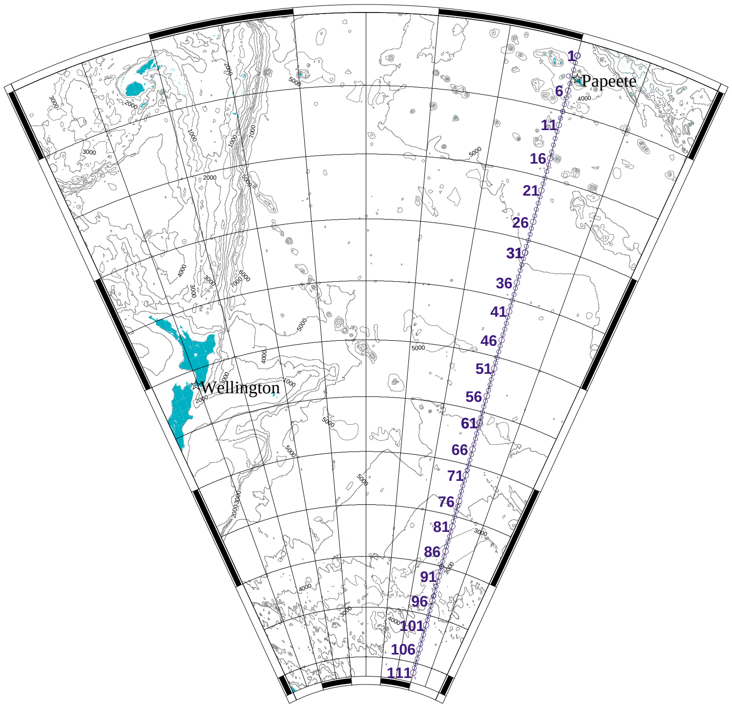
PRELIMINARY CRUISE REPORT: P16S_2005A

(Updated 2005 APR 01)



A. HIGHLIGHTS

Cruise Summary Information

WOCE section designation	**P16S_2005a**
Expedition designation (EXPOCODE)	**33RR200502**
Chief Scientist / affiliation *	**Dr. Bernadette M. Sloyan / WHOI**
Co-Chief Scientist / affiliation *	**Dr. James Swift / SIO**
Dates	2005 JAN 06 - 2005 FEB 19
Ship	*R/V Revelle*
Ports of call	Papeete, Tahiti - Wellington, New Zealand
Station geographic boundaries	16°S 150° 14.71'W 149°54.48"W 71°S
Stations	111 CTD Stations
Floats and drifters deployed	12 ARGOS floats deployed
Moorings deployed or recovered	0
Contributing Authors	none cited

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Cruise and Data* Information

Links to text locations. Shaded items are not relevant to this cruise or were not available when this report was compiled

* Data Submitted by: Shipboard Technical Support • Oceanographic Data Facility*
Kristin M. Sanborn, Susan Becker, Mary C. Johnson,
Teresa Kacena, Dan G. Schuller, Bettina Sohst

