e-02	1.36613e-04	-2.77915e-02	-1.18835e-03	3.90772e-03
749/01	1.08489e-03	-3.15783e-03	1.59603e-04	-7.30272e-03	-5.27910e-03	8.99389e-04
750/01	9.81795e-04	7.61463e-02	1.27556e-04	-2.54811e-02	-9.14099e-03	5.19314e-03
751/01	1.03046e-03	6.21426e-02	1.26067e-04	-2.63776e-02	-3.74864e-02	1.60283e-02
752/01	1.06352e-03	3.38857e-03	1.60193e-04	-6.69881e-03	1.27223e-03	2.82855e-03
753/01	1.19316e-03	-7.14764e-02	1.83943e-04	2.02358e-02	-1.73475e-02	-1.51704e-03
754/01	1.06753e-03	-1.20240e-02	1.71504e-04	-1.47634e-02	1.15604e-02	5.94094e-04
755/01	1.04002e-03	3.34986e-02	1.43687e-04	-3.56100e-02	1.20365e-02	4.30685e-03
756/01	1.11417e-03	-2.90768e-02	1.72046e-04	-6.36752e-03	1.53638e-03	-3.22713e-03
757/01	1.03159e-03	5.17161e-02	1.32950e-04	-2.78426e-02	-1.22045e-02	4.45065e-03
758/01	1.06727e-03	3.26866e-02	1.40032e-04	-2.00083e-02	-2.21015e-02	4.19773e-03
759/01	1.07458e-03	2.32103e-02	1.43934e-04	3.31199e-03	-3.82828e-02	4.30527e-03
760/01	1.03626e-03	4.95339e-02	1.33178e-04	-4.58149e-02	6.18640e-03	6.81963e-03
761/01	1.37846e-03	-1.86038e-01	2.27162e-04	4.58648e-02	-3.96518e-02	1.45495e-03
762/01	1.02235e-03	4.93738e-02	1.35020e-04	-2.86184e-02	-1.67663e-03	3.29039e-03
763/01	9.56944e-04	8.21471e-02	1.27766e-04	-3.08040e-02	-8.93907e-04	4.38508e-03
764/01	9.95644e-04	8.16647e-02	1.20702e-04	5.78796e-03	-4.89629e-02	1.14173e-02
765/01	8.81785e-04	1.59011e-01	9.60669e-05	-7.35669e-02	3.03010e-05	9.06128e-03
766/01	6.66657e-04	3.11005e-01	5.35788e-05	-9.58272e-02	-2.77111e-02	2.20680e-02
767/01	1.00595e-03	8.70842e-02	1.13879e-04	-6.61491e-02	-1.71870e-03	7.47700e-03
768/01	1.00595e-03	8.70842e-02	1.13879e-04	-6.61491e-02	-1.71870e-03	7.47700e-03
769/01	9.60211e-04	1.31875e-01	9.47621e-05	-7.78393e-02	1.85687e-02	5.80810e-03
770/01	2.85714e-04	5.69253e-01	-9.57164e-06	-1.79322e-01	-1.94009e-02	5.99516e-03
771/01	1.43330e-03	-1.49962e-01	1.79819e-04	-1.35956e-02	-4.59710e-02	1.68344e-03
772/01	4.99006e-04	3.08401e-01	8.56742e-05	-5.32395e-02	1.81703e-02	8.53352e-04

Sta/ Cast	Slope (c1)	Offset (c2)	Pcoeff (c3)	TFcoeff (c4/fast)	TScoeff (c5/slow)	OGcoeff (c6)
783/01	3.99416e-04	3.29057e-01	2.86458e-05	-1.43662e-01	1.22821e-02	1.81898e-02
784/01	8.27242e-04	6.18770e-02	3.80352e-05	-8.66567e-02	-7.50808e-02	2.46716e-02
785/01	5.82952e-04	2.64293e-01	1.51268e-05	-1.72123e-01	5.02482e-04	1.82899e-02
786/01	7.01986e-04	1.30892e-01	5.17891e-05	-1.56562e-01	2.89275e-02	2.24523e-02
787/01	1.13594e-03	-2.45698e-01	2.19656e-04	4.84864e-02	-1.08180e-02	-8.06271e-03
788/01	4.41362e-04	3.93432e-01	2.77288e-05	-1.32294e-01	-2.46089e-02	1.92975e-02
789/01	8.56845e-04	4.45344e-02	1.25687e-04	-5.25621e-02	-1.12070e-02	7.20958e-03
790/01	7.66731e-04	1.10904e-01	1.19183e-04	-9.05424e-03	-5.64651e-02	1.77683e-02
791/01	5.69547e-04	2.64954e-01	7.08795e-05	-9.53088e-02	-2.07165e-03	9.90014e-03
792/01	4.29547e-04	3.91761e-01	1.75663e-05	-9.66987e-02	-2.63754e-03	1.92703e-02
793/01	8.69680e-04	1.75433e-02	1.48746e-04	-4.27301e-02	5.44298e-03	-1.32688e-03
794/01	8.85232e-04	2.84766e-01	-6.96094e-04	-1.20620e-02	1.18321e-01	-1.52724e-03

World Ocean Circulation Experiment (WOCE) S4P

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DESCRIPTION OF MEASUREMENT TECHNIQUES AND CALIBRATIONS

ODF CTD/rosette casts were carried out with a 24 bottle rosette sampler of ODF manufacture using General Oceanics pylons. An ODF-modified NBIS Mark 3 CTD, a Benthos altimeter and a SeaTech transmissometer provided by Texas A&M University (TAMU) were mounted on the rosette frame. Seawater samples were collected in 10-liter PVC Niskin and ODF bottles mounted on the rosette frame. A Benthos pinger with a self-contained battery pack was mounted separately on the rosette frame; its signal was displayed on the precision depth recorder (PDR) in the ship's laboratory. The rosette/CTD was suspended from a three-conductor wire which provided power to the CTD and relayed the CTD signal to the laboratory.

Each CTD cast extended to within approximately 10 meters of the bottom unless the bottom returns from both the pinger and the altimeter were extremely poor. The bottles were numbered 1 through 24. When one of these 24 bottles needed servicing and repairs could not be accomplished by the next cast, the replacement bottle was given a new number. The replacement bottles were numbered 25 through 30. Subsets of CTD data taken at the time of water sample collection were transmitted to the bottle data files immediately after each cast to provide pressure and temperature at the sampling depth, and to facilitate the examination and quality control of the bottle data as the laboratory analyses were completed. The CTD data and documentation are submitted separately to the chief scientist.

After each rosette cast was brought on board, water samples were drawn in the following order: Freon (CFC-11 and CFC-12), Helium-3, Oxygen, ΣCO_2, Alkalinity, AMS ^{14}C, Tritium, Nutrients (silicate, phosphate, nitrate and nitrite), and Salinity. The samples and the ODF or Niskin sampler they were drawn from were recorded on the Sample Log sheet. Comments regarding integrity of the water sample (valve open, lanyard caught in lid, etc.) were also noted on the Sample Log sheets.

The discrete hydrographic data were entered into the shipboard data system and processed as the analyses were completed. The bottle data were brought to a useable, though not final, state at sea. ODF data checking procedures included verification that the sample was assigned to the correct depth. This was accomplished by checking the raw data sheets, which included the raw data value and the water sample bottle, versus the sample log sheets. Any comments regarding the water samples were investigated. The raw data computer files were also checked for entry errors. Investigation of data included comparison of bottle salinity and oxygen with CTD data, and review of data plots of the station profile alone and compared to nearby stations.

If a data value did not either agree satisfactorily with the CTD or with other nearby data, then analysis and sampling notes, plots, and nearby data were reviewed. If any problem was indicated, the data value was flagged. Appendix E, the Bottle Data Processing Notes, includes comments regarding missing samples and investigative remarks for comments made on the Sample Log sheets, as well as all flagged (WOCE coded) data values.

The WOCE codes were assigned to the water data using the criteria:

code 4 = Does not fit station profile and/or adjoining station comparisons. There are analytical notes indicating a problem, but data values are reported. ODF recommends deletion of these data values. Analytical notes for salinity and/or oxygen may include large differences between the water sample and CTD profiles. Sampling errors are also coded 4.

code 3 = Does not fit station profile or adjoining station comparisons. No notes from analyst indicating a problem. Datum could be real, but the decision as to whether it is acceptable will be made by a scientist rather than ODF s technicians.

code 2 = Acceptable measurement.

code 1 = Sample for this measurement was drawn from water bottle, but results of analysis not received.

The quality flags assigned to the bottle as defined in the WOCE Operations manual are further clarified as follows: If the bottle tripped at a different level than planned, ODF assigned it a code 4. If the bottle tripped between the scheduled trip and the next trip, as indicated by the water sample data, ODF coded these bottles 3. If there is a 4 code on the bottle, and 2 codes on the salinity, oxygen and nutrients then the pressure assignment was probably correct. An air leak is identified by a 3 code on the bottle and 4 code on the oxygen. Air leaks only affect the gas samples.

The following table shows the number of ODF samples drawn and the number of times each WOCE sample code was assigned.

Rosette Samples Stations 682-794

	Reported levels	WHP Quality Codes 1	2	3	4	5	7	9
Bottle	2612	0	2500	30	71	0	0	11
CTD Salt	2590	0	2565	24	1	0	0	22
CTD Oxy	2099	0	2040	59	0	24	0	489
Salinity	2565	0	2493	35	37	0	0	47
Oxygen	2553	0	2515	9	29	9	0	50
Silicate	2561	0	2533	6	22	3	0	48
Nitrate	2561	0	2484	56	21	3	0	48
Nitrite	2561	0	2538	2	21	3	0	48
Phosphate	2560	0	2532	7	21	4	0	48

Pressure and Temperature

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. All reported CTD data are calibrated and processed with the methodology described in the documentation accompanying the CTD data submission.

The temperatures are based on the International Temperature Scale of 1990.

Salinity

The water sample salinities were measured with an ODF-modified Guildline Autosal Model 8400A salinometer (Serial Number 57-396) that was standardized for each cast with IAPSO Standard Seawater (SSW) Batch P-108. Salinity samples were drawn into 200 ml Kimax high alumina borosilicate bottles with custom- made plastic insert thimbles and Nalgene screw caps. This assembly provides very low container dissolution and sample evaporation. Salinity was determined after sample equilibration to laboratory temperature, usually within 8-36 hours of collection. Salinometers were located in a temperature-controlled laboratory. Only one salinometer was used for the salinity samples. This salinometer was connected to a computer to automate the data acquisition.

Salinity bottles were rinsed three times before filling. Salinity has been calculated according to the equations of the Practical Salinity Scale of 1978 (UNESCO, 1981). This calculation uses the conductivity ratio determined from bottle samples analyzed (minimum of two recorded analyses per sample bottle after flushing). The Autosal salinometer was calibrated against a single batch of Wormley IAPSO standard seawater, P-108, with at least one fresh vial opened per cast.

Accuracy estimates of bottle salinities run at sea are usually better than 0.002 psu relative to the specified batch of standard. Although laboratory precision of the Autosal can be as small as 0.0002 psu when running replicate samples under ideal conditions, at sea the expected precision is about 0.001 psu under normal conditions, with a stable lab temperature.

Oxygen

Samples were collected for dissolved oxygen analyses soon after the rosette sampler was brought on board and after CFC and helium were drawn. Nominal 125 ml volume iodine flasks were rinsed carefully 3 times using sample seawater with minimal agitation, then filled via a drawing tube, and allowed to overflow for at least 2 flask volumes. The draw temperature was measured and reagents were added to fix the oxygen before stoppering. The flasks were shaken twice; immediately after drawing, and then again after 20 minutes, to assure thorough dispersion of the $Mn(OH)_2$ precipitate. The samples were analyzed within 4-36 hours of collection.

Dissolved oxygen analyses, reported in micromoles per kilogram, were performed via titration in the volume-calibrated iodine flasks with an SIO automated oxygen titrator with a Dosimat 665 buret driver fitted with a 1.0 ml buret, using the whole-bottle Winkler titration following the technique of Carpenter (1965) with modifications by Culberson *et al.* (1991). Standardizations were performed with 0.01N potassium iodate solutions prepared from preweighed potassium iodate crystals. Standards were run at the beginning of each session of analyses, which typically included from 1 to 3 stations. Several standards were made up and compared to assure that the results were reproducible, and to preclude the possibility of a weighing error. A correction was made for the amount of oxygen introduced with the reagents. Combined reagent/distilled water blanks were determined to account for oxidizing or reducing materials in the reagents.

The data processor and/or analyst plotted the oxygen standards and blanks and reviewed the data for possible problems with standards and/or blanks.

Oxygens were converted from milliliters per liter to micromoles per kilogram using the in-situ temperature. Ideally, for whole-bottle titrations, the conversion temperature should be the temperature of the water issuing from the Niskin bottle spigot. The temperature of the samples was measured at the time the sample was drawn from the bottle, but were not used in the conversion from milliliters per liter to micromoles per kilogram because the software is not available. Aberrant temperatures provided an additional flag indicating that a bottle may not have tripped properly. Measured sample temperatures from mid-deep water samples were about 4-7°C warmer than in-situ temperature. Had the conversion with the measured sample temperature been made, converted oxygen values, would be about 0.08% higher for a 6°C warming (or about 0.2μmol/kg for a 250μmol/kg sample).

Nutrients

The nutrient analyses were performed by an analyst from Scripps Institution of Oceanography, Shipboard Technical Support/Oceanographic Data Facility (STS/ODF). Nutrients (phosphate, silicate, nitrate and nitrite) analyses, reported in micromoles/kilogram, were performed on a modified AutoAnalyzer II. The procedures used are described in Gordon *et al.* (1992). Standardizations were performed with solutions prepared aboard ship from preweighed standards. These solutions were used as working standards before and after each cast (approximately 24 samples) to correct for instrumental drift during analyses. Sets of 4-6 different concentrations of shipboard standards were analyzed periodically to determine the linearity of colorimeter response and the resulting correction factors. Phosphate was analyzed using hydrazine reduction of phosphomolybdic acid as described by Bernhardt & Wilhelms (1967). Silicate was analyzed using stannous chloride reduction of silicomolybdic acid. Nitrite was analyzed using diazotization and coupling to form dye; nitrate was reduced by copperized cadmium and then analyzed as nitrite. These three analyses use the methods of Armstrong *et al.* (1967).

Samples were drawn into 45 ml high density polypropylene, narrow mouth, screw-capped centrifuge tubes which were rinsed twice before filling. Some samples may have been refrigerated at 2 to 6°C for a maximum of 12 hours.

Nutrients were converted from micromoles per liter to micromoles per kilogram by dividing by sample density calculated at a laboratory temperature measured at 25°C.

DATA COMPARISONS AND COMMENTS

The oxygen and nutrient data were compared by ODF with those from adjacent stations. Dr. James Swift did comparisons with historical data sets.

Data checking procedures included verification of sample depth, accuracy of data entry, and data comparisons. Checking the raw data recordings, which included the raw data value and the water sample bottle, versus the sample log sheets verified sample trip depths. The raw data computer files were also checked against data sheets and logs for entry errors. Investigation of data included comparison of bottle salinity and oxygen with CTD data, and review of data plots of the station profile alone and compared to nearby stations.

If a data value did not either agree satisfactorily with the CTD or with other nearby data (for example in a plot comparison), analysis and sampling notes, plots, and nearby data were reviewed. If any problem was indicated the data value was flagged. ODF preserved all bottle data values.

Historically, most failures to return a validated water sample can be traced to the rosette pylon, with ship's wire and CTD cable end termination the next most frequent leading cause. However, on this expedition the pylons and wire worked nearly perfectly, and the leading causes of failure to return a reportable water sample were miscellaneous mechanical problems with the rosette bottles, i.e., a lanyard hanging up in a lid, open spigot and/or vent.

REFERENCES AND UNCITED SUPPORTING DOCUMENTATION

Armstrong, F. A. J., C. R. Stearns, and J. D. H. Strickland, 1967. The measurement of upwelling and subsequent biological processes by means of the Technicon Autoanalyzer and associated equipment, *Deep-Sea Research,* **14**, 381-389.

Atlas, E. L., S. W. Hager, L. I. Gordon and P. K. Park, 1971. A Practical Manual for Use of the Technicon® AutoAnalyzer® in Seawater Nutrient Analyses; Revised. Technical Report 215, Reference 71-22. Oregon State University, Department of Oceanography. 49 pp.

Bernhardt, H. and A. Wilhelms, 1967. The continuous determination of low level iron, soluble phosphate and total phosphate with the AutoAnalyzer, Technicon Symposia, Volume I, 385-389.

Brewer, P. G. and G. T. F. Wong, 1974. The determination and distribution of iodate in South Atlantic waters. *Journal of Marine Research,* **32**,1:25-36.

Bryden, H. L., 1973. New Polynomials for Thermal Expansion, Adiabatic Temperature Gradient, *Deep-Sea Research*, **20**, 401-408.

Carpenter, J. H., 1965. The Chesapeake Bay Institute technique for the Winkler dissolved oxygen method, *Limnology and Oceanography,* **10**, 141-143.

Carter, D. J. T., 1980 (Third Edition). *Echo-Sounding Correction Tables,* Hydrographic Department, Ministry of Defence, Taunton Somerset.

Chen, C.-T. and F. J. Millero, 1977. Speed of sound in seawater at high pressures. *Journal Acoustical Society of America,* **62**, No. 5, 1129-1135.

Culberson, C. H., Williams, R. T., *et al,* August, 1991. A comparison of methods for the determination of dissolved oxygen in seawater, *WHP Office Report WHPO 91-2.*

Fofonoff, N. P., 1977. Computation of Potential Temperature of Seawater for an Arbitrary Reference Pressure. *Deep-Sea Research,* **24**, 489-491.

Fofonoff, N. P. and R. C. Millard, 1983. Algorithms for Computation of Fundamental Properties of Seawater. UNESCO Report No. 44, 15-24.

Gordon, L. I., Jennings, Joe C. Jr, Ross, Andrew A., Krest, James M., 1992. A suggested Protocol for Continuous Flow Automated Analysis of Seawater Nutrients in the WOCE Hydrographic Program and the Joint Global Ocean Fluxes Study. OSU College of Oceanography Descr. Chem Oc. Grp. Tech Rpt 92-1.

Hager, S. W., E. L. Atlas, L. D. Gordon, A. W. Mantyla, and P. K. Park, 1972. A comparison at sea of manual and autoanalyzer analyses of phosphate, nitrate, and silicate. *Limnology and Oceanography,* **17**, 931-937.

Lewis, E. L., 1980. The Practical Salinity Scale 1978 and Its Antecedents. *IEEE Journal of Oceanographic Engineering,* OE-5, 3-8.

Mantyla, A. W., 1982-1983. Private correspondence.

Millero, F. J., C.-T. Chen, A. Bradshaw and K. Schleicher, 1980. A New High Pressure Equation of State for Seawater. *Deep-Sea Research,* **27A**, 255-264.

Saunders, P. M., 1981. Practical Conversion of Pressure to Depth. *Journal of Physical Oceanography,* **11**, 573-574.

Sverdrup, H. U., M. W. Johnson, and R. H. Fleming, 1942. *The Oceans, Their Physics, Chemistry and General Biology,* Prentice-Hall, Inc., Englewood Cliff, N.J.

UNESCO, 1981. Background papers and supporting data on the Practical Salinity Scale, 1978. UNESCO Technical Papers in Marine Science, No. 37, 144 p.

APPENDIX E Data comments: Hydrographic data

Remarks for deleted samples, missing samples, and WOCE codes other than 2 from RUKDIOFFE6/1 WOCE S4P. 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 milliliters per liter for oxygen and micromoles per liter for Silicate, Nitrate, and Phosphate, unless otherwise noted. The first number before the comment is the cast number (CASTNO) times 100 plus the bottle number (BTLNBR).

Station 684

111	CTDO Processor: "Top 20db CTD oxygen questionable."
106	Not enough water left for salt. Salt sample logged and run. Delta-S .022 low at 162db. Calc ok. High gradient. Footnote salinity questionable.
103	Sample log:"Bad air vent leak-not tight" Delta-S .002 low at 303db. Other water samples also ok.
102	Sample log:"Not enough left for salt" Salt sample logged and run. Delta-S .006 low at 363db. Good agreement with CTD S. Footnote salinity questionable.

Station 686

118	CTDO Processor: "Top 15db CTD oxygen questionable."
113	Sample log: "No water." Lanyard hangup.
101	Sample log: "Leak" type not specified. Delta-S .000 at 1524db. Other water samples also ok.

Station 687

Cast 2	CTDO Processor: "No CTD oxygen data (sensor not working properly)."
208	Sample log: "Small leak." Delta-S .002 low at 1060db. PO4 .07 low, chart rechecked, but other water samples ok. Good O2 & SIL gradients. JHS: "OA agrees PO4 at least 0.06 low." Nutrient processor: "Looks real, NO3 also little lower." Footnote bottle leaking. Footnote po4 questionable.
207	Delta-S .005 high at 1207db. Calc ok. No corresponding bump in CTD trace. Other water samples have normal gradient. JHS: "OA agrees S ca. 0.006 high." Footnote salinity questionable.
201	Delta-S .004 low at 2410db. Calc ok.Other water samples look ok. SIL max. Footnote salinity questionable. Cast 1 aborted due data acquisition problem after rosette brought out of water due tag line problem.

Station 688

Cast 1	CTDO Processor: "no CTD oxygen data (sensor not working properly)."
108	Sample log: "Dripping from spigot, can't be stopped." Delta-S .000 at 1511db. Other water samples also ok.
103	JHS: "OA says PO4 low by ca. 0.02." Nutrient Analyst: "Low on chart." Footnote phosphate questionable.

Station 689

Cast 1	CTDO Processor: "no CTD oxygen data (sensor not working properly)."
111	Delta-S at 1261db is -0.0074, salinity is 34.722. See 105 salinity comment. Assume related to 5 & 8 Autosal problem. Footnote salinity bad.
110	See 105 salinity comment. Delta-S .02 low at 1513db. Calc ok. Assume related to 5 & 8 Autosal problem. Footnote salinity bad.
109	See 105 salinity comment. Delta-S .03 low at 1765db. Calc ok. Assume related to 5 & 8 Autosal problem. Footnote salinity bad.

108	See 105 salinity comment. Delta-S .025 low at 2016db. Calc ok. Footnote salinity bad.
107	Delta-S at 2270db is -0.0055, salinity is 34.706. See 105 salinity comment. Assume related to 5 & 8 Autosal problem. Footnote salinity bad.
106	Delta-S at 2527db is -0.005, salinity is 34.703. See 105 salinity comment. Assume related to 5 & 8 Autosal problem. Footnote salinity bad.
105	Salinity data sheet: "Bottle 5 & 8 would not read correctly." Salinity data sheet: 5 1.98412 > 1.98438. Salinity data sheet: 8 1.98404 > 1.98441. Delta-S .012 low at 2781db. Calc ok. Footnote salinity bad.
Station 690	
Cast 1	CTDO Processor: "no CTD oxygen data (sensor not working properly)."
104	No hydro oxygen. Titration error. Footnote oxygen lost.
103	Sample log: "Air vent open." Delta-S .000 at 3452db. Other water samples also ok. Footnote salinity questionable. JHS: "OA suggests O2 0.02 low." Calc ok. Footnote oxygen questionable, footnote bottle leaking.
102	Delta-S .003 low @ 3758 db. Calc OK. Footnote salinity questionable.
Station 691	
124	Sample log: "Air vent open." Delta-S .000 at 17db. Other samples look reasonable for near surface sample.
108-112	See 101-112 comments. Footnote salinity questionable.
107	Sample log: "No water. Lanyard caught up." Footnote bottle samples not drawn.
106	See 101-112 comments. Footnote salinity questionable.
105	Delta-S at 2940db is -0.0037, salinity is 34.699. See 101-112 comments. Footnote salinity questionable.
104	Delta-S at 3242db is -0.005, salinity is 34.697. See 101-112 comments. Footnote salinity questionable.
103	JHS: "OA suggests NO3 ca. 0.2 low." Nutrient Analyst: "Bad peak, make it .646 instead of .643." Footnote no3 questionable. DQE suggests NO3 flagged 2, ODF agrees. Delta-S at 3546db is -0.0056, salinity is 34.696. See 101-112 comments. Footnote salinity questionable.
101-112	JHS: "OA shows 1012 db to bottom to have lowest S per theta on entire cruise. O2 in deep water looks a bit high, and SiO3 below 2500 is some of highest of cruise. Acts like double trip at bottom, with skipped trip above. Virtually impossible, of course, but this is a strange station anyway you look at it." Nutrient Analyst: "Can't find any SIL problems." Footnote salinities questionable.
101	Delta-S at 4066db is -0.0039, salinity is 34.697. See 101-112 comments. Footnote salinity questionable.
Station 692	
Cast 1	Salinity: "After this salinity run, technician replaced lamp and cell tubing." CTDO Processor: "no CTD oxygen data (sensor not working properly)."
117	Sample log: "No water in 17." "Lanyard hangup." Footnote bottle samples not drawn.
107	Delta-S .87 low. All samples indicate NB 7 closed near surface. Probable lanyard hangup. Footnote bottle leaking, footnote samples bad. ODF recommends deletion of water samples.
101	Delta-S .006 low at 3594db. Calc ok. Other water samples ok. CTD S trace straight at bottom. JHS: "OA suggests S low by at least 0.003." Footnote salinity questionable.
Station 693	

101	Delta-S .004 high at 3371db. Calc ok. Other water samples ok. CTD S trace straight at bottom. JHS: "OA suggest S high by 0.006." Footnote salinity questionable.
Station 694	
Cast 3	Biology station, no samples.
116	No nutrients. Sample tube empty. Sample log indicates sample should have been drawn. Footnote sil, no3, no2, and po4 lost.
108	Delta-S at 2068db is -0.0039, salinity is 34.708. No action, leave as is.
Station 695	
Cast 1	JHS: "OA shows PO4 high while NO3 low over almost all of water column. OA suggests it may be NO3 that is "off"." Nutrient Analyst: "Can't find anything wrong."
122	Sample log: "Small leak." Not specified. Delta-S.385 high at 85db. Other water samples indicate NB22 closed around 175db. Footnote bottle leaking, footnote samples bad. ODF recommends deletion of all water samples.
121	Sample log: "Small leak." Not specified. Samples look ok for high gradient area at 125db. DQE: "124.8db bottle may leak, SALNTY is 0.017 less than upcast CTDSAL, which means water sample could be mixed with shallower waters, as well as for oxygen, OXYGEN is higher than downcast CTDOXY." Based on DQE comment and comment from Sample Log, footnote bottle leaking and samples bad even though DQE indicated only Salinity and oxygen since that was the only data DQE was looking at.
105	JHS: "OA suggests S high by ca. 0.003." Delta-S .002 high at 2774db. Calc ok. Footnote salinity questionable.
Station 696	
124	CTDO Processor: "Top 18db CTD oxygen questionable."
123	Sample log: "Salt btl has loose thimble" Delta-S .001 high at 54db.
120	Sample log: "Salt btl has loose thimble" Delta-S .012 high at 175db. High grad.
118	Sample log: "Salt btl has loose thimble" Delta-S .007 low at 255db. High gradient.
113	Sample log: "Salt btl has loose thimble" Delta-S .001 high at 759db. No hydro oxygen. "Parity error" on O2 computer before data saved. Footnote oxygen lost.
111	Sample log: "Salt btl has loose thimble" Delta-S .001 low at 1264db.
106	Sample log: "Salt btl has loose thimble" Delta-S .000 at 2627db.
104	Sample log: "Salt btl has loose thimble" Delta-S .000 at 3236db.
103	Sample log: "Air vent leak. Not tight." Delta-S .000 at 3545db. Other water samples also ok.
Station 698	
Cast 1	Tripping problem. First trigger had no trip box confirm & 5 ISI confirms. Data indicate NBs 1&2 closed at bottom and no sample at 10db. Possibly ramp shaft turned back from 1 to 24 instead of cocking 24 with 3rd hand to hold ramp shaft.
107	JHS: "OA suggests PO4 high by 0.02-0.03." Nutrient Analyst: "Peak ok, higher." Footnote phosphate questionable. DQE suggests PO4 flagged 2, ODF agrees.
106	Sample log: "Bottom end cap leaked." Delta-S .001 high at 3248db. Other water samples also ok.
101	Sample log: "Air vent closed lightly. bottom end cap leaked." Delta-S .001 high at 4296db. Other water samples also ok.
Station 699	
124	CTDO Processor: "Top 40db CTD oxygen questionable."

121	No hydro oxygen. "Parity Error" on computer before data saved. Footnote oxygen lost.
Station 700	
113	Delta-S .02 low at 1003db. Calc ok. CTD S trace shows no corresponding bump. Same value at NB14, probable dupe draw or run. Footnote salinity bad.
101	Sample log: "Small leak." Delta-S .001 low at 4407db. Other water samples also look ok.
Station 701	
106	Sample log: "Leaking after air vent opened? (Also, there is an unintelligible note on sample log re this bottle) Same note in Russian?" Delta-S .000 at 2171db. Other water samples also ok.
Station 702	
224	CTDO Processor: "Top 70db CTD oxygen questionable."
220	Delta-S .3 high at 212db. Other water samples also indicate NB20 closed deeper. Footnote bottle leaking, footnote samples bad. ODF recommends deletion of all water samples. Cast aborted.
Station 703	
Cast 1	Tripping problem. 25 confirms. B file indicates 2 trips at 204db. Ramp shaft 1 position too far.
123-124	CTDO Processor: "Top 120db CTD oxygen questionable."
120	lower lanyard permitted lid closure too early Footnote bottle leaking, footnote samples bad. ODF recommends deletion of all water samples.
117	Sample log: "spigot too small for helium tube"
101	Sample log: "1 bot leak" Delta-S .000 at 2635db. Other water samples also ok. Note: NBs 1&7 reversed for freon check.
Station 704	
123-124	CTDO Processor: "Top 100db CTD oxygen questionable."
120	lower lanyard permitted lid closure too early Footnote bottle leaking, footnote samples bad. ODF recommends deletion of all water samples.
102	JHS: "OA suggests S high by 0.002." Delta-S .002 high at 4184db. Calc ok. Footnote salinity questionable.
101	Delta-S .004 low @ 2618db. Calc OK. Other water samples OK. Same value as NB8 above. Possible dupe draw or run. Note: NBs1&7 reversed for freon check.
Station 705	
Cast 1	Rosette hit A-frame on recovery. Tripping problem. First bottle had no confirms on trip box, 5 confirms on ISI. Again looks like 2 bottles closed at bottom and no 10db sample.
124	CTDO Processor: "Top 100db CTD oxygen questionable."
120	Lower lanyard permitted lid closure too early Footnote bottle leaking, footnote samples bad. ODF recommends deletion of all water samples.
118	Delta-S .09 high at 505db. Other water samples indicate NB18 closed early. Possibly long lanyard allowed bottom end cap to close. Footnote bottle leaking, footnote samples bad. ODF recommends deletion of all water samples.
112	Sample log:"damaged on recovery" Broken spigot. Nuts & salt drawn but no oxygen. Nuts & salt look ok.
111	Sample log:"damage on recovery" Barrel broken about half way up. Nuts & salt drawn but no oxygen. Nuts & salinity data look ok.

110	Bottle did not trip as scheduled. SIL, NO3, NO2, PO4 not drawn
109	Sample log:"damaged on recovery." Spigot collar broken. No samples drawn.
108	Sample log:"Damaged on recovery. Missed O2."
Station 706	
125	Sample log: "Leaking from bottom end cap." Delta-S .002 low at 2292db. Other water samples also look ok.
108	Delta-S .002 low at 2597db. But only samples with definite gradients, O2 & SIL, indicate NB8 closed at NB7 level. Changed tripping information file to 2894db. Samples appear to be okay and agree with duplicate trip. Footnote bottle didn't trip as scheduled.
Station 707	
125	Delta-S .000 at 2161db but other water samples indicate NB25 closed near 1200db. Salinity same at 1200db & 2161db. Footnote bottle leaking, footnote samples bad. ODF recommends deletion of all water samples.
113	Delta-S .028 low at 1010db. Calc ok. Same value as NB14 above. Possible dupe draw or run.
102	JHS: "OA suggests S high by 0.002." Delta-S .002 high at 4636db. Calc ok. Footnote salinity questionable.
Station 708	
Cast 1	Tripping problem? 2 ISI confirms on first bottle. Trip box & ramp shaft ok. Data indicates all bottles tripped as intended. JHS: "OA suggests NO3 may be "high" while PO4 is "low". However, may be O.K. (See Sta. 709.)." Nutrient Analyst: "Change PO4 F1E=4.455, B(E)=.068." NO3 column apparently failing; data may be slightly unreliable see Station 709. Footnote no3 questionable. DQE has recoded NO3 as acceptable, with the exception of bottles 25 and 15. Nutrient analyst reply to DQE comment: "NO3 looks okay, agree with DQE, code NO3 acceptable, except 15 code questionable."
125	Delta-S .01 low at 1999db. Other water samples also indicate NB25 leaked. Footnote bottle leaking, footnote water samples bad. ODF recommends deletion of all water samples.
124	CTDO Processor: "Top 12db CTD oxygen questionable."
122	Unintelligible note on sample log. Data ok.
120	Unintelligible note on sample log. Data ok.
115	DQE: "High NO3. Q1 noted whole station as having high NO3. Flag assigned: 3."
104	No hydro oxygen. "Parity error" on computer before data saved. Footnote oxygen lost.
103	Delta-S .004 high at 4292db. Calc ok. No corresponding bump on CTD S trace. JHS: "OA shows S 0.003 high." Footnote salinity questionable.
Station 709	
Cast 1	Lost CTD signal at 4339db coming up. Two bottles had been tripped with normal confirmations. Tripped remaining bottles on wire out. Problem was in CTD/transmissometer bulkhead connector. Entered estimated pressures for missing trips based on comparing wire out readings on previous station. Entered estimated temp for missing trips based on T-S curve and hydro salinity plus estimated pressure and Delta-S from down cast real-time printout. Footnote CTD pressure and temperature as extrapolated from CTD data down cast. Nutrient data sheet: "large NO3 drift - column?" Nitrates appear higher than adjacent stations. High end base. Replaced Cad column prior station 710 and NO3s back to normal. Nutrient Analyst: " NO3 920306."Base Shift" JHS: "OA sees high NO3 at 708 and 709." Footnote no3 questionable. Nutrient analyst:

	"After comments by DQE, reinvestigation indicates NO3 is questionable for 8, 25, 10, 26 and 12-19."
126	See Cast 1 Nutrient comment. Footnote NO3 questionable.
125	See Cast 1 Nutrient comment. Footnote NO3 questionable. DQE: "High NO3 with no increase in PO4. Flags assigned: 3."
123-124	CTDO Processor: "Top 80db CTD oxygen questionable." CTDO Processor refers to down trace. Signal lost on CTD, no CTD salinity or oxygen.
112-119	See Cast 1 Nutrient comment. Footnote NO3 questionable.
112-117	DQE: "High NO3 with no increase in PO4. Flags assigned: 3."
110	See Cast 1 Nutrient comment. Footnote NO3 questionable. DQE: "High NO3 with no increase in PO4. Flags assigned: 3."
108	See Cast 1 Nutrient comment. Footnote NO3 questionable.
106-108	DQE: "High NO3 with no increase in PO4. Flags assigned: 3." See Cast 1 Nutrient comment.
106	JHS: "OA suggests PO4 high by ca. 0.02." Nutrient Analyst: "bad peak, should be .574." Corrected, @3095db.
Station 710	
125	Sample log: "Leak, low water flow." Delta-S .001 low at 2202db. Other samples also look ok.
122-124	CTDO Processor: "Top 100db CTD oxygen questionable."
Station 711	
Cast 1	CTD salinity (conductivity) shift this station. Down different from up and both lower CTD salinity than adjacent stations. Cause unknown. CTD Processor: "had to treat this sta specially to line up deep CTD with surrounding stas - maybe something got on sensors am making comment that CTD data somewhat suspect." Footnote CTD salinity questionable.
126	Delta-S at 1410db is -0.0173, salinity is 34.729. See Cast 1 CTD comment, footnote CTD salinity questionable.
125	Delta-S at 2016db is -0.1143, salinity is 34.615. See Cast 1 CTD comment, footnote CTD salinity questionable. Sample log: "Leaking from bottom end cap." Delta-S .1 low at 2015db. Other water samples also indicate leak or late close. Footnote bottle leaking, footnote samples bad. ODF recommends deletion of water samples.
123-124	CTDO Processor: "Top 110db CTD oxygen questionable."
114	Delta-S at 592db is -0.0164, salinity is 34.611. See Cast 1 CTD comment, footnote CTD salinity questionable.
113	Delta-S at 787db is -0.0118, salinity is 34.682. See Cast 1 CTD comment, footnote CTD salinity questionable.
112-124	See Cast 1 CTD comment, footnote CTD salinity questionable.
112	Delta-S at 1097db is -0.016, salinity is 34.721. See Cast 1 CTD comment, footnote CTD salinity questionable.
110	Delta-S at 1716db is -0.0127, salinity is 34.726. See Cast 1 CTD comment, footnote CTD salinity questionable.
108	Delta-S at 2415db is -0.0033, salinity is 34.713. See Cast 1 CTD comment, footnote CTD salinity questionable.
107	Delta-S at 2824db is -0.0076, salinity is 34.708. See Cast 1 CTD comment, footnote CTD salinity questionable.