Shipboard Technical Support • Shipboard Electronics Group*
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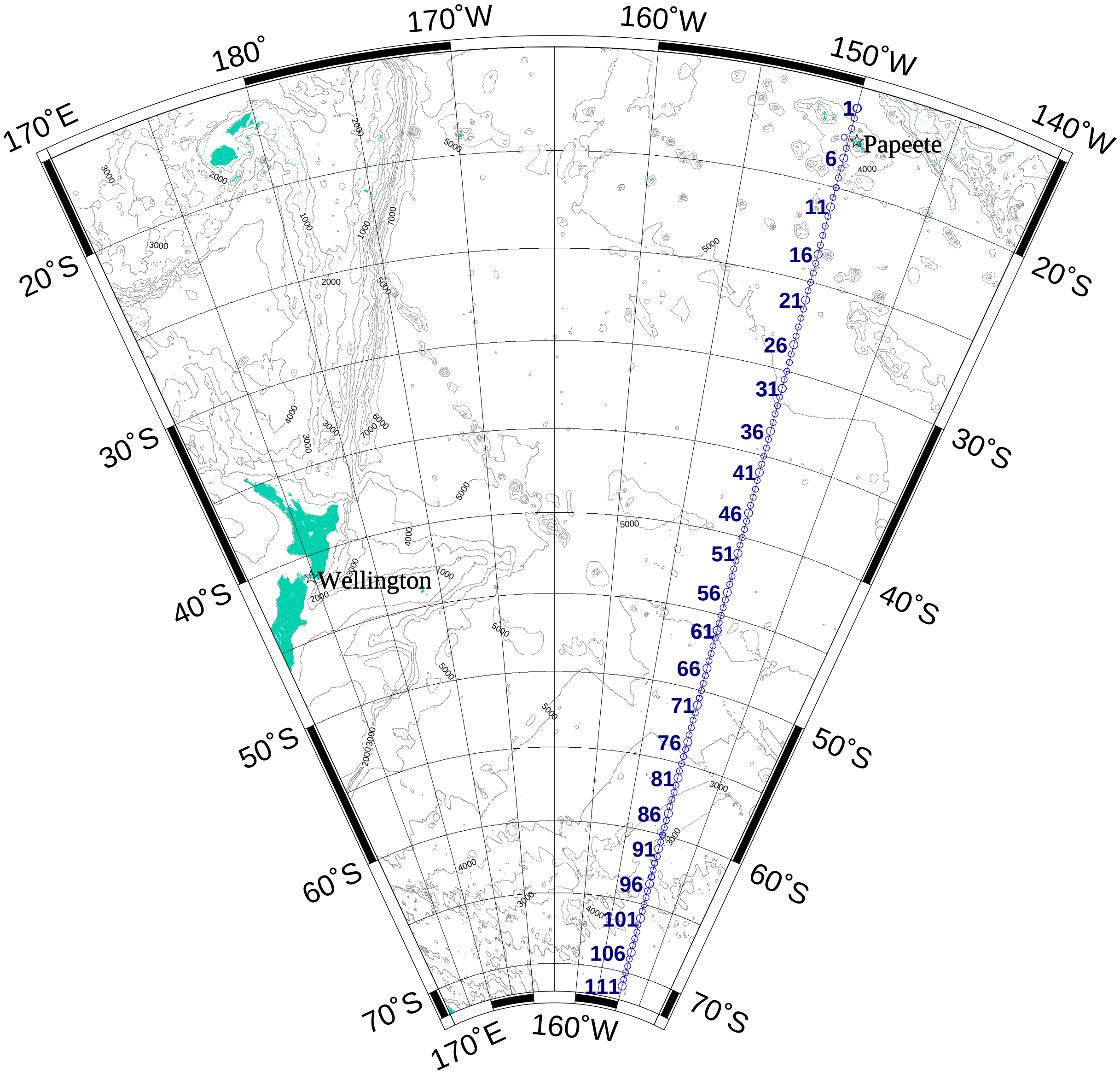
P16S_2005a Station Locations • Sloyan/Swift • *R/V Roger Revelle*



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A.2. Summary

A hydrographic/carbon/tracer survey in the South Pacific Ocean was carried out from *R/V Roger Revelle* from 9 January through 19 February 2005. The cruise departed from Papeete, Tahiti on 9 January, 2005. A meridional transect from 16 to 71 degrees South along 150 degrees West was completed. 111 full-depth CTD/rosette/LADCP casts (at one-half degree spacing), 4 shallow CDOM rosette casts, and 58 trace metals CTD/rosette casts were completed from 10 January to 11 February. Salinity, dissolved oxygen, and nutrients were analyzed for up to 36 water samples from each cast of the principal CTD/rosette program. Other parameters sampled included CFCs, helium, total inorganic carbon, alkalinity, radiocarbon, tritium, several parameters related to dissolved organic matter, and nitrogen-15. Additional deployments included 12 ARGOS floats and 21 Bio-Optics casts. The cruise ended in Wellington, New Zealand on 19 February 2005.