106	Delta-S at 3235db is -0.0057, salinity is 34.704. See Cast 1 CTD comment, footnote CTD salinity questionable.
105	Delta-S at 3645db is -0.0046, salinity is 34.702. See Cast 1 CTD comment, footnote CTD salinity questionable.
101-108	See Cast 1 CTD comment, footnote CTD salinity questionable.
Station 712	
122-124	CTDO Processor: "Top 100db CTD oxygen questionable."
122	Sample log: "Empty. Broken cover." End caps off, monofilament on top end missing along with spring. End caps were wrapped around bar inside rosette frame. No water samples.
103	Sample log: "Air vent not tight." Delta-S .000 at 4373db. Other water samples also ok.
101	No hydro oxygen. Titration problem. Footnote oxygen lost.
Station 713	
124	Sample log: "No sample." Bottom end cap went down closed. Lanyard not hooked. No samples drawn.
123-124	CTDO Processor: "Top 100db CTD oxygen questionable."
121	Cryptic note on sample log: "Found 803 1117 during ______ analyses." (?) Oxygen flasks for NB20 & NB21 found reversed during analysis. Data looks good assuming Sample log order correct.
120	Cryptic note on sample log: "Found 803 1117 during ______ analyses." (?) Oxygen flasks for NB20 & NB21 found reversed during analysis. Data looks good assuming Sample log order correct. Delta-S .013 low @ 205db. Calc OK. High gradient.
103	DQE: Low NO3. Flag assigned: 3. Nutrient analyst reply to DQE comment: "Use original NO3 value = 32.21 um/kg, not rerun value. Data corrected."
Station 714	
123-124	CTDO Processor: "Top 70db CTD oxygen questionable."
119	Sample log has O2 flask 1053. O2 flask 1073 in box. Data looks good. Assume 1053 recorded in error. Delta-S .016 low @ 303db. Calc OK. High gradient.
101-112	DQE: "Low NO3 and low PO4. SIL looks ok. Flags assigned: 3." Nutrient Analyst: After corrections of standards, Data are acceptable.
Station 715	
124	Sample log: "N H780 from bottle N24 for Dorothea." Special LDGO sample.
101-112	DQE: "NO3 high by about 0.5, outside envelope of data from adjacent stations. PO4 also a bit high, but within envelope of adjacent stations. Flags assigned to NO3: 3." Nutrient Analyst reply to DQE comment: After corrections of standards, data are acceptable.
Station 716	
115	Delta-S .034 high at 505db. Calc ok. Other samples ok. Same salt value as NB14. Assume dupe draw or run. Footnote salinity bad.
105	No PO4. Original and rerun AA peaks both bad. "Moly going bad". Footnote po4 lost.
102-103	DQE indicated (on tabulation of code changes) that PO4 should be flagged "3". There was not supporting comment made by DQE. Nutrient analyst double checked these values and did not see any problem. Perhaps, DQE coded the wrong station.
Station 717	
126	Delta-S .002 high at 1485db. Calc ok. Other Delta-Ss very smooth this area. No corresponding bump in CTD S trace. Possible dupe draw from NB12. Footnote salinity questionable.

123-124	CTDO Processor: "Top 70db CTD oxygen questionable (noted at sea that oxygen sensor probably frozen through mixed layer)."
Station 718	
Cast 1	Tripping Problem. 24 Triggers, 23 confirms on trip box, 28 confirms on ISI. Data indicate NB24 & NB1 tripped at bottom, and no sample from 10db.
127	Footnote bottles did not trip as scheduled, data looks okay after trip information corrected. See Cast 1 tripping comments.
126	JHS: "OA suggests S high by 0.002." Delta-S .004 high at 1818db. Calc ok. Footnote salinity questionable. Sample log: "No O2 draw temp." Therm wet. Estimated draw temp from CTD Potential Temp based on difference on previous station. Footnote bottles did not trip as scheduled, data looks okay after trip information corrected. See Cast 1 tripping comments.
124	Sample log: "No O2 draw temp." Therm wet. Estimated draw temp from CTD Potential Temp based on difference on previous station.
123	CTDO Processor: "Top 40db CTD oxygen questionable."
112-124	Footnote bottles did not trip as scheduled, data looks okay after trip information corrected. See Cast 1 tripping comments.
110	Footnote bottles did not trip as scheduled, data looks okay after trip information corrected. See Cast 1 tripping comments.
101-108	Footnote bottles did not trip as scheduled, data looks okay after trip information corrected. See Cast 1 tripping comments.
Station 719	
Cast 1	CTDO Processor: "no CTD oxygen data (sensor not working properly)."
Station 720	
Cast 1	CTDO Processor: "no CTD oxygen data (sensor not working properly)."
Station 721	
Cast 1	CTDO Processor: "no CTD oxygen data (sensor not working properly)."
Station 722	
126	Sample log: "Small leak." Not specified. Delta-S .000 at 1310db. Other samples also ok.
122-124	CTDO Processor: "Top 80db CTD oxygen questionable."
104	Sample log: "Broken hose clamp."
Station 723	
Cast 1	CTDO Processor: "no CTD oxygen data (sensor not working properly)."
Station 724	
Cast 1	CTDO Processor: "no CTD oxygen data (sensor not working properly)."
119	No hydro oxygen. Flask broke before titration. Footnote oxygen lost.
115-118	Sample log:"Reddish sea matter inside btl. No apparent effect on data.
104	Sample log: "Air leak." Delta-S .000 at 3643db. Other water also ok.
Station 725	
122	Sample log:"Empty. Lanyard caught." Top lanyard loop pinched by pylon ball. No samples.
Station 728	
104	Sample log:"Air leak." Delta-S .000 at 3655db. Other water samples also ok.
Station 729	

104	Sample log: "Leak." Assume air leak. Delta-S .000 at 3751db. Other water samples also ok.
Station 730	
123-124	CTDO Processor: "Top 100db CTD oxygen questionable."
106	JHS: "OA suggests NO3 low by 0.2." Nutrient Analyst: "Looks real, can't find anything amiss."
105-107	DQE: "Slightly low NO3, but agree with values at station 727 (see note above). Flags assigned: 2."
105	JHS: "OA suggests NO3 low by ca. 0.6." Nutrient Analyst: "Looks real, can't find anything amiss."
104	Sample log:"Air." (Air vent leak?) Delta-S .000 at 3909db. Other water samples also ok. JHS: "OA suggests NO3 low by ca. 0.8." Nutrient Analyst: "Looks real, can't find anything amiss."
103	JHS: "OA suggests NO3 low by ca. 0.8." Nutrient Analyst: "Looks real, can't find anything amiss."
102	JHS: "OA suggests NO3 low by ca. 0.5." Nutrient Analyst: "Looks real, can't find anything amiss."
101-104	DQE: "Unusually low NO3, also noted by Q1. PO4 looks fine. Flags assigned: 3." Nutrient Analyst: "Okay to flag as 3."
Station 731	
104	Sample log: "Slight air vent leak." Delta-S .001 low at 3965db. Other water samples also ok.
103-105	DQE: "NO3 a bit high; no corresponding change in PO4. Flags assigned: 3." Nutrient analyst: "Agree with DQE. Higher on chart as well. Probably not real, flag as questionable."
Station 732	
126	Sample log: "Slow end cap leak" Delta-S .000 at 1310db. Other water samples also look ok.
119	Sample log:"Serious air leak - bottom cap may be loose (air vent was closed tight)" JS: Possibly some foreign object in bottom end cap? (Water sprays from it when bottom cap is touched.) Delta-S .009 low at 203db. High gradient. Other water samples also look ok.
Station 733	
123-124	CTDO Processor: "Top 70db CTD oxygen questionable."
Station 734	
124	CTDO Processor: "Top 70db CTD oxygen questionable."
108	Sample log:"Leaked from spout after air vent opened." Delta-S .000 at 2521db. Other water samples also ok.
104	Sample log:" Air leak." Delta-S .000 at 3747db. Other water samples also ok.
Station 735	
104	Sample log:"Leaks" Type not specified. Probably air leak as on previous stations. Delta-S .001 low at 3498db. Other water samples also ok, SIL max. New air vent, top end cap & top o-ring no help. Barrel replaced after this station.
102	Acid not added to sample before titration per raw oxy notebook. No sample results. Footnote oxygen lost.
Station 736	

112	Hydro O2 appears .06 low at 1104db. Calc . ok. PO4 & NO3 slightly high. Salt & SIL have normal gradient and look good. Footnote oxygen questionable.
Station 737	
128	Sample log: "Air vent not tight." Delta-S .000 at 3757db. Other water samples also ok.
114	Hydro O2 .05 low at 655db. Calc ok. Footnote oxygen questionable. Footnote salinity questionable. N03 & PO4 slightly high. SIL has normal gradient. Delta-S is .000 with same value as levels above and below. Footnote nitrate and phosphate questionable. DQE: "NO3 and PO4 a bit high but within envelope. SIL is fine. Flags assigned: 2." Changed NO3 & PO4 flag from 3 to 2 per DQE comment.
101	Sample log: "small air leak." Delta-S .000 at 4468db. Other water samples also ok.
Station 739	
Cast 1	Delta-S appear .001 to .002 higher than adjacent stations. Autosal run looks normal, essentially the same standard dial, air temp, and no drift. Hydro look the same as adjacent stations. Same preliminary G corrections used.
123-124	CTDO Processor: "Top 80db CTD oxygen questionable."
Station 740	
126	Hydro O2 appears .03 high at 1618db. Calc ok. NO3 & PO4 same value as levels above and below. SIL slightly high. Delta-s .002 low. Possibly bottle closed a little early. Found one top spring lanyard loop off after Sta 746. Assume bottom opened a little during rough weather jerks. Footnote bottle leaking, samples bad.
123-124	CTDO Processor: "Top 80db CTD oxygen questionable."
103	Delta-S .002 low at 4059db. Calc ok. CTD S trace normal. Footnote salinity questionable.
Station 741	
126	Hydro O2 appears .04 low at 1509db. Calc ok. NO3 & PO4 same values as levels above and below. Delta-S .002 low, and SIL could be a little high. Possible early bottle close. Found one top spring lanyard loop off after Sta 746. Assume bottom opened a little during rough weather jerks. Footnote bottle leaking, footnote samples bad. ODF recommends deletion of all water samples.
Station 742	
127	Hydro O2 appears a little high on Pot Temp vs O2 plot. Delta-S .0015 low at 2020db. Nutrients ok. Freon very high. 110 O2 doesn’t fit 127. Footnote oxygen and salinity questionable.
126	Delta-S .002 low at 1413db. Calc ok. Hydro O2 appears about .08 high. Nutrients look ok. Found one top spring lanyard loop off after Sta 746. Assume bottom opened a little during rough weather jerks. Footnote bottle leaking, samples bad.
108	Hydro O2 appears a little high on Pot Temp vs O2 plot. Delta-S and other water water samples ok. Freon ok. 127 O2 much better fit for 108 Footnote oxygen questionable.
107	Hydro O2 appears a little high on Pot Temp vs O2 plot. Delta-S and other water water samples ok. Freon ok. 108 O2 much better fit for 107. Footnote oxygen questionable.
Station 743	
126	Delta-S .002 low at 1350db. Calc ok. Hydro O2 .04 high. NO3 & PO4 same as adjacent levels. SIL appears about 2-3 high which contradicts possible leak indicated by Salt & O2. Found one top spring lanyard loop off after Sta 746. Assume bottom opened a little during rough weather jerks. Footnote bottle leaking, footnote samples bad. ODF recommends deletion of all water samples.
123-124	CTDO Processor: "Top 70db CTD oxygen questionable."

120	Delta-S .014 low @ 122db. Calc OK High gradient DQE: "122.2db bottle may leak. SALNTY is 0.014 less than upcast CTDSAL, which means water sample could be mixed with shallower waters, as well as for oxygen, OXYGEN is higher than downcast CTDOXY." Reply to DQE comment: NO3 and PO4 appear to be okay, but salinity and silicate are low, and oxygen high as DQE has indicated. Footnote bottle leaking and salinity, oxygen and silicate bad.
107	SIL a little high on Pot Temp-SIL plot. Recheck chart. Peak OK, Calc OK. Footnote silicate questionable.
106	SIL a little high on Pot Temp-SIL plot. Recheck chart. Peak OK, Calc OK. Footnote silicate questionable.
101	Sample log: "Air leak." Delta-S .000 at 3816db. Other water samples also ok.
Station 744	
126	Delta-S .008 low at 1292db. Calc ok. Hydro O2 about .15 high. Nutrients look ok though no change in NO3 & PO4 in adjacent levels. Found one top spring lanyard loop off after Sta 746. Assume bottom opened a little during rough weather jerks. Footnote bottle leaking, footnote samples bad. ODF recommends deletion of all water samples. DQE: "SIL a bit high versus theta. Q1 notes also that O2 was high and considers bottle to be a leaker. Flags assigned (all nutrients): 3." ODF would like the data to be flagged as is (4) instead of 3 as suggested by DQE.
115	Sample log: "Bottom cap leak." Delta-S .000 at 498db. Other water samples also ok.
110	Delta-S .003 low at 1602db. Calc ok. Hydro O2 about .08 high. Nutrients look ok, tho no change in NO3 & PO4 in adjacent levels; SIL appears high if off at all, which contradicts leak indicated by Salt & O2. Mark Warner says freon min this sample. Footnote oxygen bad. DQE: "High SIL on theta plot. Flag assigned: 3." Nutrient analyst: "Agree with DQE, Sil could be a bit high, although peak looks okay, but higher than adjacent peaks."
108	Delta-S .001 low at 2200db. Calc ok. Hydro O2 .2 high, and nutrients appear a little low. Apparent leaker. Footnote bottle leaking, footnote samples bad. ODF recommends deletion of all water samples.
Station 745	
120	Sample log:"Top lid handle broken. Time and depth of closing unknown." Delta-S .002 high at 187db. Other water samples also look ok.
107	Delta-S .002 high at 2476db. Calc ok. Smooth CTD S trace. Other water samples ok. Hydro S appears high. Footnote salinity questionable.
101	Sample log: "Leak." Not specified. Delta-S .001 low at 3973db. Other water samples also look ok.
Station 746	
127	Delta-S .002 low at 1748db. Calc ok. Other water samples ok. Same value as level below. Possible dupe draw or run. Footnote salinity questionable.
106-113	DQE: "High NO3 with no corresponding change in PO4. Station 747 is also high. Flags assigned: 3."
106-108	Nutrient Analyst in reply to DQE comment: "NO3 high by 0.4 to 0.6, others (127,110,126,112,113) look okay. Rechecked raw data and adjusted slightly, but will accept flag of 3."
Station 747	
127	See 102 DQE comments. Flag 3 as suggested by DQE.
110	See 102 DQE comments. Flag 3 as suggested by DQE.

108	Sample Log: "Leak from end cap after air vent opened." Delta-S .000 at 2328db. Other water samples also ok.
105-108	See 102 DQE comments. Flag 3 as suggested by DQE.
102	NO3 .5 low at 3961db. Recheck chart. Don't see that it's low. Peak OK, calc OK. DQE: "High NO3 with no increase in PO4. These values and those at station 746 are outside the theta/NO3 envelope by 0.3 - 0.5. Flags assigned: 3." Nutrient Analyst: "NO3 are high on chart as well. Either real or contaminated. Flag 3 as suggested by DQE."
Station 748	
102	Sample log: "O2 drawer notices 'not much water', but other samplers find no noticeable problems." Delta-S .001 low at 4023db. Other water samples including O2 ok.
101	NO3 .4 low at 4200db. Rerun used, original was .2 higher. Check with Nutrient Analyst re using original. Nutrient Analyst: "Use original."
Station 751	
124	CTDO Processor: "Top 40db CTD oxygen questionable."
110	High n:p ratio. PO4 .04 low, NO3 only 0.2 low at 1417db. Other water samples have normal gradient. Recheck chart. JHS: "OA agrees that NO3 & PO4 are suspicious." Nutrient Analyst: "Looks real, rerun checks out - omit?" Footnote nitrate and phosphate questionable. DQE: "Low PO4; NO3 and SIL seem ok. Flag assigned: 3." Removed questionable flag on NO3 based on DQE comment.
Station 752	
124	CTDO Processor: "Top 20db CTD oxygen questionable."
123	Sample log: "Salt bottle 23 (Case 8) has neck too large for ODF thimbles." Footnote salinity questionable. Delta-S .002 low at 42db.
122	Sample log: "Leak when spigot opened. Air vent was closed tight." Delta-S .013 low at 67db. Calc ok. Other water samples look ok. High gradient.
110	No hydro O2. Titration problem. Footnote oxygen lost.
101-103	Sample log: "Redraw O2; pickle problem." Values look ok.
Station 755	
127	Delta-S .002 low at 1769db. Calc ok. Hydro O2 .15 high. Nutrients look ok but not much change. CO2 values also odd. Assume leak. Footnote bottle leaking, footnote samples bad. ODF recommends deletion of water samples. DQE: "Q1 noted high O2 and odd CO2 and assumed bottle leaked. Nutrients look ok and delta-S was small. Flags assigned: 2." Reply to DQE comment: "Leave nutrient data flagged 4."
121	DQE: "128.7 db bottle may leak. SALNTY is 0.017 less than upcast CTDSAL, which means water sample could be mixed with shallower waters. CTDOXY data differs by 18. from bottle OXYGEN." Reply to DQE comment: "Gradient area, nutrients agree with adjoining stations and CTD oxygen should not be used as a level by level comparison. Leave data as coded."
Station 756	
123	Sample Log:"Leak." Not specified. Delta-S .012 low at 57db. Calc ok. High gradient.
Station 759	
123-124	CTDO Processor: "Top 80db CTD oxygen questionable."
Station 760	
128	DQE: "High NO3, no corresponding increase in PO4. Flags assigned: 3." Nutrient Analyst: "NO3 within 1% full scale. Rechecked raw data, found no problem, adjusted NO3 for 105-106, but not enough to make any difference. Do not agree with DQE code. Leave as acceptable."