Introduction

A sea-going science team gathered from eight oceanographic institutions around the U.S. participated on the cruise. Several other science programs were supported with no dedicated cruise participant. The science team and their responsibilities are listed below.

A.3. Personnel

Principal Programs

ANALYSIS	INSTITUTION	PRINCIPAL INVESTIGATOR
CTDO/S/O2/Nutrients	UCSD/SIO	Jim Swift
Transmissometer	TAMU	Wilf Gardner
CO2-Alkalinity	UCSD/SIO	Andrew Dickson
CO2-DIC + Underway pCO2	NOAA	Dick Feely/Chris Sabine
DOC/DON	RSMAS-UMiami/UCSB	Dennis Hansell/Craig Carlson
CDOM	UCSB	Dave Siegel/Norm Nelson / Craig Carlson
C-13/C-14	WHOI/Princeton Univ.	Ann McNichol/Robert Key
CFCs	RSMAS-UMiami	Rana Fine
He-3/Tritium	LDEO	Peter Schlosser
ADCP/LADCP	UHawaii	Eric Firing
Trace Elements	UHawaii/FSU	Chris Measures/Bill Landing
ARGO Floats	NOAA	Greg Johnson/Elizabeth Steffen
15N	Princeton	Daniel Sigman / Peter DeFiore

Scientific Personnel

DUTIES	**NAME**	**AFFILIATION**	**EMAIL**
CH SCI	Bernadette Sloyan	WHOI	bsloyan@whoi.edu
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ODF BOT PR	Kristin Sanborn	UCSD/SIO/ODF	kris@odf.ucsd.edu
SEG ET	John Calderwood	UCSD/SIO/SEG	jkc@odf.ucsd.edu
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ODF TECH	Bettina Sohst	UCSC	blauhai@ucsc.edu
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ALK TECH	Justine Afghan	UCSD/SIO	jafghan@ucsd.edu
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DIC TECH	Andrew McDonnell	UCSD/SIO	amcdonnel@ucsd.edu
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CFC TECH	Charlene Grall	UM/RSMAS	cgrall@rsmas.miami.edu
CFC TECH	David Cooper	UM/RSMAS	dcooper@rsmas.miami.edu
HE/TR	Anthony Dachille	LDEO	dachille@ldeo.columbia.edu
TRACE MET	Bill Landing	FSU	landing@ocean.fsu.edu
TRACE MET	Amy Apprill	U of Hawaii	appril@hawaii.edu
TRACE MET	Clifton Buck	FSU (PhD student)	buck@ocean.fsu.edu
TRACE MET	Matthew Brown	U Hawaii	mbrown@soest.hawaii.edu
TRACE MET	Chis Measures	U Hawaii	measures@hawaii.edu
DON/DOC	Stu Goldberg	UCSB (student)	s_goldbe@lifesci.ucsb.edu
CDOM	Chantal Swan	UCSB (PhD student)	swan@icess.ucsb.edu

Officers and Crew

Name	**Position**
David Murline	Captain
Paul Mauricio	Chief Engineer
Eric Wakeman	1st Mate
Joe Ferris	2nd Mate
Alejo Alejo	3rd Mate
Steve St. Martin	1st A/E
Randy Fannigan	2nd A/E
Chris Quijano	3rd A/E
Ed Miller	Senior Cook
Davy Jones	Cook

Name	**Position**
James Pearson	Boatswain
Manuel Elliot	Electrician
Michelle Jackson	A/B
Brian Mattiesen	A/B
Heather Galiher	A/B
Sean Mix	Oiler
Mike Hotchkiss	Oiler
Ernie Bayer	Oiler
Rick McCormick	Oiler
Phil Hogan	Wiper
Eric Magellen	OS

A.4. Narrative

At 0112, 10 January 2005 (UTC) the *R/V Roger Revelle* set sail from Papeete, Tahiti, French Polynesia, to begin the US Carbon/Repeat Hydrography P16S section. This section is a repeat of the WOCE P16C and P16A sections that were occupied in September 1991 and October-November 1992, respectively. This cruise re-occupied both the previous WOCE sections, although shifted slightly eastward to 150°W and spanned the latitude range of 16°S to 71°S. The principal sampling program was full-depth CTD/rosette/LADCP casts, over the side, at 30 degree spacing along 150°W. Trace Metal rosette casts with separate equipment were performed off the ship's fantail, usually on alternate CTD/rosette stations. Close to local noon on most days a shallow (0-250m) hand-deployed optics profiler cast was performed at a suitable point in the program. The final station (71°S 150°W) was completed at 0600, 11 February (UTC). Good weather conditions and excellent performance from all electronic equipment and water chemistry analysis systems resulted in no significant time delays during the cruise. This allowed us to complete additional southern stations beyond that originally proposed in the CLIVAR Carbon/Repeat Hydrography science plan.

We had an 8 hour steam from Papeete to our first station. On arrival at Station 001 we performed a shallow test cast to check that the CTD, rosette, and LADCP electronics were working appropriately, and that sample bottles closed and sealed properly. We began the P16S stations after the successful completion of the test cast. Station spacing of 30nm (55.56km) was maintained throughout the cruise. The seawater measurements covered a broad spectrum of those properties most useful to the study and understanding of the ocean's role in global change and the carbon system. Extensive carbon-related measurements were coupled to high quality temperature, salinity, oxygen, and nutrient data, along with systematic measurements of CFCs, helium, tritium, and radiocarbon. An extensive suite of biological measurements (e.g. DOC/DOM, CDOM, bacteria, chlorophyll) were also supported on this cruise. Separate Trace Metal casts measured iron, aluminum, magnesium and nutrients in the upper 1000m of the water column. Twelve ARGO floats were also deployed for the Pacific Marine Environmental Laboratory (PMEL) along the cruise track north of 59.5°S.

A.5. ARGO Floats

Twelve ARGO floats were deployed along the cruise track at specific latitudes request by the PMEL ARGO scientists. There were concerns about the performance of some ARGO floats that were deployed during the first week of the cruise: On the deployment of two floats limited or no satellite transmissions were received while these floats were at the surface. We worked with Elizabeth Steffen (PMEL) to diagnose why transmissions from these floats were not received. This entailed starting up two ARGO floats and placing them on the fantail for six hours. On this initial test one of the ARGO floats performed as expected with a number of transmission received by the satellite. No messages were received from the other float. However, upon retesting (float strapped upright on ships fantail) transmissions were received. The suggested cause of lack of received transmissions from deployed float was due to a longer than normal time for the float to right themselves while at the surface. After the successful tests were performed all remaining floats were deployed at pre- set latitudes. The position of two float deployments was, however, slightly modified. Upon re-surfacing all ARGO floats returned temperature and salinity profile as expected.

ARGO Deployments along 150°W

1741	18.5°S
1742	24.0°s
1743	26.5°S
1744	29.0°S
1745	40.0°S
1746	44.0°S
1747	46.5°S
1748	48.0°S
1752	52.0°S
1753	56.0°S
1754	58.0°S
1755	59.5°S

B. UNDERWAY MEASUREMENTS

B.1. Shipboard and Lowered ADCP

Two acoustic velocity profilers are considered to be the primary instruments for this cruise. Two additional sonars were evaluated on this cruise for their data quality and their potential for high-quality velocity measurements on this and future cruises.