105-107	See 128 DQE and nutrient analyst. NO3 is acceptable per ODF.
Station 761	
123	PO4 looks .10 uM high Other nutrients same as 124 above. Oxy and salt same as well. Peak and calc OK. Footnote PO4 questionable.
122-124	CTDO Processor: "Top 80db CTD oxygen questionable."
Station 762	
118	Sample log: "Spring lanyard broken. No water." Footnote bottle samples not drawn.
Station 763	
128	Sample log:"Hit frame during recovery. Spigot broke. RTW recovered S and nuts. Nut tube 8 used by accident." Delta-S .000 at 3053db. NO3 appears about 0.3 high. PO4 & SIL ok. Footnote no3 questionable, oxygen not drawn. DQE: "Slightly high NO3 per Q1. Falls within NO3/theta envelope. flag assigned: 2." Change flag for NO3 to acceptable per DQE comments.
126	DQE: "1078db OXYGEN is less than CTDOXY by 4 Umol/kg Bottle OXYGEN is Bad." Reply to DQE comment: "Oxygen agrees with adjoining stations, data is acceptable."
108	Sample Log:"Nut tube 4 used; see 0128." Data looks ok.
106	Sample log:"Hit frame during recovery. Spigot broke. RTW recovered S and nuts." Delta-S .000 at 2441db. NO3 appears about 0.3 high. PO4 & SIL ok. Footnote no3 questionable, oxygen not drawn. DQE: "Slightly high NO3 per Q1. Falls within NO3/theta envelope. Flag assigned: 2." Change flag for NO3 to acceptable per DQE comments.
105	Sample log:"Hit frame during recovery. Bottle destroyed. No sample." Footnote bottle samples not drawn.
Station 764	
127	Sample log:"Dripping from bottom end cap after air vent open." Delta-S .001 low at 1700db. Other samples also look ok.
119	Sample log:"Top end cap open. No sample." O-ring out of place. Footnote bottle samples not drawn.
118	Delta-S .01 low at 254db. Calc ok. Up = down. DQE: "I dont consider bottles at 253.6 and 399.8 dbars Qble. This layer has many intrusions." Reply to DQE comment: Data is not coded questionable.
116	DQE: "I dont consider bottles at 253.6 and 399.8 dbars Qble. This layer has many intrusions." Reply to DQE comment: Data is not coded questionable.
106	Sample log:"Dripping from bottom end cap after air vent opened." Delta-S .000 at 2553db. Other water samples also look ok. SIL max.
101	Sample log:"Vent not tight." Delta-S .000 at 3777db. Other water samples also look ok.
Station 765	
119	Sample log:"Air leak." Delta-S .002 low at 200db. Other water samples also look ok.
Station 766	
127	Delta-S .002 low at 1872db. Calc ok. Hydro O2 about .13 high. Nutrients look ok. Freon also high. Assume leaker. Footnote bottle leaking, footnote samples bad. ODF recommends deletion of water samples. DQE: "Q1 noted that CFC and O2 data was high and considers bottle a leaker. Nutrients look ok. Flags assigned: 2." Change flag on nutrients to 2 as suggested by DQE.
119	Sample log: "Air leak." Delta-S .000 at 203db. Other water samples also look ok.

118	Delta-S .02 low at 253db. Calc ok. Normal CTD S gradient. Other water samples look ok. Same salinity value as 119 above. Possible dupe draw or run. 117 value gives good Delta-S for 118, and 116 value gives good Delta-S for 117. 115 salinity ok.
117	Delta-S .015 low at 302db. Calc ok. Normal CTD S gradient. Other water samples look ok. 116 value gives good Delta-S for 117. Possible drawing or run error. See 0118.
116	Delta-S .011 low at 405db. Calc ok. Normal CTD S gradient. See 0118 & 0117. Possible drawing or run error. Footnote salinity bad.
Station 767	
128	Delta-S .003 low at 2970db. Calc ok. Other water samples look ok. Normal CTD S gradient. Same value as 129 above Possible dupe draw or run. Footnote salinity bad.
127	See 108 DQE NO3 comment. Nutrient Analyst in reply to DQE comment: "NO3 looks okay, leave flag as 2."
126	See 108 DQE NO3 comment. Nutrient Analyst in reply to DQE comment: "Changed peak value per charts (raw data), won't make much difference, but within tolerance. Leave flag as 2."
114	See 108 DQE NO3 comment. Nutrient Analyst in reply to DQE comment: "Odd peak, should be same as 115, changed value, much better. Leave flag as 2."
113-116	CTDO Processor: "Temperature, salinity, oxygen in 530 - 800 db interval seem real." DQE: "Maybe it is an intrusion, measurements do not seem questionable."
112-113	See 108 DQE NO3 comment. Nutrient Analyst in reply to DQE comment: "Changed peak value per charts (raw data), won't make much difference, but within tolerance. Leave flag as 2."
110	Delta-S .003 low at 1158db. Calc ok. Hydro O2 appears .06 high. All values same as sample 127 below. Freon also high. Footnote bottle leaking, footnote samples bad. ODF recommends deletion of water samples. See 108 DQE NO3 comment. DQE: "High SIL on theta plot; also Q1 noted high O2 and CFC values. Flags assigned (all nutrients): 3." ODF flags data from leaky bottle as bad, leave flags 4.
108	DQE: "High NO3 with no increase in PO4. Flags assigned: 3." Nutrient Analyst: "High on chart (raw data), flag as 3 as suggested by DQE."
Station 768	
124	Sample log:"Leak from bottom end cap after air vent opened." Delta-S .00 at 16db. All water samples same as other mixed layer sample below. CTDO Processor: "Top 40db CTD oxygen questionable."
121	Delta-S .035 low at 108db. Calc ok. High gradient. DQE: "107.7db bottle may leak SALNTY is 0.033 less than upcast CTDSAL, which means water sample could be mixed with shallower waters, as well as for oxygen, OXYGEN is higher than downcast CTDOXY." Reply to DQE comment: "This station was reoccupied as Station 781. Even though sampling was not done at the exact potential temperature, the bottle data does not appear unreasonable. This is a high gradient area, and the CTD Processor had noted a problem with the CTD oxygen for this station. The nutrient DQE did not indicate any problems with the Nutrients. ODF suspects the data are acceptable and the bottle did not leak."
119	Sample log:"Air leak." Delta-S .002 low at 208db. Other water samples also ok.
110	Delta-S .003 low at 1132db. Calc ok. Hydro O2 appears .04 high. Salt & nuts same as 127 below, SIL high. Freon looks good. Footnote salinity, oxygen and nutrients questionable.
106	DQE: "2203 db OXYGEN is Qble." Reply to DQE comment: "Oxygen as well as other parameters agree with adjoining stations and reoccupation Station 781."

101	Sample log:"Leak from bottom end cap after air vent opened." Delta-S .000 at 3216db. Other water samples also ok.
Station 769	
Cast 1	Sample log:"Most O2 (29-24) without O2 draw temps." Draw temps & Pot temp. Data look ok.
129	Sample log:"O2 draw therm read -2.5 to 3.0."
127	No Hydro O2. Part of sample accidentally spilled after adding acid. Footnote oxygen lost.
110	Delta-S .003 low at 1518db. Calc ok. Hydro O2 appears .1 high. Salt & nuts similar to 127 below. No freon or CO2 this sample. Smooth CTD S & O traces. Footnote bottle leaking, footnote samples bad.
Station 770	
128	Delta-S .003 low at 2941db. Calc ok. Other water samples ok. Normal CTD S gradient. Similar (.001 lower) to 103 value below. Possible dupe draw or run. Footnote salinity questionable.
123-124	CTDO Processor: "Top 60db CTD oxygen questionable (noted at sea that oxygen sensor probably frozen as air temp -4.6 deg)."
119	Sample Log:"Air leak." Delta-S .001 high at 202db. Other samples also look ok.
118	Sample log:"Air vent leak." Delta-S .000 at 252db. Other samples also look ok.
Station 771	
Cast 1	DQE: "All bottles: NO3 seems about 0.5 low relative to station 772 with no change in PO4. No problems noted by Q1. Following stations get increasingly shallow and NO3 values do drop, so that station 771 is within the overall envelope except for bottles tripped in the Warm Deep Water with theta above 0.5 degrees. Flags assigned: 3 to all NO3." Nutrient Analyst reply to DQE comment: "New Cd Column this station, apparently no reducing @ > 99%, therefore, NO3 probably low. Flag NO3 as 3."
123-124	CTDO Processor: "Top 60db CTD oxygen questionable (noted at sea that oxygen sensor probably frozen)."
121	Sample log:"Leak. Bottom Lid." Delta-S .001 low at 124db. Other water samples also ok.
119	RTW (personal communication):"Leaked from bottom lid again."?? Had been air leak on previous casts. Delta-S .000 at 234db. Other water also look ok.
115	Sample log:"Not closed. No water." Lanyard hangup. Footnote bottle samples not drawn.
101	Sample log:"Small Leak." Not specified. Delta-S .001 low at 3389db. CTD S trace a little bumpy at bottom. Other water samples ok.
Station 772	
Cast 1	DQE: "All bottles: NO3 seems a bit high relative to station 771 and following stations except for station 776. NO3 values are well within envelope for the preceding group of stations. Flags assigned: 2." Nutrient Analyst: "NO3 does have higher NO3 as noted by DQE, because Station 771 is low. Station 771 is flagged as 3."
128	Sample log:"Air vent not tight." Delta-S .000 at 2835db. Other water samples also ok.
126	Sample log:"Air vent not tight." Delta-S .000 at 1415db. Other water samples also ok.
123-124	CTDO Processor: "Top 50db CTD oxygen questionable."
123	Delta-S .025 high at 46db. Calc ok. Bottom of mixed layer. Salinity spike on CTD up trace. Best salinity value on printout is 33.903 which gives Delta-S .03 high. Other water samples look ok. Hydro salinity still looks odd. Footnote salinity questionable.

119	Sample log:"Air leaked." Delta-S .002 low at 206db. Other water samples also ok.
Station 773	
Cast 1	Console operator: "ISI crashed shortly before bottom approach. Was restarted after bottom approach. Cast was replayed post-cast from VCR tape as Cast 99. No problems during replay." CTDO Processor: "no CTD oxygen data (CTD oxygen sensor failed at 10 m)."
128	Sample log:"Air leak." Delta-S .000 at 2530db. Other water samples also ok.
124	Sample log:"frozen."(JHS: "assume they mean spigot.") Delta-S .000 at 13db. Other water also look ok.
122	Sample log:"frozen."(JHS: assume they mean spigot.) Delta-S .001 high at 115db. Other water samples also look ok.
112	Sample log:"Air vent was open." Delta-S .001 high at 1313db. Other water samples also ok.
Station 774	
Cast 1	JHS: "No problems with ice in spigots." CTDO Processor: "no CTD oxygen data (no CTD oxygen sensor)."
123	Sample log:"Leak from bottom cap." Delta-S .003 high at 88db. Other water samples also look ok.
119	Sample log:"Air leak" Delta-S .000 at 304db. Other water samples also look ok.
Station 775	
Cast 1	CTDO Processor: "no CTD oxygen data (no CTD oxygen sensor)."
130	Sample log:"Leaking from lower lid." Delta-S .005 low at 272db. Other water samples look ok. High gradient.
128	Sample log:(Air vent)"not closed" Delta-S .000 at 2419db. Other water samples also look ok.
123	Sample log:(Air vent)"not closed." Delta-S .00 at 62db. Other water samples also ok.
121	Sample log:(Air)"leak." Delta-S .00 at 183db. Other water samples also ok.
120	Sample log:(Air vent)"not closed" Delta-S .003 low at 243db. Other water samples also look ok. High gradient.
113	Sample log:(Air)"leak." Delta-S .003 high at 908db. Other water samples look ok. High gradient.
Station 776	
Cast 1	CTDO Processor: "no CTD oxygen data (no CTD oxygen sensor)."
112	Delta-S .004 low at 809db. Calc ok. Hydro O2 .1 high. Nutrient gradient changes. No CTD oxy sensor. CTD T&S inversion this level. Probably good.
101	Sample log: "Leak." Not specified. Delta-S .000 at 2520db. Other water also look ok.
Station 777	
Cast 1	CTDO Processor: "no CTD oxygen data (no CTD oxygen sensor)."
128	Sample Log: "Air vent not tight." Delta-S .000 at 1520db. Other water samples also look ok.
118	Delta-S .016 low at 334db. Calc ok. T inversion, Down = Up. NO3 & NO2 hi; PO4 and other water samples ok. Nutrient Analyst: "Chart readings ok."
107	No nutrients. Sample tube empty. Sample log indicates sample should have been drawn. Footnote sil, no3, no2, and po4 lost.
Station 778	

Cast 1	JHS: "Virtually every bottle had freeze- up at one time or other. Salts, which were last, were sometimes drawn from bottles which had had frozen spigots 3-5 times. Inspection of inside of Niskins after drawing S showed small ice crystals in some, but mostly the problem seemed confined to the spigots." Data look ok except for problems noted below. CTDO Processor: "no CTD oxygen data (no CTD oxygen sensor)."
128	Sample log: "Leak" Not specified. Delta-S .001 low at 696db. Other water samples also look ok.
127	Sample log: "Frozen" Delta-S .000 at 302db. Hydro O2, PO4 & NO3 appear low with no corresponding Temp feature. Footnote no3 and po4 questionable. DQE: "Q1 noted sample freezing in Niskin bottle. Nutrients look ok. Flags assigned: 2." Changed NO3 and PO4 flags from 3 (questionable) to 2 (acceptable) per DQE comment.
126	Sample log: "Frozen" Delta-S .005 high at 172db. Smooth down CTD S trace. Hydro O2, PO4 & NO3 all appear low with no corresponding temp feature. Footnote salinity, oxygen and nutrients questionable.
114	Delta-S at 11db is 0.0549, salinity is 34.216. Bottle salinity looks reasonable for surface water. Footnote CTD salinity bad.
110	JHS: "S particularly difficult to draw due to repeated freeze-up during draw." Delta-S .05 high at 242db. Calc ok. Smooth down CTD S trace. SigTh high. Footnote salinity bad.
Station 779	
Cast 1	Sample log: Even-numbered pylon positions were duplicate trips for IOAN biology only. No check samples. CTDO Processor: "no CTD oxygen data (no CTD oxygen sensor)."
127	Salinity sample bottles 5 & 6 in reverse order in box. Data looks best with sample log order i.e. Salt btl 5 for 127.
126	Salinity sample bottles 5 & 6 in reverse order in box. Data looks best with sample log order i.e. Salt btl 6 for 126.
Station 780	
Cast 1	JHS: "Console ops log shows 18-24, but the pylon was reset, so sample log is correct with 1-7." CTDO Processor: "no CTD oxygen data (no CTD oxygen sensor)."
Station 781	
Cast 1	CTDO Processor: "no CTD oxygen data (no CTD oxygen sensor)."
Station 782	
Cast 1	CTDO Processor: "no CTD oxygen data (no CTD oxygen sensor)."
Station 783	
123-124	CTDO Processor: "Top 80db CTD oxygen questionable."
Station 784	
130	Delta-S .027 low at 208db. Calc ok. See 0121 and 0120. Assume no salinity sample drawn from NB 30. Deleted hydro salinity.
123-124	CTDO Processor: "Top 50db CTD oxygen questionable."
Station 785	
Cast 1	Sample log: Indecipherable bottle number with comment "loose". ???
126	No nutrients, logged ok on Sample log sample tube empty. Sample log indicates sample should have been drawn. Footnote sil, no3, no2, and po4 lost.
114	JHS: "OA shows NO3 low by ca. 0.2, PO4 low by ca. 0.03, SiO3 low by ca. 0.3-0.5 (the only SiO3 minimum in region). No feature in S or O2. No feature on CTD plot." Nutrient peaks OK, Calcs OK. Values within 1% FS.

101	Sample log: "leak" Not specified. Delta-S .000 at 3195db. Other water samples also ok.
Station 787	
Cast 1	Sample log: "Sampled during blizzard."
117	Sample log:"During recovery the line knocked open either Nb 17 or one next to 17." JHS: "OA: O2 slightly high." Hydro O2 appears .04 high on Pot Temp vs O2 plot. Other water samples ok. Footnote bottle leaking, oxygen affected, footnote oxygen bad.
116	JHS: "OA: O2 slightly high." Hydro O2 appears .04 high on Pot Temp vs O2 plot. Probably affected by tag lines (See 117). Other water samples ok. Footnote bottle leaking, oxygen affected, footnote oxygen bad.
115	JHS: "OA: O2 high by >0.2." Hydro O2 is 2.6 high on Pot Temp vs O2 plot. Assume hit by tag lines (See 114) No nutrients, logged ok on Sample log but sample tube empty. Footnote bottle leaking, oxygen affected, footnote oxygen bad.
114	Sample log:"During recovery the line knocked open bottom end cap." JHS: "OA: O2 high by >0.2." Hydro O2 is 2.8 high on Pot Temp vs 02 plot. Other water samples ok. Footnote bottle leaking, oxygen affected, footnote oxygen bad.
113	JHS: "OA: O2 slightly high." Hydro O2 appears .04 high on Pot Temp vs O2 plot. Other water samples look ok. Probably affected by tag lines (See 114). Other water samples ok. Footnote bottle leaking, oxygen affected, footnote oxygen bad.
Station 788	
128	Sample log:"Air vent not tight." Delta-S .000 at 2700db. Other water samples also ok.
110	Delta-S .001 low at 1198db. Calc ok. Hydro O2 .05 high on Pot Temp vs O2 plot. SIL looks a little high, NO3 & PO4 same as adjacent levels. Freon bad (high). May have closed a little early. Footnote bottle leaking, footnote samples bad. ODF recommends deletion of samples.
Station 789	
110	Delta-S .001 low at 1213db. Calc ok. Hydro O2 appears .03 high on Pot Temp vs O2 plot. SIL a little high and NO3 & PO4 same as adjacent levels. Looks similar to Sta 788 sample 110 problem except this time freon looks good. Footnote salinity, oxygen and silicate questionable.
Station 791	
116	Sample Log: "Air leak; air vent tight." Delta-S .001 high at 399db. Other samples also ok.
Station 792	
116-118	CTDO Processor: "Top 80db CTD oxygen questionable."
116	Sample log:"Broke salt bottle 16; substituted 24." Salt data sheet (printout) has salt bottle 16. Delta-S .008 high at 73db. Down CTD T&S traces not same as up traces. Autosal operator says should be salt bottle 24.
102	Sample log: "O2 sampling only. Was duplicate CSC trip." Freon also sampled per Sample log. SLT not drawn. No nutrients drawn.
Station 793	
103	PO4 .10 high at 998db. Calc & peak ok. NO3 ok. Possible PO4 contamination. Footnote phosphate questionable.
102	Sample log:"No samples; Duplicate CSC trip."
Station 794	
102	Sample log:"No sampling; duplicate CSC bottle trip." Sample log says freon sampled.

S4P
Final Report
for AMS ^{14}C Samples

Robert M. Key and Peter Schlosser

January 19, 1999

1.0 General Information

WOCE cruise S4P was carried out aboard the R/V Akademik Ioffe in the southern Pacific Ocean. The WHPO designation for this cruise was 90KDIOFFE6/1. Mikhail H. Koshlyakov (Shirshov Inst.) and James G. Richman (OSU) were the chief scientists. The cruise track included WHP stations beginning on the continental shelf of the Antarctic Peninsula at 67° 28′S 71° 5′W on February 22, 1992, continuing west along ca. 67°S at nominally 30 nautical mile intervals. The first ten stations were made along a northwesterly line approximately perpendicular to the continental slope with stations over the shelf break and slope located on isobaths separated by approximately 800 m. Over the Bellingshausen Abyssal Plain between 91° 34′W and 130° 41′W and over the Amundsen Abyssal Plain between 142° 11′W and 157° 41′W, the station spacing was increased to nominally 40 nautical miles. At 174° 15′E, the track turned southwestward to run perpendicular to the Antarctic continental shelf. The section was completed with a station in 200 m of water off Cap Daemon at 70° 39′S 168° 04′E. The section was restarted with a repeat station at 67° S 174° 15′E and continued east-northeast to end in 400 m of water off Young Island of the Balleny Islands at 66° 25′ S 162° 41′E. 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 594 $\Delta^{14}C$ samples were collected at 30 stations.