The two primary instruments for this cruise are the hull-mounted RDI 150KHz Narrowband ADCP and a rosette-mounted Self Contained 150KHz Broadband ADCP. Final processing of the former yields 5-minute averages of 8-m resolution vertical profiles down to 200-300m for the duration of the cruise; the latter yields a 20-m vertical resolution profile for as much of the water column as the instrument could determine. The other two (Hydrographic Doppler Sonar Systems) are designed and maintained by Dr. R. Pinkel at Scripps Institute of Oceanography. HDAS data and limited software and documentation are available for scientists on the Revelle. An attempt was made to evaluate these instruments and apply standard ADCP processing techniques to the data.

Data from the RDI shipboard ADCP is usually acquired by RDI's DAS2.48 or a later compilation, DAS2.49 (which has higher baud rates). For this cruise, a Linux laptop was configured to acquire the data using "UHDAS". UHDAS communicates directly with the instrument, sending configuration settings and collecting subsequent data as the instrument pings. It also collects the necessary suite of data required to process shipboard ADCP data: gyro heading, gps positions, and a gps-based heading (Ashtech on the Revelle). UHDAS also provides a web site with access to documentation and regularly-updated data and figures. Standard CODAS processing is used, including a sound-speed correction based on the thermistor temperature at the transducers, an amplitude and phase calibration constant applied to the measured velocities, and a correction from gyro to Ashtech heading.

The 150KHz Narrowband shipboard ADCP was configured with 8-m blank and pulse; 50 8-m bins were collected. In addition to the temperature-dependent sound speed correction, a scale factor of 0.978 and a heading misalignment angle of 2.09 degrees were applied. Data were averaged into 5-minute profiles. Data penetration extended to about 200-250m from 15°S to 35°S, and deepened to over 300m by about 43°S. South of 45°S, rough weather affected underway data, causing underway bias in some cases, sometimes rendering it useless. On station data were compromised as well. Little data between 46°S and 51°S is useful. South of 51°S, penetration was 250m-350m and data quality improved.

The primary lowered ADCP instrument was configured with a bad setting during the first cast. The spare (same model) was used for casts 2-10, during which time the bad setting on the primary instrument was discovered and corrected. The primary instrument was used from station 11-111. The configuration for stations 2-66 was for a 16-m blank, 16m pulse, and 16 16-m bins. From station 67 to the end, the resolution was doubled (32 8-m bins). All data were collected in beam coordinates, with staggered pinging of 1.0 and 1.5 seconds between pings, to reduce data loss from previous-ping interference. Scattering was low from 15°S to 40°S and LADCP profiles did not reach full depth until 40°S. Ancillary data were generated from the CTD cast in the form of a 1/2second time-series file, with CTD pressure, temperature, salinity, and ship position. Preliminary processing was performed during the cruise. LADCP and ancillary data will be sent to Lamont Earth Observatory for final processing following the cruise.

Each of the two HDSS sonar systems is suffering from transducer failure: beam 3 (aft starboard) on the 140KHz system has failed, and beams 1 and 2 (forward beams) on the 50KHz system have failed. The 140KHz transducer malfunction may be repairable at the next drydock without requiring a transducer replacement; repair status for the 50KHz sonars is unknown. Each beam lost at a given frequency compromises the system. Both instruments are affected by bubbles from the ship's hull. In heavy weather, each suffered, with some underway data a complete loss. When unaffected by bubbles, the range of the 140Khz system was 175m (in low scattering) to 275 (in higher scattering). The underway 50KHz range was from 600m-800m. The velocity data from these instruments is under evaluation and will be released if merited.

All three hull-mounted Doppler systems were affected by bubbles during heavy weather. The HDSS 50KHz fared worst; the NB150 was affected least, though it still suffered from bouts of underway bias and loss of data. It is likely that the HDSS systems would have fared slightly better if they had possessed their full complement of beams.

Underway systems were also run nearly continuously along 150°W, including meteorology, bathymetric systems including multi-beam, **thermosalinograph**, ADCP systems, and pCO2.