TABLE 1. S4P $\Delta^{14}C$ Station Locations

Station Number	Date	Latitude	Longitude	Bottom Depth
682	2/22/92	-67.468	-70.089	236
683	2/22/92	-67.166	-71.121	453
684	2/23/92	-66.895	-71.998	445
685	2/23/92	-66.800	-72.250	831
686	2/23/92	-66.782	-72.264	1571
687	2/24/92	-66.732	-72.238	2430
688	2/26/92	-66.685	-72.265	3087
691	2/24/92	-65.906	-75.013	4037
698	2/26/92	-66.998	-82.233	4262
703	3/2/92	-67.001	-88.534	4437
710	3/2/92	-66.987	-99.980	4718
716	3/4/92	-67.003	-110.248	4388
722	3/6/92	-67.002	-120.460	4555

TABLE 1. S4P $\Delta^{14}C$ Station Locations

Station Number	Date	Latitude	Longitude	Bottom Depth
726	3/7/92	-66.982	-127.236	4465
732	3/9/92	-67.000	-135.834	4661
736	3/10/92	-66.991	-140.951	4175
740	3/12/92	-67.007	-147.483	4457
744	3/13/92	-66.967	-154.328	4251
748	3/15/92	-66.983	-160.290	4172
754	3/17/92	-66.993	-167.907	3427
760	3/18/92	-66.973	-175.628	2831
764	3/20/98	-67.037	179.231	3747
768	3/21/92	-67.049	174.319	3179
772	3/22/92	-68.703	171.441	3312
775	3/22/92	-69.933	169.344	2731
777	3/23/92	-70.411	168.496	1722
778	3/23/92	-70.451	168.414	1058
779	3/23/92	-70.493	168.308	386
780	3/23/92	-70.648	168.066	209
790	3/29/92	-66.022	164.803	2814

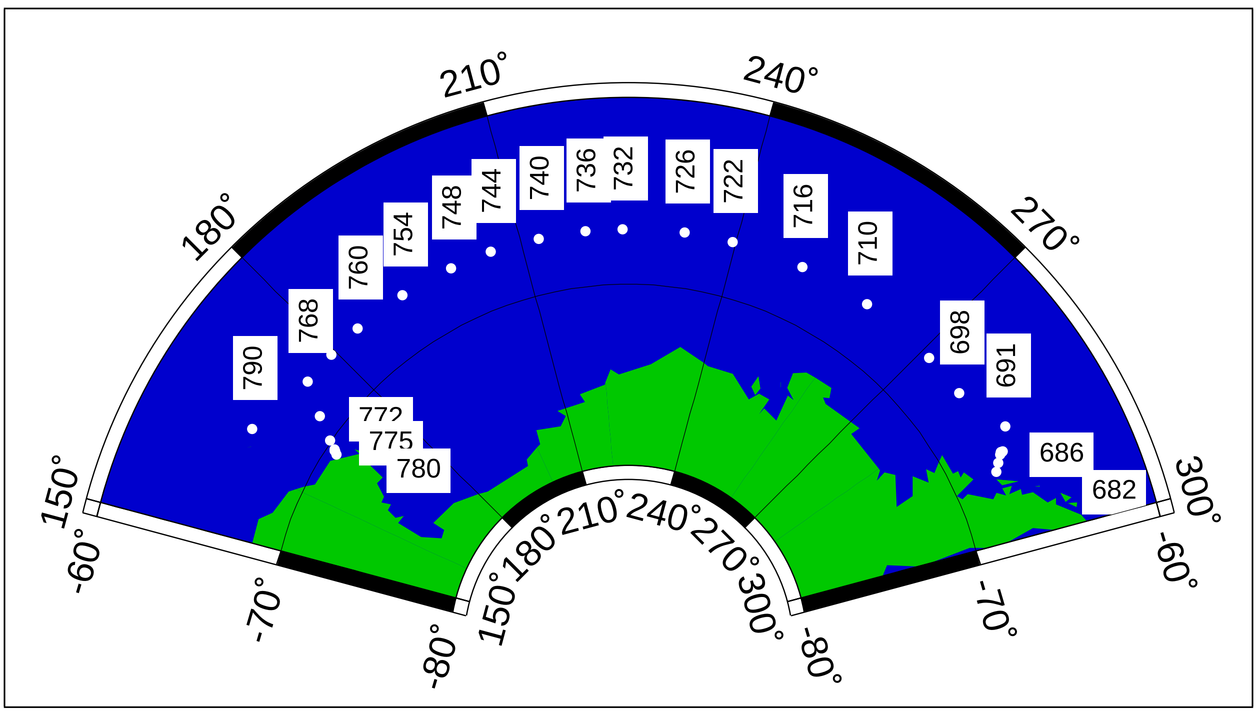

Figure 1: AMS ^{14}C station locations for WOCE S4P.

2.0 Personnel

^{14}C sampling for this cruise was carried out by Jordan Clark (now at UCSB) and Dorothea Bauch (now at GEOMAR in Germany). ^{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 (1/99). Peter Schlosser (LDEO) 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, 1998), September 16, 1998. That reports included preliminary 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 34 water samples. These replicate analyses are tabulated in Table 2. The table

Table 2: Summary of Replicate Analyses

Sta-Cast-Bottle	$\Delta^{14}C$	Err	E.W.Mean[a]	Uncertainty[b]
683-1-9	-153.8	2.9	-153.8	2.6
	-153.8	5.7		
683-1-10	-149.2	2.9	-147.4	5.7
	-140.0	3.8		
	-150.3	3.1		
683-1-11	-149.1	6.0	-146.0	3.2
	-144.8	3.8		
686-1-4	-163.0	2.9	-163.2	2.6
	-163.7	6.2		
687-2-5	-165.8	2.5	163.6	5.0
	-158.6	4.6		
688-1-11	-171.2	6.1	-169.4	3.7
	-168.4	4.6		
688-1-18	-143.4	3.5	-144.7	2.6
	-146.3	3.8		
688-1-19	-136.4	2.6	-136.7	1.9
	-137.2	2.7		
688-1-20	-139.5	3.6	-138.0	2.1
	-137.2	2.6		
688-1-21	-115.1	2.2	-113.6	2.7
	-111.2	2.7		

Table 2: Summary of Replicate Analyses

Sta-Cast-Bottle	$\Delta^{14}C$	Err	E.W.Mean[a]	Uncertainty[b]
688-1-23	-91.1	3.8	-90.2	3.1
	-88.4	5.3		
688-1-24	-82.4	3.2	-81.6	2.1
	-81.0	2.7		
703-1-2	-168.4	2.8	-161.0	2.3
	-161.4	4.5		
703-1-3	-168.4	2.3	-166.6	3.6
	-163.4	3.1		
703-1-5	-162.0	2.2	-162.1	1.9
	-162.2	3.6		
703-1-7	-157.6	2.5	-157.0	2.2
	-154.8	4.4		
703-1-12	-158.3	4.1	-155.3	3.4
	-153.5	3.1		
703-1-13	-153.4	2.2	-154.3	2.6
	-158.3	8.7		
	-158.2	5.3		
	-154.1	2.9		
703-1-20	-117.4	2.6	-117.4	1.8
	-117.4	2.4		
703-1-22	-87.7	3.2	-84.8	3.2
	-83.2	3.0		
703-1-23	-81.1	5.3	-82.6	2.6
	-93.1	3.0		
716-1-2	-162.5	2.8	-153.0	13.5
	-143.4	2.8		
726-1-8	-150.1	3.7	-151.1	2.8
	-152.4	4.2		
732-1-1	-151.6	2.8	-150.2	2.6
	-147.9	3.6		
736-1-28	-170.4	4.6	-169.9	3.0
	-169.7	3.9		
744-1-10	-167.9	3.8	-166.5	2.4
	-165.7	3.1		
764-1-16	-139.9	4.4	-138.2	2.4
	-137.5	2.9		
768-1-6	-179.3	3.2	-176.2	5.0
	-172.2	3.6		
768-1-7	-177.0	2.6	-178.5	2.6
	-180.7	3.3		
768-1-8	-165.1	3.0	-161.2	5.2
	-157.8	2.8		

Table 2: Summary of Replicate Analyses

Sta-Cast-Bottle	$\Delta^{14}C$	Err	E.W.Mean[a]	Uncertainty[b]
768-1-29	-164.7	3.4	-162.2	3.4
	-159.9	3.2		
772-1-18	-161.4	4.8	-162.3	2.9
	-162.7	3.6		
775-1-13	-153.7	2.7	-152.0	2.0
	-151.7	3.2		
	-153.7	5.6		
777-1-1	-133.4	4.1	-142.4	11.0
	-149.0	3.5		

a. Error weighted mean reported with data set

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

shows 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 2.8‰. This precision estimate is a bit lower than the average error for the time frame over which these samples were measured (Aug. 1996 - Apr. 1998) and a bit 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 3-4‰ may be 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	544
3	12
4	2
5	6
6	30[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

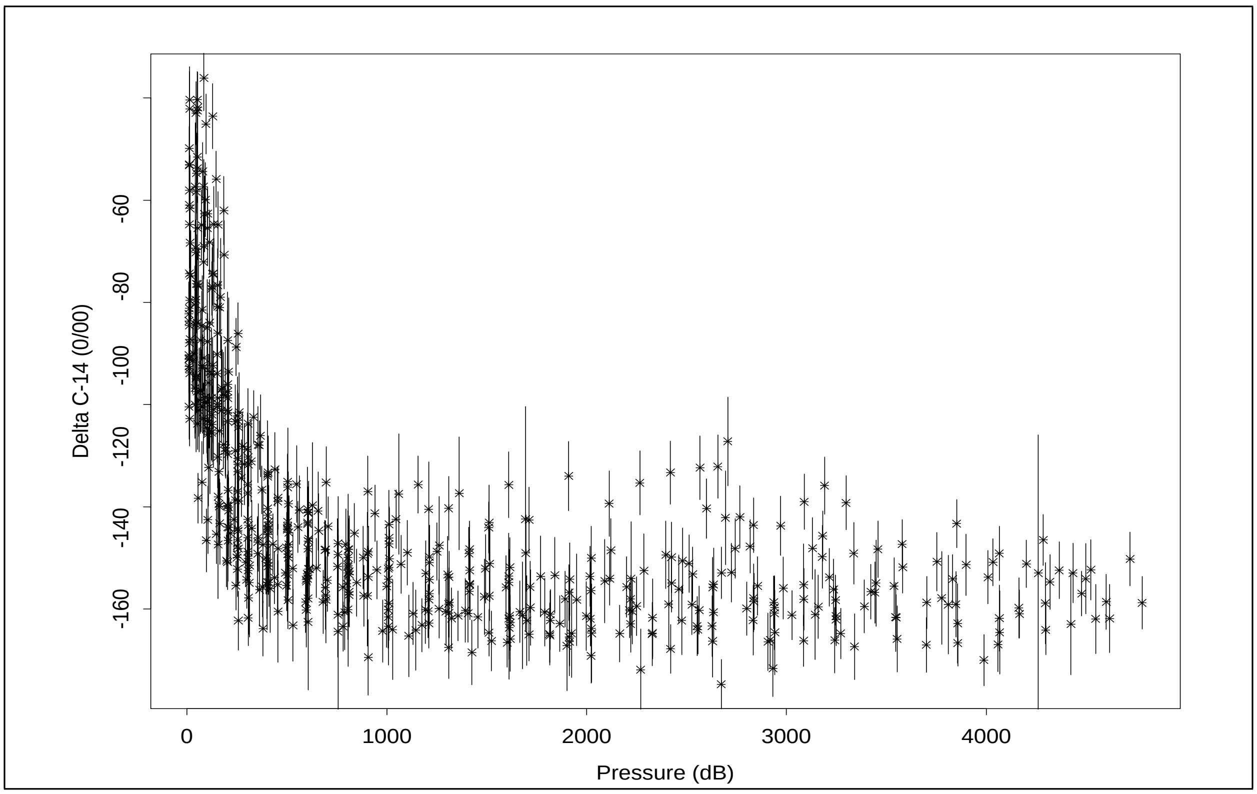

Figure 2: $\Delta^{14}C$ results for S4P stations shown with 2σ error bars.Only those measurements having a quality control flag value of 2 or 6 are plotted.

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 $\Delta^{14}C$ = -156.0±8.5‰ with a substantial fraction of this variance due to the samples collected very near the Antarctic slope. 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.

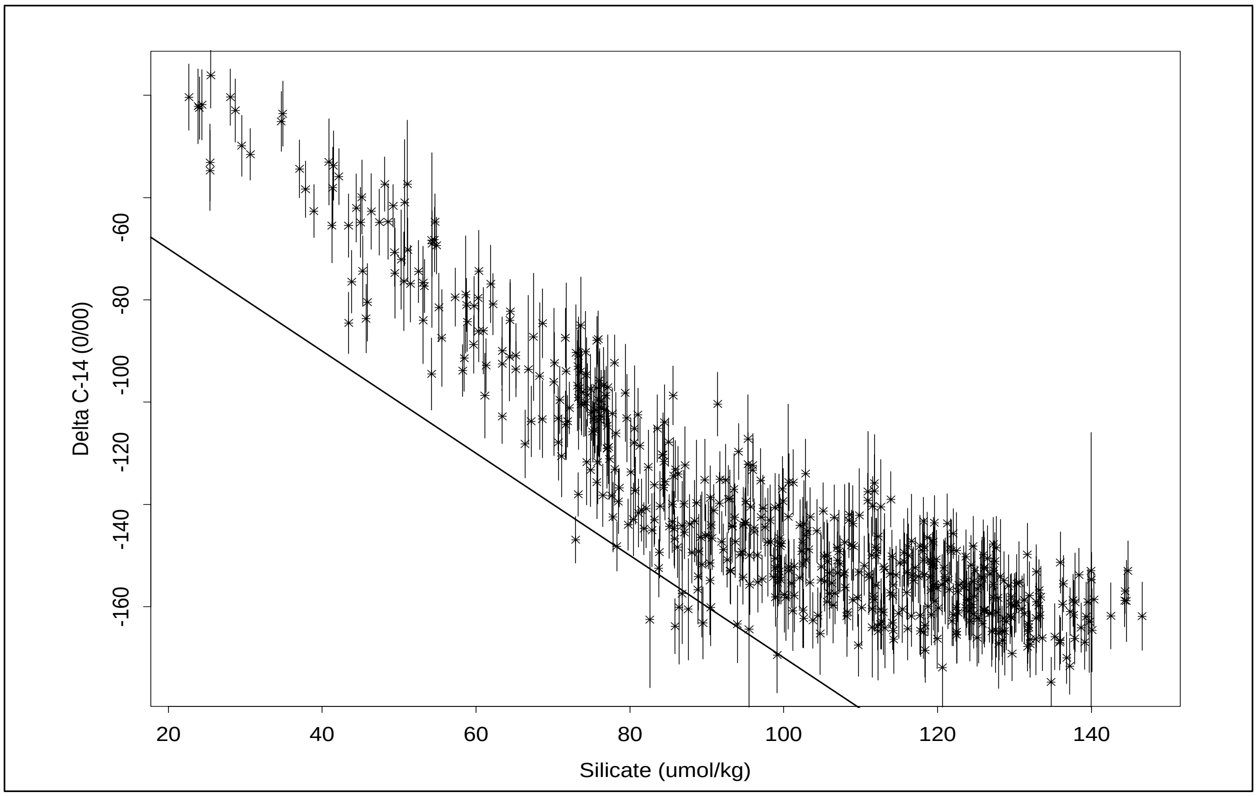

Figure 3: $\Delta^{14}C$ as a function of silicate for S4P AMS samples. The straight line shows the relationship proposed by Broecker, *et al.*, 1995 ($\Delta^{14}C$ = -70 - Si with radiocarbon in ‰ and silicate in µmol/kg).

Figure 4 shows all of the S4P 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 ~2395 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.

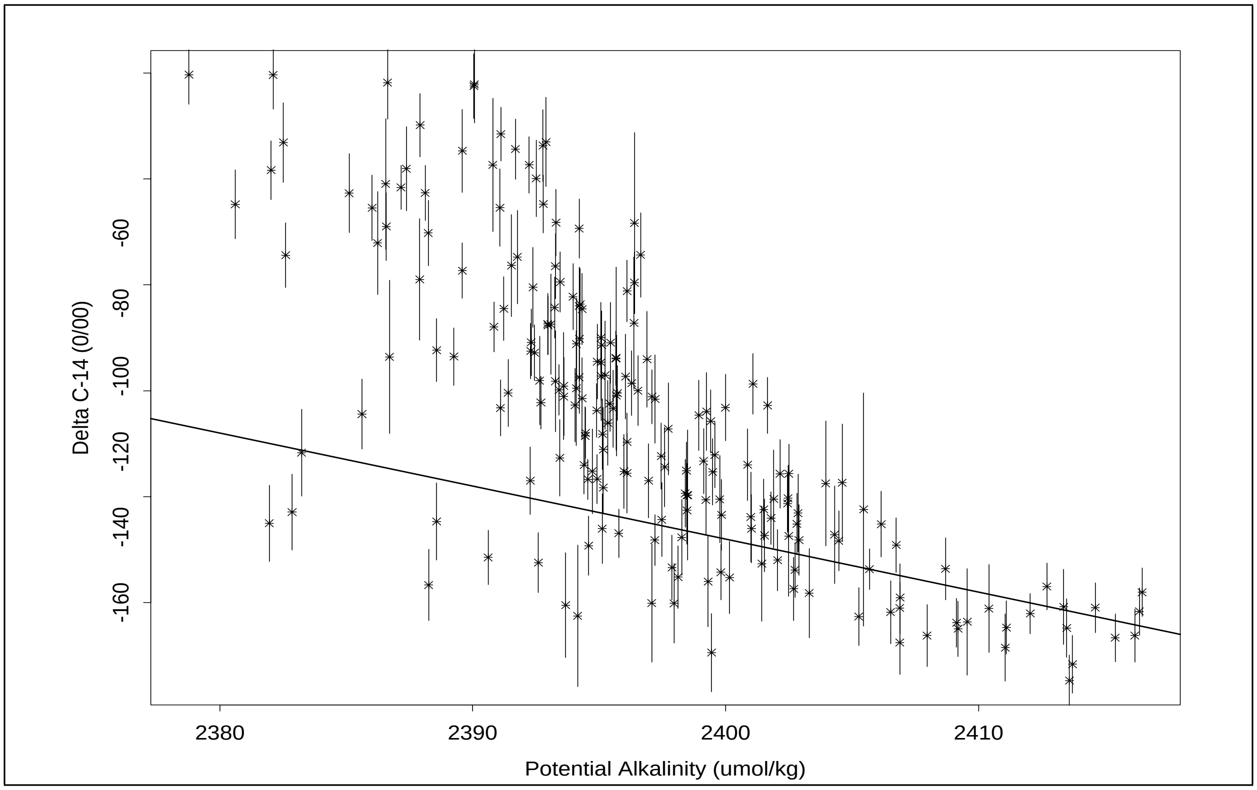

Figure 4: Based on the new method devised by S. Rubin, the samples which plot above the line and have potential alkalinity values less than 2395μmole/kg are contaminated with bomb-produced ^{14}C. Two sigma error bars shown for all samples flagged as “good” or “replicate”.

Figure 5 shows the main cruise section along ~67°S and Figure 6 shows a contoured section of the $\Delta^{14}C$ distribution along the portion of the cruise track along ~170°E. Note that the color scale used in the two figures is different. 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). In Figure 5 the variability in values from depths greater than 500 meters is essentially the same as the measurement error. The 170°E section clearly shows penetration of bomb radiocarbon along the Antarctic continental slope. No other WOCE section yet measured shows $\Delta^{14}C$ values as high as -140‰ in Southern Ocean bottom water. The source of this “new” bottom water appears to be somewhere along the shelf in the Ross Sea as indicated by Figure 7 which shows the near bottom ^{14}C for stations where the water depth is at least 3500m. In this rather crude map the heavy line is continental outline and the lighter line the 3500m bathymetry. The data for this figure were gridded using the objective analysis technique described by Sarmiento, *et al.* (1982).

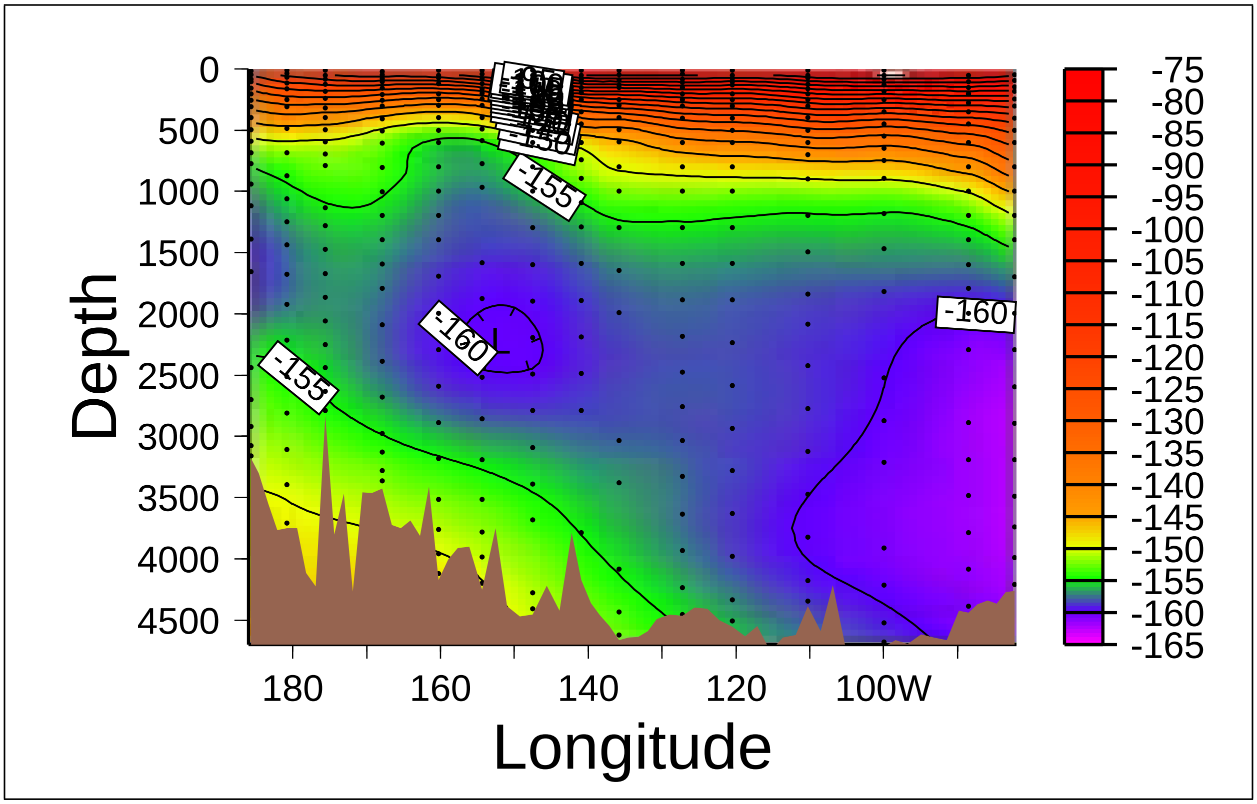

Figure 5: $\Delta^{14}C$ along main east-west section of S4P at approximately 67°S.

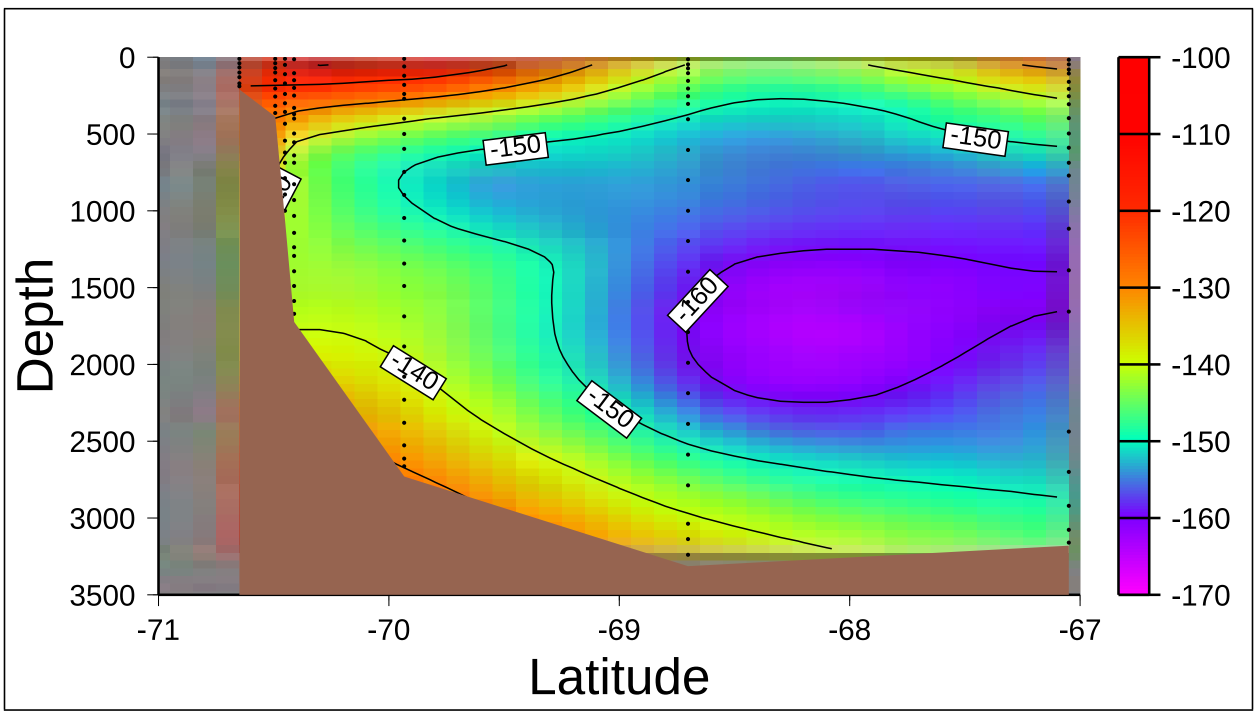

Figure 6: $\Delta^{14}C$ along ~170°E near the Antarctic slope. Note that both the scaling and color table are different than used in Figure 5. The near bottom values along the lower slope are the lowest circumpolar bottom values measured during WOCE and indicate entrainment of "new" bottom water.

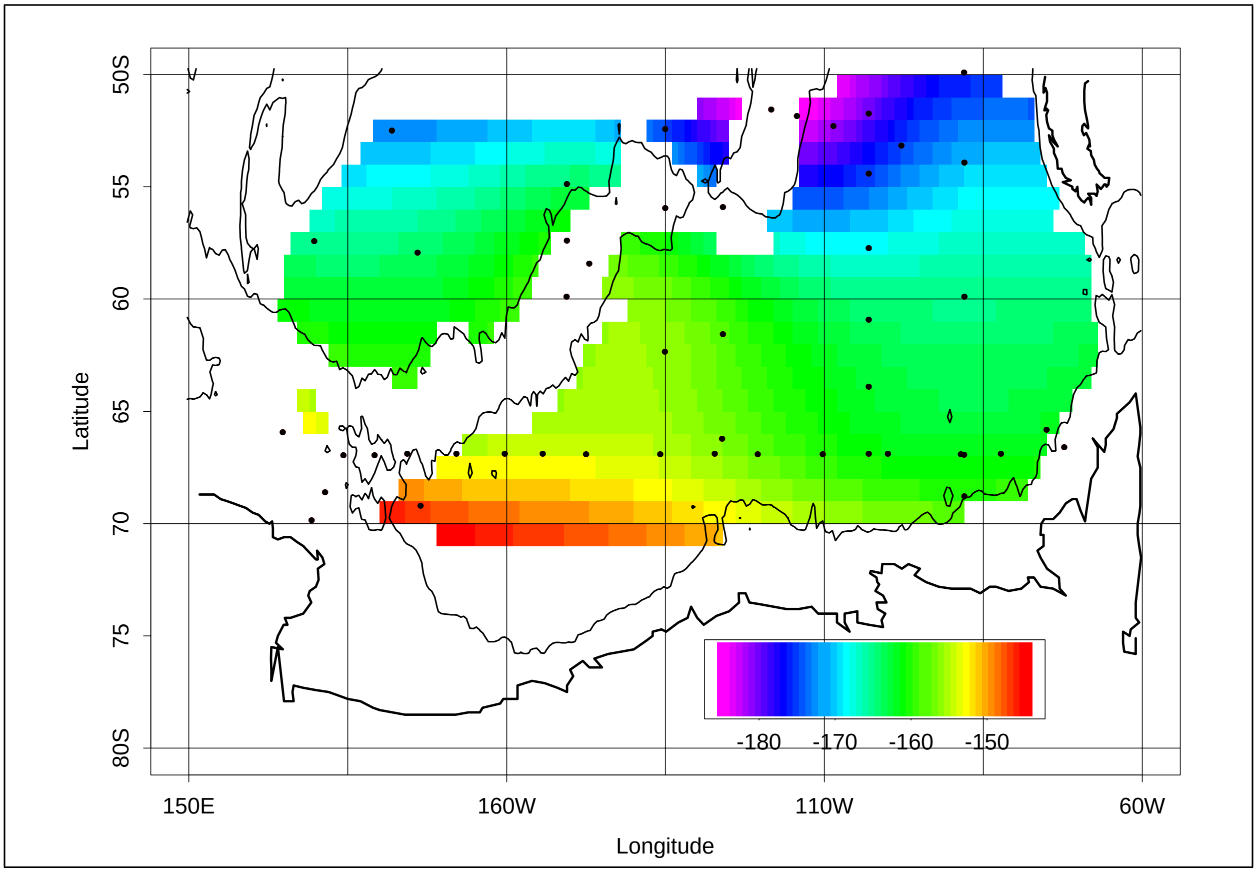

Figure 7: Objective map of near bottom ^{14}C for WOCE stations in the far southeastern Pacific. The heaviest line is the continental outline, the lighter line is the 3500 meter bathymetry. Regions where the water depth was less than 3500 meters were masked after gridding. The pattern suggests that there is a source of bottom water in the Ross Sea.

6.0 References and Supporting Documentation

Broecker, W.S., S. Sutherland and W. Smethie, Oceanic radiocarbon: Separation of the natural and bomb components, *Global Biogeochemical Cycles, 9(2)*, 263-288, 1995.

Chambers, J.M. and Hastie, T.J., 1991, Statistical Models in S, Wadsworth & Brooks, Cole Computer Science Series, Pacific Grove, CA, 608pp.

Chambers, J.M., Cleveland, W.S., Kleiner, B., and Tukey, P.A., 1983, Graphical Methods for Data Analysis, Wadsworth, Belmont, CA.

Cleveland, W.S., 1979, Robust locally weighted regression and smoothing scatterplots, J. Amer. Statistical Assoc., 74, 829-836.

Cleveland, W.S. and S.J. Devlin, 1988, Locally-weighted regression: An approach to regression analysis by local fitting, J. Am. Statist. Assoc, 83:596-610.

Elder, K.L. A.P. McNichol and A.R. Gagnon, Reproducibility of seawater, inorganic and organic carbon ^{14}C results at NOSAMS, *Radiocarbon, 40(1)*, 223-230, 1998

Joyce, T., and Corry, C., *eds*., Corry, C., Dessier, A., Dickson, A., Joyce, T., Kenny, M., Key, R., Legler, D., Millard, R., Onken, R., Saunders, P., Stalcup, M., *contrib.*, Requirements for WOCE Hydrographic Programme Data Reporting, WHPO Pub. 90-1 Rev. 2, 145pp., 1994.

Key, R.M., WOCE Pacific Ocean radiocarbon program, *Radiocarbon, 38(3),* 415-423, 1996.

Key, R.M., P.D. Quay, G.A. Jones, A.P. McNichol, K.F. Von Reden and R.J. Schneider, WOCE AMS Radiocarbon I: Pacific Ocean results; P6, P16 & P17, *Radiocarbon, 38(3),* 425-518, 1996.

NOSAMS, National Ocean Sciences AMS Facility Data Report #98-122, Woods Hole Oceanographic Institution, Woods Hole, MA, 02543, 9/16/1998.

Sarmiento, J.L., J. Willebrand and S. Hellerman, Objective analysis of tritium observations in the Atlantic Ocean during 1971-74, Ocean Tracer Lab, Technical Report #1, July, 1982.

WHPO SUMMARY

Several data files are associated with this report. They are the s4.sum, s4.hyd, s4.csl and *.wct files. The s4.sum file contains a summary of the location, time, type of parameters sampled, and other pertinent information regarding each hydrographic station. The s4.hyd file contains the bottle data. The *.wct files are the ctd data for each station. The *.wct files are zipped into one file called s4wct.zip. The s4.csl file is a listing of ctd and calculated values at standard levels.

The following is a description of how the standard levels and calculated values were derived for the s4.csl file:

Salinity, Temperature and Pressure

These three values were smoothed from the individual CTD files over the N uniformly increasing pressure levels using the following binomial filter-

$$t(j) = 0.25ti(j-1) + 0.5ti(j) + 0.25ti(j+1) \quad j=2....N-1$$

When a pressure level is represented in the *.csl file that is not contained within the ctd values, the value was linearly interpolated to the desired level after applying the binomial filtering.

Sigma-theta(SIG-TH:KG/M3), Sigma-2 (SIG-2: KG/M3), and Sigma-4(SIG-4: KG/M3) These values are calculated using the practical salinity scale (PSS-78) and the international equation of state for seawater (EOS-80) as described in the UNESCO publication 44 at reference pressures of the surface for SIG-TH; 2000 dbars for Sigma-2; and 4000 dbars for Sigma-4.

Gradient Potential Temperature

(GRD-PT: C/DB 10-3) is calculated as the least squares slope between two levels, where the standard level is the center of the interval. The interval being the smallest of the two differences between the standard level and the two closest values. The slope is first determined using CTD temperature and then the adiabatic lapse rate is subtracted to obtain the gradient potential temperature. Equations and Fortran routines are described in UNESCO publication, Processing of Oceanographic Station Data, 1991.

Gradient Salinity

(GRD-S: 1/DB 10-3) is calculated as the least squares slope between two levels, where the standard level is the center of the standard level and the two closes values. Equations and Fortran routines are described in UNESCO publication, Processing of Oceanographic Station Data, 1991.

Potential Vorticity

(POT-V: 1/ms 10-11) is calculated as the vertical component ignoring contributions due to relative vorticity, i.e. pv=fN2/g, where f is the coriolius parameter, N is the buoyancy frequency (data expressed as radius/sec), and g is the local acceleration of gravity.

Buoyancy Frequency

(B-V: cph) is calculated using the adiabatic leveling method, Fofonoff (1985) and Millard, Owens and Fofonoff (1990). Equations and Fortran routines are described in UNESCO publication 44.

Potential Energy

(PE: J/M2: 10-5) and Dynamic Height (DYN-HT: M) are calculated by integrating from 0 to the level of interest. Equations and fortran routines are described in UNESCO publication, Processing of Oceanographic Station Data, 1991.

Neutral Density

(GAMMA-N: KG/M3) is calculated with the program GAMMA-N (Jackett and McDougall) version 1.3 Nov. 94.

CTD DQE, WOCE SECTION S04P
(Eugene Morozov)

Data quality of 2-db CTD temperature, salinity and oxygen profiles and reference rosette samples were examined. Vertical distributions and theta-salinity curves were compared for individual stations using the data of up and down CTD casts and rosette probes.

Data of several neighboring stations were compared. The distance between stations was 20 miles or greater, that is why I made comparison of no more than 4-5 stations, otherwise there was a great difference between measurements.

There are no CTDOXY upcast data in the .hy2 file. Questionable data in *.hy2 file were marked in QUALT2 word. The general opinion of the data is that this is a high-quality data set with little remarks that could be done by me. The entire data set fully matches WOCE requirements.

Listing of results from the comparison of salinity and oxygen data. Only those stations are listed which have data remarks.

STN	GENERAL REMARKS	REMARKS BY J.SWIFT	REMARKS BY E. MOROZOV
684		Top 20db CTDOXY Qble	
686		Top 15db CTDOXY Qble	
687	No CTDOXY		
688	No CTDOXY		
689	No CTDOXY		
690	No CTDOXY		
692	No CTDOXY		
695			124.8db bottle may leak, SALNTY is 0.017 less than upcast CTDSAL, which means water sample could be mixed with shallower waters, as well as for oxygen, OXYGEN is higher than downcast CTDOXY.
696		Top 18db CTDOXY Qble	
699		Top 40db CTDOXY Qble	
702		Top 70db CTDOXY Qble	OXYGEN exceeds CTDOXY in 2600-3850 db interval by 4 µmol/k CTDOXY data in this interval are less than on stations 701,703, while OXYGEN data on these three stations match well. I consider CTDOXY data in this interval Qble.

STN	GENERAL REMARKS	REMARKS BY J.SWIFT	REMARKS BY E. MOROZOV
703		Top 120db CTDOXY Qble	170 - 400 db CTDOXY Qble the origin seems the same as for the upper layer - problems with CTDOXY calibration, CTDOXY data are less than OXYGEN.
704		Top 50db CTDOXY Qble	
705		Top 100db CTDOXY Qble	
708		Top 12db CTDOXY Qble	
709		Top 80db CTDOXY Qble	OXYGEN exceeds CTDOXY in 1500-3000 db interval by 3 µmol/kg CTDOXY data are lower than on neighboring stations. CTDOXY data in this interval needs better calibration. CTDOXY is very noisy, they occupy a very broad band. It seems that correct values are located to the right side of this vertical profile band. All noise reduces CTDOXY values.
710		Top 100db CTDOXY Qble	
711	Bad station	Top 100db CTDOXY Qble	200-300db CTDOXY Qble. Top 150 db downcast CTDSAL seem Qble, and probably many errors in 0-1000db interval. Upcast CTDSAL exceed SALNTY by 0.01
712		Top 100db CTDOXY Qble	Very noisy CTDOXY
713		Top 100db CTDOXY Qble	Very noisy CTDOXY
714		Top 100db CTDOXY Qble	Very noisy CTDOXY
715			Two Qble CTDOXY peaks around 1600 and 2400 db
717		Top 70db CTDOXY Qble	
718		Top 40db CTDOXY Qble	
719	No CTDOXY		
720	No CTDOXY		

STN	GENERAL REMARKS	REMARKS BY J.SWIFT	REMARKS BY E. MOROZOV
721	No CTDOXY		
722		Top 80db CTDOXY Qble	
723	No CTDOXY		
724	No CTDOXY		
726			OXYGEN exceeds CTDOXY in 1800-3000 db interval by 3 µmol/k, there is an opposite situation below 4000 db. CTDOXY data need better calibration.
730		Top 100db CTDOXY Qble	
732			OXYGEN exceeds CTDOXY in 2000-3000 db interval by 3 µmol/k, CTDOXY data are Qble in this interval.
733		Top 70db CTDOXY Qble	
734		Top 40db CTDOXY Qble	
736 737 738			CTDSAL are 0.002-0.003 PSU larger than SALNTY in deep water below 1200 db (st. 736, 737, 738). I consider CTDSAL calibration was wrong for these stations.
739		Top 80db CTDOXY Qble	
740		Top 80db CTDOXY Qble	OXYGEN exceeds CTDOXY in 2000-3000 db interval by 2 µmol/k
741			OXYGEN exceeds CTDOXY in 1800-2800 db interval by 2 µmol/k
742			OXYGEN exceeds CTDOXY in 2000-3000 db interval by 2 µmol/k Problems with CTDOXY calibration for stations 740, 741, 742.

STN	GENERAL REMARKS	REMARKS BY J.SWIFT	REMARKS BY E. MOROZOV
743		Top 70db CTDOXY Qble	122.2db bottle may leak. SALNTY is 0.014 less than upcast CTDSAL, which means water sample could be mixed with shallower waters, as well as for oxygen, OXYGEN is higher than downcast CTDOXY.
744			1291.9db bottle may leak
748			OXYGEN exceed CTDOXY in 1800-2600 db interval by 2 µmol/k, CTDOXY calibration is wrong.
751		Top 40db CTDOXY Qble	
752		Top 20db CTDOXY Qble	
755			OXYGEN exceeds CTDOXY in 500-2200 db interval by 3 µmol/k CTDOXY calibration is wrong. 128.7 db bottle may leak. SALNTY is 0.017 less than upcast CTDSAL, which means water sample could be mixed with shallower waters. CTDOXY data differs by 18. from bottle OXYGEN.
759		Top 80db CTDOXY Qble	
761		Top 80db CTDOXY Qble	
763			1078db OXYGEN is less than CTDOXY by 4 µmol/kg Bottle OXYGEN is Bad.
764			I don't consider bottles at 253.6 and 399.8 dbars Qble. This layer has many intrusions.
767		Temperature, salinity, oxygen in 530-800 db interval, seem real, maybe it is an intrusion, measurements do not seem Qble.	

STN	GENERAL REMARKS	REMARKS BY J.SWIFT	REMARKS BY E. MOROZOV
768		Top 40db CTDOXY Qble	OXYGEN exceeds CTDOXY in 1400-2200 db interval by 2 µmol/k, CTDOXY calibration may be wrong. 107.7db bottle may leak SALNTY is 0.033 less than upcast CTDSAL, which means water sample could be mixed with shallower waters, as well as for oxygen, OXYGEN is higher than downcast CTDOXY. 2203 db OXYGEN is Qble.
770		Top 60db CTDOXY Qble	OXYGEN exceeds CTDOXY in 150-750 db interval by 3 µmol/kg. OXYGEN is less than CTDOXY in 1200-2800 db interval by 3 µmol/k OXYGEN exceeds CTDOXY in 3200-3350 db interval by 2 µmol/k and I especially dont like it because the difference is in the deep water and there was no time lag between up and down casts. CTDOXY in deep water is less than on neighboring stations. Something may be wrong with the CTDOXY calibration.
771		Top 60db CTDOXY Qble	
772		Top 50db CTDOXY Qble	
773	No CTDOXY		
774	No CTDOXY		
775	No CTDOXY		
776	No CTDOXY		
777	No CTDOXY		
778	No CTDOXY		
779	No CTDOXY		
780	No CTDOXY		
781	No CTDOXY		
782	No CTDOXY		

STN	GENERAL REMARKS	REMARKS BY J.SWIFT	REMARKS BY E. MOROZOV
783		Top 80db CTDOXY Qble	Very noisy CTDOXY
784		Top 50db CTDOXY Qble	Very noisy CTDOXY
786			Very noisy CTDOXY
787			OXYGEN is less than CTDOXY in 270-1100 db interval by 3 µmol/kg, CTDOXY data is Qble.
792		Top 80db CTDOXY Qble	Very noisy CTDOXY

HYDROGRAPHIC DQE, WOCE SECTION S04P

(J.C. Jennings)

The nutrient data from the WOCE S4 section appears to be of very high quality; particularly the silicate and phosphate data. We compared groups of 10 stations using nutrient/theta and nutrient/pressure plots. Nitrate data is generally good, but there is relatively more spread in the nitrate theta plots than in the phosphate/theta plots for the same station groups. For several of the station groups the total width of the phosphate/theta "envelope" in the deep and bottom water is ca. 0.02 - 0.03 micromoles/kg; or about 1.0% - 1.5% of the maximum phosphate concentrations. The width of the nitrate/theta envelopes ranges from 0.5 - 1.0 micromoles/kg; roughly 1.5% - 3% of the maximum concentrations observed. The overall range in the deep and bottom water silicate concentrations is 20 - 25 micromoles/kg, reflecting both interaction with bottom sediments and the increasing presence of Ross Sea Bottom Water in the western half of the section. This wide range in observed silicate concentrations should make the silicate data particularly useful as a water mass tracer. The real variability in the silicate concentrations makes it more difficult to assess the precision of these measurements, but for station groups exhibiting a "tight" silicate/theta relationship in the Circumpolar Deep Water, the relative precision seems to be Û 1% of the maximum concentrations. The nitrite data seems to be of uniformly high quality, with maximum concentrations observed of about 0.5 micromoles/kg.

It was not possible to compare the S4 data with recent historical nutrient observations in the same area because the data either does not exist or has not yet been disseminated. The early ELTANIN data was not used because there are known problems with much of the nutrient data from these cruises.

The quality control notes supplied by the data originator were extremely useful and served as a model for the format of the individual comments that follow. In most cases, we were hesitant to assign a quality code of "4" designating bad data with known sampling or analytical problems, instead using the quality code of "3" for questionable data. With access to the sample logs and analyst's logbooks, the data originators are better qualified to assign a code of "4".

INDIVIDUAL COMMENTS:

The following is a summary of quality observations made during the DQE "Q2" analysis of the WOCE S4 nutrient data. Comments referring to specific bottles include the pressures to the nearest whole decibar.

Station 683:	Btl 109 @ 439db:	High SIL relative to theta. Sample at bottom so probably caused by flux from sediments.	Flag assigned: 2
Station 684:	Btl 101 @ 417db:	High SIL relative to theta. Bottom bottle of cast so probably ok (See note for STN 683).	Flag assigned: 2
Station 687:	Btl 108 @ 1059db:	Low PO4.	Flag assigned: 3
	Btls 105 - 112 @ 450db - 1613db:	All NO3 about 0.3 low relative to adjacent stations. No problems noted by Q1.	Flag assigned: 2
Station 688:	Btl 103 @ 2675db:	PO4 low by about 0.03.	Flag assigned: 3

Station 689:	Btl 117 @ 303db:	High PO4 by about 0.03. Right at nutrient maximum, and no problem noted by Q1, so probably ok.	Flag assigned: 2
	Btl 118 @ 253db:	High NO3 by about 0.3. As with Btl 117 (above) this is the nutrient maximum and is probably ok:	Flag assigned: 2
Station 692:	Btl 107 @ 2260db:	All nutrients low. Noted as a leaking bottle by Q1.	Flags assigned: 4
Station 693:	Btls 110 - 117 @ 305 - 1160db:	Slightly low PO4. No obvious problem found by Q1.	Flag assigned: 2
Station 695:	Btl 122 @ 85db:	All nutrients high. Q1 considers bottle a leaker.	Flag assigned: 3
	Btls 101 - 124:	All NO3 seems a bit low. Noted by Q1 but no problems identified.	Flag assigned: 2
Station 698:	Btl 107 @ 2942db:	PO4 a bit high.	Flag assigned: 2
Station 701:	Btls 101 - 124:	All NO3 a bit low relative to following stations, but agrees better with preceding station concentrations.	Flag assigned: 2
Station 702:	Btl 120 @ 212db:	High SIL. Salinity also high, and noted as leaker by Q1:	Flags assigned (all nutrients): 3
Station 703:	Btl 120 @ 204:	High SIL. Noted as pre-trip by Q1.	Flags assigned (all nutrients): 3
Station 704:	Btl 120 @ 209db:	High SIL. Noted as pre-trip by Q1:	Flags assigned (all nutrients): 3
Station 705:	Btl 118 @ 505db:	High SIL, Low NO3 and PO4. Noted as possible leaker by Q1.	Flag assigned (all nutrients): 3
	Btl 120 @ 305db:	High SIL, low NO3 and PO4. Noted as pre-trip by Q1.	Flag assigned (all nutrients): 3
Station 707:	Btl 125 @ 2161db:	Low SIL, high NO3 and PO4.	Flags assigned (all nutrients): 3
Station 708:	Btl 115 @ 464db:	High NO3. Q1 noted whole station as having high NO3.	Flag assigned: 3
	Btl 125 @ 1999db:	Low Sil, high NO3 and PO4. Also large delta Salt. Apparent leaker.	Flags assigned (all nutrients): 4
Station 709:	Btls 106 - 110 @ 3095 - 1900db:	High NO3 with no increase in PO4.	Flags assigned: 3
	Btls 112 - 117 @ 1300 - 403db:	High NO3 with no increase in PO4.	Flags assigned: 3
Station 711:	Btl 125 @ 2016db:	Low SIL, high NO3 and PO4; apparent leaker.	Flags assigned (all nutrients): 4
Station 713:	Btl 103 @ 4219db:	Low NO3.	Flag assigned: 3

Station 714:	Btls 101 - 112:	Low NO3 and low PO4. SIL looks ok.	Flags assigned: 3
Station 715:	Btls 101 - 112:	NO3 high by about 0.5, outside envelope of data from adjacent stations. PO4 also a bit high, but within envelope of adjacent stations.	Flags assigned to NO3: 3
Station 717:	Btl 127 @ 1963db:	Slightly high SIL on theta plot. No problem noted by Q1.	Flag assigned: 2
Station 727:	Btl 108 @ 2535db:	SIL a bit low on theta plot; no problems noted by Q1.	Flag assigned: 2
	Btl 102 - 108 @ 4371 - 2535db:	Deep NO3 values all look slightly low compared to adjacent stations. No corresponding shift in PO4 values. No problem noted by Q1.	Flags assigned: 2
Station 730:	Btls 101 - 104 @ 2834 - 4684db:	Unusually low NO3, also noted by Q1.PO4 looks fine.	Flags assigned: 3
	Btls 105 - 107:	Slightly low NO3, but agree with values at station 727 (see note above).	Flags assigned: 2
Station 731:	Btls 103 - 105 @ 3600 - 4300db:	NO3 a bit high; no corresponding change in PO4.	Flags assigned: 3
Station 737:	Btl 114 @ 655db:	NO3 & PO4 a bit high but within envelope. SIL is fine.	Flags assigned: 2
Station 741:	Btl 126 @ 1509db:	Slightly high SIL. Q1 notes low O2 and considers bottle to be a leaker.	Flag assigned: 3
Station 742:	Btl 126 @ 1413db:	Q1 noted problem with O2. Nutrients appear to be ok.	Flags assigned: 2
Station 743:	Btls 106 and 107 @ 2517 and 2200db:	SIL looks high on theta plot.	Flags assigned: 3
	Btl 126 @ 1350db:	SIL high. Q1 noted that O2 was high. PO4 and NO3 appear fine.	Flag assigned: 3
Station 744:	Btl 105 @ 3246db:	SIL looked a bit high in depth profile, ok on theta plot.	Flag assigned: 2
	Btl 108 @ 2200db:	Low nutrients, high O2. Probable leaker.	Flags assigned (all nutrients): 3
	Btl 110 @ 1602db:	High SIL on theta plot.	Flag assigned: 3
	Btl 126 @ 1291db:	SIL a bit high versus theta. Q1 notes also that O2 was high and considers bottle to be a leaker.	Flags assigned (all nutrients): 3
Station 746:	Btls 106 - 113 @ 2504 - 897db:	High NO3 with no corresponding change in PO4. Station 747 is also high.	Flags assigned: 3

Station 747:	Btls 102 and 105 - 110 @ 3961db, 3245 - 1718db:	High NO3 with no increase in PO4. These values and those at station 746 are outside the theta/NO3 envelope by 0.3 - 0.5.	Flags assigned: 3
Station 751:	Btl 110 @ 1417db:	Low PO4; NO3 and SIL seem ok.	Flag assigned: 3
Station 755:	Btls 120 and 121 @ 154 and 129db:	Low NO3 on theta plots. These are shallow samples above the Tmin, probably ok.	Flags assigned: 2
	Btl 127 @ 1769db:	Q1 noted high O2 and odd CO2 and assumed bottle leaked. Nutrients look ok and delta-S was small.	Flags assigned: 2
Station 756:	Btl 120 @ 152db:	Low NO3. Probably ok, see note for station 755.	Flag assigned: 2
Station 757:	Btl 121 @ 114db:	Nutrients look low on theta plots, but this is due to overlying layer of Winter Water.	Flags assigned: 2
Station 760:	Btls 128, 105, 106, 107 @ 2287 - 1696db:	High NO3, no corresponding increase in PO4.	Flags assigned: 3
Station 761:	Btls 107, 108, 127 @ 1865 - 2672db:	Slightly high NO3 with no corresponding increase in PO4. No problems noted by Q1.	Flags assigned: 2
	Btl 23 @ 34db:	High PO4; other nutrients same as rest of mixed layer.	Flag assigned: 3
Station 763:	Btl 106 @ 2441db:	Slightly high NO3 per Q1. Falls within NO3/ theta envelope.	Flag assigned: 2
	Btl 128 @ 3053db:	Slightly high NO3 per Q1. Falls within NO3/theta envelope.	Flag assigned: 2
Station 766:	Btl 127 @ 1872db:	Q1 noted that CFC and O2 data was high and considers bottle a leaker. Nutrients look ok.	Flags assigned: 2
Station 767:	Btls 108 - 114 @ 710 - 1572db:	High NO3 with no increase in PO4.	Flags assigned: 3
	Btl 110 @ 1158:	High SIL on theta plot; also Q1 noted high O2 and CFC values.	Flags assigned (all nutrients): 3
Station 768:	Btl 10 @ 1132db:	High SIL on theta plots. Q1 noted high O2 as well and considered bottle a leaker.	Flags assigned (all nutrients): 3
Station 769:	Btl 10 @ 1518:	Low NO3, Q1 noted that O2 was high and considered bottle a leaker.	Flag assigned: 3

Station 771:	All bottles:	NO3 seems about 0.5 low relative to station 772 with no change in PO4. No problems noted by Q1. Following stations get increasingly shallow and NO3 values do drop, so that station 771 is within the overall envelope except for bottles tripped in the Warm Deep Water with theta above 0.5 degrees.	Flags assigned: 3 to all NO3
Station 772:	All bottles:	NO3 seems a bit high relative to station 771 and following stations except for station 776. NO3 values are well within envelope for the preceding group of stations.	Flags assigned: 2
Station 778:	Btl 126 @ 172db:	Low PO4 and NO3. Q1 notes a sample log entry of "frozen".	Flags assigned (all nutrients): 3
	Btl 127 @ 303db:	Q1 noted sample freezing in Niskin bottle. Nutrients look ok.	Flags assigned: 2
Station 781:	Btl 107 @ 1897db:	PO4 just a bit high. Within PO4/theta envelope of surrounding stations.	Flag assigned: 2
Station 788:	Btl 110 @ 1198db:	SIL a bit high. Q1 noted that O2 and CFCs were high.	Flags assigned (all nutrients): 3
Station 789:	Btl 110 @ 1201db:	Similar to bottle 110 at preceding station; slightly high SIL, NO3 and PO4 seem ok. CFC data good at this station.	Flag assigned: 2
Station 793:	Btl 103 @ 998:	High PO4. Other nutrients look ok.	Flag assigned: 3

Data Processing Notes

Date	Contact	Data Type	Data Status Summary
05/18/94	Gordon, H.	SUM/DOC	Sent to DQE
	Dear Dr. Gordon (Louis): Dr. Joyce asked me to send you the enclosed two diskettes with the bottle data from SR4 (ANT VIII and ANT IX) and S4. Besides the data files, there are *.SUM and *.DOC files for each cruise. We are including reference data from AJAX2 for your use and the latest version of WHPEDIT.		
07/01/94	Joyce	BTL	Submitted by J.Rickman for DQE
	Dear Dr. Rickman: Thank you for sending the WOCE Hydrographic Programme Office the bottle data from your cruise aboard the Ak. Ioffe for WOCE Line S4. The expocode used to refer to this cruise is 90KDIOFFE6/1.		
07/01/94	Joyce	BTL	Submitted by M. Koshlyakov for DQE
	Dear Dr. Koshlyakov: Thank you for sending the WOCE Hydrographic Programme Office the bottle data from your cruise aboard the Ak. Ioffe for WOCE Line S4. The expocode used to refer to this cruise is 90KDIOFFE6/1.		
10/05/94	Dunworth	C14/CO2/CFC/HeTr	Data Request
	Mikhail Koshlyakov has requested that the WHP office solicit data, on his behalf, from his S4 cruise on the Prof Ioffe. Our records show the following PIs , and their measurement responsibilities: Dr. Greg Rau: carbon isotopes Dr Peter Schlosser: AMS C14, helium, tritium, 018 Dr David Chipman: TC02, pC02 and underway pC02. Dr Mark Warner: CFCs If the WHPO can help in any way with the formatting and/or merging of the data into the WOCE format, please don't hesitate to contact us.		
12/01/94	Kozyr	CO2	DQE Begun: update note to T.Joyce
	I am pleased to inform you that the Carbon Dioxide Information Analysis Center (CDIAC) has received the final carbon-related measurements (Total C02 and PC02) from the 1992 R/V Akademik Ioffe expedition 90KDIOFF6/1 (WOCE section S4P). Taro Takahashi, David Chipman, and Stewart Sutherland of Lamont Doherty Earth Observa-tory provided the carbon-related measurements along with files containing the preliminary hydrographic and chemical measurements and the station inventories. We will furnish you with the results of our DQE on the S4P data after completion. If there are further developments on the DQE and processing of the hydrographic measure-ments, please let us know.		
12/08/94	Joyce	CTD/BTL/SUM	Data Status Update: to Mikhail N. Koshlyakov
	We have been waiting for the data evaluator reports on your bottle data from S4, and have only a partial report on the nutrients. We also are still waiting for the CFC data from Mark Warner and the CTD data from Scripps. We will continue to seek these data and will keep you posted when something happens; perhaps a message from you asking for them to be submitted might help? In the meantime, the enclosed floppy disk contains the most up to date version of the bottle data and station summary file we have, as well as a program, written for an IBM-type PC, for looking at the bottle data. It is provided to the data quality evaluators for flagging bad or questionable data; you might find it helpful. Those individuals you listed as needing access to this data set have been contacted by us; you need not send them a copy of the data enclosed.		

Data Processing Notes

Date	Contact	Data Type	Data Status Summary
03/14/95	Morozov	CTD/S/O	DQE Report Submitted
03/30/95	Joyce	NUTs/CTD	DQE Complete; Notice to PI’s
	We have now heard back from two DQEs on your IOFFE S4 dataset. Lou Gordon & Joe Jennings examined the nutrients while Eugene Morozov, who is visiting the WHPO for three months, looked at the salinity, oxygen and CTD data. Each of the reports is attached as well as a table where each of the DQEs have some disagreement with the quality assessment of the bottle data. First, both of them agree that the data are of high quality, but there are, of course, some problems in their view. As for the CTD data, they were not submitted with any CTDOXY in the bottle data. Some of the early datasets from ODF did not have this, but more recent ones do. You should contact Jim Swift and request that it be added to the file. Besides making the bottle data more complete, it greatly facilitates the DQEs' task of judging how well the CTDOXY is 'calibrated' to the bottles. Note that many of Morozov's comments deal with CTDOXY from the CTD files and how it 'disagrees' with bottle data from the up cast. There are also some suggestions from the data about possible leaking bottles that you might consider. There are only 6 instances where the DQE differs from the quality assessment as submitted by you. Unless there are strong arguments to the contrary, we will accept the DQE suggestions. There are numerous comments on the nutrient data, particularly the nitrate. Also note that the DQE thought many of your data flagged bad were either questionable or good. In this case, we will let you be the judge-if you want to retain you quality flag of "4", we will do so. Both reviewers noted that the lack of previous high quality data in the region, makes it impossible to compare with earlier cruises; this means that your dataset will become our standard for comparison with other W11P cruises in the southern reaches of the Pacific. I am sending this report to both of you, but I expect Jim Richman to respond to this letter.		
03/30/95	Jennings-Jr.	NUTs	DQE Report sent to PI
04/12/95	Koshlyakov	CTD/BTL/CFCs	Status Update: PIs named
	There is an agreement that Dr. Jim Swift has taken responsibility for preparation of the FINAL CTD/Rosette data (except CFCs) and submitting it to WHP Office for further release. Dr. Mark Warner is responsible for the preparation of the CFCs. I have no objections against data release for public use and greet that these data would be accessible for oceanographic community. Regards, Mikhail Koshlyakov.		
01/14/99	Talley	SUM	Data Update
01/14/99	Warner	CFCs/TCARBN	DQE Issues Resolved
01/14/99	Diggs	BTL	Website Updated: New BTL file online
	I have placed the new bottle data file on the website from the WHOI Pacific Atlas. Mark Warner pointed out to me that he had indeed given the CFCs to Terry Joyce right before the conference. In any case, this file also has TCARBN values and is public. All tables have been updated to reflect these changes. -sd 1999.01.14		

Data Processing Notes

Date	Contact	Data Type	Data Status Summary
03/25/99	Diggs	S/O/NUTs/CFCs	Website Updated: status changed to public
	We're finally getting caught up here and we'll be putting out the AMS C14 data for S04P (90KDIOFFE6_1: Feb 1992). NOSAMS date was 9/16/2000, and I'm pretty sure that you've already OK'd this, but one can't be too sure. Simple confirmation is all that is required. I hope that all is well on your end. BTW, I'm still working on translating A12 data from you and straightening out the A13/A14 flag weirdness.		
04/29/99	Bartolacci	DELC13	Data Request to A. McNichol
	My understanding from Bob is that processing of C-13 for these lines is finished. Is it possible to obtain the data and/or an update on their status for the following cruise lines? Any information you can provide would be greatly appreciated! Thank you for your time!		
09/23/99	Anderson	NUTs	Data Update: changed nitrate values
	I have changed the three nitrite values for S04P station 716, bottles 4, 5, and 6 to 0.01 per Jim's e-mail. I also reformatted the .sum file. Usual shifting, adding, deleting columns. I did change the ExpoCode in the .sum file from 90KDIOFFE6/1 to RUKDIOFFE6_1 to conform with what is used on the web site and in the .sea file (I assume this means we are using RU for Russia instead of 90 which was used for the Soviet Union).		
02/04/00	Kozyr	TCARBN/PCO2	Final Data Submitted, DQE Complete
02/15/00	Hohmann	He/Tr	Almost ready to submit
	Peter Schlosser asked me to start with submitting our helium and tritium data sets that are ready. - I am about to send you the S4P, P16 and P17 data, but want to compare them with John Lupton's data first.		
03/10/00	Hohmann	He/Tr	Submitted
	I just submitted the He, Ne and Tr data from the WHPO lines S4P and P16A/P17A. Please let me know if you can successfully read the data.		
03/22/00	Bartolacci	CO2	Website Updated: Data Online
	Merging notes for CO2 merging into S04P: • Data sent from Alex Kozyr on 2000.02.14. Stripped header info from file. • S04P bottle file obtained from WHPO website. • Used mrgsea (DMN) to merge: TCARBN, PCO2, PCO2TMP. • Missing values in co2 file sent by Kozyr was -999.9. This was changed to WOCE format -9.0 in edited version of data prior to merging. • Changed expocode in WHPO bottle file from: 90KDIOFFE6/1 to 90KDIOFFE6_1. • Changed cruise date in WHPO bottle file from: Feb. 14-April 6 to 021492-040692. • Ran wocecvt, only detected errors were in sumfile. • Ran read_hyd, no errors. • Ran maskhyd to add date/name stamp. • Output file called s04phy_mrg.txt		

Data Processing Notes

Date	Contact	Data Type	Data Status Summary
03/22/00	Bartolacci	CO2	Website Updated: Data Online
	I have merged Alex Kozyr's CO2 data into the WHP S04P bottle file. Merged were total carbon, pco2 and pco2 tmp. Old bottle file has been moved to the original directory and replaced with the new merged file. All tables and entries have been updated to reflect this change. No errors were detected.		
04/19/00	Bartolacci	DELC14	Data Query: Can't locate data
	S04P Neither myself nor Jerry could find any documentation that these data came in, nor the data file itself. I will ask Steve about this one ASAP.		
04/19/00	Diggs	CTD/BTL/SUM	ExpoCode Update Needed
	Please change "RU" to "90" on Russian cruises Please change all designations of "RU" to "90" for the Russian cruises. We agreed on this a long time ago.		
04/20/00	Kappa	DELC14/DOC	Submission acknowledgement to B. Key
	Just letting you know your 3 files (one data file, 2 doc files) made it across the ether and look fine. The data file has the following header: Station,Cast,Bottle Number,Pressure (dB),Delta C-14 (0/00),c14e,c14f and includes stations 682 - 794. The pdf doc file has 11 pages, which we will insert directly into our online pdf doc for s04p. One question. Do you have a plain text file for this report that you could send? - Jerry The 3 files described in my e-mail of earlier today have been ftp'ed to the WHPO INCOMING directory. - bob		
04/20/00	Key	DELC14/DOC	Final Data Submitted; release date is 9/16/2000
	S4P was a Schlosser cruise. The official release date for this data is 9/16/2000 which is about the same as the expected release date for the next CD-ROM. It is quite possible (probable) that this omission is my error rather than WHPO (I'm more hesitant to submit other's data and this may have fallen through the cracks in the process). Assuming this to be the case, I have attached an ascii version of the final data (S4P.C14). My data dump software isn't picky about format, so extra decimal values can be rounded to WOCE specs and any truncated too short can have O's added in the decimal field. otherwise, the data is to WOCE specs. I have also attached two versions of the final C14 report for this cruise (S4P.Cl4.pdf and S4P.C14.ps). The report is similar to previous final reports, has an OTL Tech Rep. # for reference, includes color figures, and is also accessible via the GLODAP web site. This cruise can now be listed as WHPO-RAW. I have talked to Steve regarding the LVS and I believe he is working on them. On the upcoming CD-ROM release it would be nice if the C-14 data could somehow be linked to the various Final Reports.		
04/21/00	Key	Cruise Report	Submitted;ascii version
	I put a copy of the report (S4P.txt) in your INCOMING directory. Unfortunately, my translator strings the tables out (by row) so it is a bit messy and the figures are cut. I do have all of the figures available as either simple ps or epsi files and could transform into pdf if there is any gain.		

Data Processing Notes

Date	Contact	Data Type	Data Status Summary
10/05/00	Anfuso	He/Tr/Ne	Website Updated: Data Online
	Merged DelHe3, Helium, Tritium, and Neon from Hohmann into hyd file. Updated hyd file is on line. Merging notes in original subdir 2000.03.10_S04P_HE_NE_HOHMANN. EXPO codes in sum and hyd file do not match. Notes per S. Anderson (1999.09.23) suggest EXPO code in sum file should be changed. Read-only permission on this file. Please see 00_README notes in original subdir regarding EXPO code: 2000.10.04 SRA Merged DELHE, DELHER, HELIUM, HELIER, TRITIUM, TRITER, NEON, NEONER. Split data file S4PHeNeTr.sea into a separate file for each parameter, removed blank spaces (no data) from Neon data. NOTE: NEON data for station 768 btl 15 had no data (white space) and flag = 2. Changed flag to 9.		
12/11/00	Uribe	Cruise Report	Submitted; found in 'sum file' dir.
	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.		
02/26/01	Schlosser	He/Tr/Ne	Website Updated: Status Changed to Public
	Following up on Bill Jenkins's message, I would like to ask you to make public all LDEO WOCE tritium/he data that have been submitted to you. because the tritium/he community has not yet finished the final calibration of the data, I might have to apply minor corrections to these data once the intercal. effort has been completed. our acce work was funded over a 5-year period that ended in 2000. consequently, this data set is further behind in quality control before submission, but I expect that we will get these data ready soon. SR3 was never funded in a 'regular' fashion, but I used NOAA corc funds to keep the measurements of this sample set moving. I expect to finish the analyses this summer and submit them in fall.		
06/19/01	Swift	CTDTMP	Update Needed
	An oceanographically-insignificant error in CTDTMP data for this cruise has been found (ca. -0.00024*T - 0.00036 degC). A data update is forthcoming. In the interim the corrected data files can be obtained from: ftp://odf.ucsd.edu/pub/HydroData/woce/crs		

Data Processing Notes

Date	Contact	Data Type	Data Status Summary
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. 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:

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

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

Data Processing Notes

	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
	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
06/21/01	Uribe	BTL	Website Updated: Exchange file online
	Bottle exchange file was put online.		
06/28/01	Uribe	CTD	Website Updated: Exchange file online
	CTD were converted to exchange format and put online.		

Data Processing Notes

<table>
<tr><th>Date</th><th>Contact</th><th>Data Type</th><th>Data Status Summary</th></tr>
<tr><td>08/07/01</td><td>Muus</td><td>BTL</td><td>Website Updated: Data & Exchange file Online</td></tr>
<tr><td></td><td colspan="3">1. Merged CFC-11, CFC-12, TCARBN, PC02, PCO2TMP, DELHE3, DELHER, HELIUM, HELIER, TRITUM, TRITER, NEON, and NEONER from 20000105WHPOSIOSRA bottle file into ODF bottle file revised July 5, 2001, to correct a minor ITS-90 calculation error.
2. Tritium header changed from TRITIUM to TR
3. C-14 data from: /usr/export/html-public/data/onetime/southern/s04/s04p/original/2000.04.20_C14_HE_TR_KEY/S4P.C14 also merged into bottle file on being determined to be public data.
4. New ODF summary file, dated May 24, 2001, was used to make exchange file with new bottle file.
5. New ODF sea file has Station 694 Cast 3 containing CTD data only but new ODF summary has no 694 Cast 3.
Original ODF stacst has:
1 694 1250292 ROS67 0.4S 77 1.7W1319 3755CTD #1, 24 Bottles 12
1 694 2250292 TOW6659. S 77 2. W Net Tow
1 694 3250292 ROS6655.8S 7711.8W2219 CTD #1, 300m for Biology only
1 695 1260292 ROS6659.9S 7818.8W0244 3906CTD #1, 24 Bottles 14
Sta 694 Cast 3 not on WHPO web site. Cast 1 only. Deleted Cast 3 from new s04phy.txt. Notified ODF.</td></tr>
<tr><td>08/13/01</td><td>Diggs</td><td>CTD/BTL/SUM/C14</td><td>Website Updated: Data Update</td></tr>
<tr><td></td><td colspan="3">14C was added and made public. ODF updated CTD files and CTD values for bottle files have been added to the website. Sumfile from ODF added to website as well. All files re-linked and checked out. (as per D. Muus note below)
08/13/01
Steve, Newly merged S04P files are in ~dave/SDIGGS/S04P. Includes sea file, summary file, exchange file and notes file. wocecvt and Java Ocean Atlas successfully run on new data files.
- Dave</td></tr>
<tr><td>08/20/01</td><td>Uribe</td><td>Cruise Report</td><td>Website Updated: pdf version online</td></tr>
<tr><td></td><td colspan="3">PDF documentation for this cruise has been put online.</td></tr>
<tr><td>12/26/01</td><td>Uribe</td><td>CTD</td><td>Website Updated: Exchange file online</td></tr>
<tr><td></td><td colspan="3">CTD has been converted to exchange using the new code and put online.</td></tr>
<tr><td>01/8/02</td><td>Hajrasuliha</td><td>CTD</td><td>Data Consistency Check completed</td></tr>
<tr><td></td><td colspan="3">created *check.txt file for the cruise. created *.ps files for this cruise.</td></tr>
<tr><td>05/22/02</td><td>Anderson</td><td>DELC13</td><td>Website Updated: Data & new CSV file online</td></tr>
<tr><td></td><td colspan="3">Merged DELC13 data into online file s04phy.txt (20010810WHPOSIODM). DELC13 data were retrieved from Bob Key's ftp site in May of 2001.
Bottle file had a sta. 694 cast 3, but the sum file did not have a cast 3 for sta. 694 (this was noted by Dave Muus (2001/08/07). Dave deleted the cast from the bottle file since it only contained CTD data. Subsequently a new bottle file was put online (2001/08/13) which had the same problem. Cannot create exchange format with this problem, so I deleted sta. 694, cast 3. This problem needs to be resolved. I created a new exchange file and put it online.</td></tr>
</table>

Data Processing Notes

Date	Contact	Data Type	Data Status Summary
05/26/03	Anderson	SUM/Nitrite	Nitrate values edited, SUM reformatted
	I have changed the three nitrite values for S04P station 716, bottles 4, 5, and 6 to 0.01 per Jim's e-mail. I also reformatted the .sum file. Usual shifting, adding, deleting columns. I did change the ExpoCode in the .sum file from 90KDIOFFE6/1 to RUKDIOFFE6_1 to conform with what is used on the web site and in the .sea file (I assume this means we are using RU for Russia instead of 90 which was used for the Soviet Union). I have put the files on WHPO in /usr/export/ftp/pub/WHPO/S_ANDERSON/S04P.		
09/23/03	Warner	CFCs	DQE Summary report not found at WHPO
	I believe the CFC-12 section looks good when contoured. The size of the unknown correction due to the poor integration of CFC-12 on a tailing peak is relatively small (I believe). It becomes a real problem when you try to calculate rations for the lower CFC concentrations. You could get away with presenting the section and somehow noting the problem. I thought we had sent the documentation to WHPO. I better double-check on that.		
11/12/03	Warner	CFCs	Final Data Submitted
	I ended up sending a tar of all the cruises for which we did the DQE process. In general, the CFC PI agreed with our evaluation and changed their QUALT1 flag to agree with our suggested QUALT2 flag. Please feel free to ask questions. (Fortunately, we had sent all of this data to Alex Orsi over a year ago, so the atlas is made with this data.) The file: final_cfc_data.tar - 1618432 bytes has been saved as: 20031112.171702_WARNER_A21_final_cfc_data.tar in the directory: 20031112.171702_WARNER_A21 The data disposition is: Public The file format is: Plain Text (ASCII) The archive type is: NONE - Individual File The data type(s) is: Other: Final DQE The file contains these water sample identifiers: WARNER, MARK would like the following action(s) taken on the data: Merge Data Update Parameters Any additional notes are: Miscommunication between myself and Dong-Ha Min have resulted in this delay. I will upload all of the data with its assigned (and agreed upon with the PI) QUALT2 (q2) and revised q1 characters.		

Data Processing Notes

Date	Contact	Data Type	Data Status Summary
11/13/03	Anderson	CFCs	Website Updated: Data Online
	Mark Warner submitted a file with updated cfc data. I merged the CFC-11 and CFC-12 from file s04p_cfc_whpo_dat into the online file. Online file only had QUALT1 flags. Since the cfc file sent by Warner had both Q1 and Q2 flags, I copied the Q1 flags to the Q2 in the online file before I merged the CFCs. File from Warner had Q flags of 1 for missing data. I changed them to 9.		
01/09/04	Talley	NUTs	Data Query: Nitrite on Sta 716 not correct
	Date: Fri, 9 Jan 2004 17:27:12 -0800 (PST) From: Lynne Talley <lynne@gyre.ucsd.edu> To: aorsi@tamu.edu, jswift@ucsd.edu, lynne@gyre.ucsd.edu, sarilee@minerva.ucsd.edu, sharon@gyre.ucsd.edu Subject: nitrites on s4p Hi Sarilee - I'm not sure who to check with on nutrients for S4P. Nitrite on station 716, bottles 6, 5, 4 at 2818,3179, 3538 dbar can't possibly be right (> 2.5 where they should be very close to zero). I think I'm counting quality flags right and don't see anything other than a 2 for the flags for these 3 bottles. How do we go about resolving this?		
01/09/04	Talley	DELC13	Data Question: 1 decimal point accuracy?
	Bob and Sarilee - just checking - is it correct that delc13 values on S4p have only one decimal point accuracy?		
01/12/04	Key	DELC13	Data Update: NOSAMS precision
	The 13C for S4P should have normal precision reported by NOSAMS, i.e. not 1 decimal. I have attached the latest version of that data as I received it from them (Dana Stuart) on 8/9/99. These values need to be truncated.		
1/12/04	Anderson	NITRIT	Sta 716 error previously corrected
	Lynne Talley inquired about the DELC13 and 3 N02 values (see attached emails). Bob Key sent a file with DELC13 and I remerged it with two decimal places instead of one. I changed the N02 for sta. 716, samples 6, 5, and 4, at 2818.0, 3179.7, and 3538.7db to 0.01. I had done this previously (see Data History 199/09/23). The bad values were reintroduced when ODF resubmitted the data (2001/06/20) when they discovered a small error in their algorithm to convert ITS90 temp. calibration data to IPTS68.		
08/01/05	Kappa	Cruise Report	Reformatted, expanded Data Processing Notes