This section traversed 55° of latitude (6111.6 km). We began (16°S) at the boundary between the tropical Pacific and sub-tropical Pacific circulations, completely sampled the South Pacific sub-tropical gyre, Subantarctic Zone, and Antarctic Polar Frontal Zone, and ended in the Antarctic Zone (71°S). The boundaries between the various regions were marked by either increased surface currents as recorded by the ship-board ADCP and/or changes in water mass properties as recorded in the CTDO, nutrient and other water property data.

Problems

The most significant problem encountered during the cruise was related to the new cable on the *R/V Roger Revelle's* primary CTD winch. The cable performed well mechanically and electrically, but it extruded a large amount of grease. During the first two weeks of CTDO/rosette operations grease built up on the outside of the wire and on the sheave. This grease subsequently fell onto the deck, CTDO/rosette, and into the water when we deployed and/or retrieved the package. The ship's crew did a great job of removing excess grease from the sheave and deck between stations. Our concern with the wire was principally that the grease would compromise some of the measurements, especially those for organic carbon and nitrogen and CFCs. CFC levels in the deep water remained at blank levels which suggested that there was no contamination of the water samples due to the grease. However, the trace organic group were collecting samples to be analyzed on shore post-cruise. They are measuring very low (organic) concentrations and any contamination would compromise their samples. To allay these concerns, we switched to the spare CTD cable (on the second CTD winch), an older cable which had no grease coating. The termination to the spare wire was done during the transit between Stations 27 and 28. The spare winch wire performed to expectation during the remainder of the cruise. We recommend that the exact compounds in the grease on the new wire be determined, and the results investigated by the specialists for the various parameters measured from the rosette bottles, in order to determine whether or not this wire is suitable for future hydrographic surveys.

The long transit leg (approximately 7 days) from 71°S to Wellington, New Zealand allowed the science party to dismantle and pack their equipment. Extensive data quality control continued during the transit to port.

B.2. Navigation and Bathymetry Data Acquisition

Navigation data were acquired at 1-second intervals from the ship's Trimble PCODE GPS receiver by one of the Linux workstations beginning January 9. Data from the ship's Knudsen 320B/R Echosounder (3.8 KHz transducer) were also acquired and merged with the navigation. The Knudsen bathymetry data were noisy and occasionally subject to washing out when the seas were choppy.

Bathymetric data from the ship's multibeam (Simrad) echosounder system were also logged by the *R/V Revelle's* underway system.

B.3. Underway pCO2

The underway surface pCO2 system was started shortly after leaving Papeete, Tahiti. The semi-autonomous system analyzes surface water collected from the ship's uncontaminated seawater supply and marine air from the ship's bow on a repeating hourly cycle. The first quarter of each hour is devoted to calibration with four CO2 standards (Feely et al., 1998). A second order polynomial calibration curve is calculated for the LiCor 6262 infrared detector. The remaining time in each hour is used to measure equilibrator air (15 min), bow air (15 min), and equilibrator air once again (15 min). The analytical precision of the system is estimated to be approximately 0.3-0.4 ppm for seawater and for air.

The underway system operated without problems until January 27, 2005, when rough weather forced the uncontaminated seawater supply to be shut down. On January 28th, the system was re-plumbed to take seawater from the sea-chest which could still operate in rough weather. On February 3rd, the weather had calmed again so the seawater intake was switched back to the uncontaminated supply from the bow. The system continued to run until February 8th when the computer running the underway system failed preventing any additional analyses for the remainder of the cruise.

C. DESCRIPTION OF MEASUREMENT TECHNIQUES

C.1. CTD / Hydrographic Measurements Program

The basic CTD/hydrographic measurements consisted of salinity, dissolved oxygen and nutrient measurements made from water samples taken on CTD/rosette casts, plus pressure, temperature, salinity, dissolved oxygen and transmissometer from CTD profiles. A total of 111 CTD/rosette casts were made usually to within 10 meters of the bottom. No major problems were encountered during the operation. The distribution of samples is illustrated in figure 1.0.

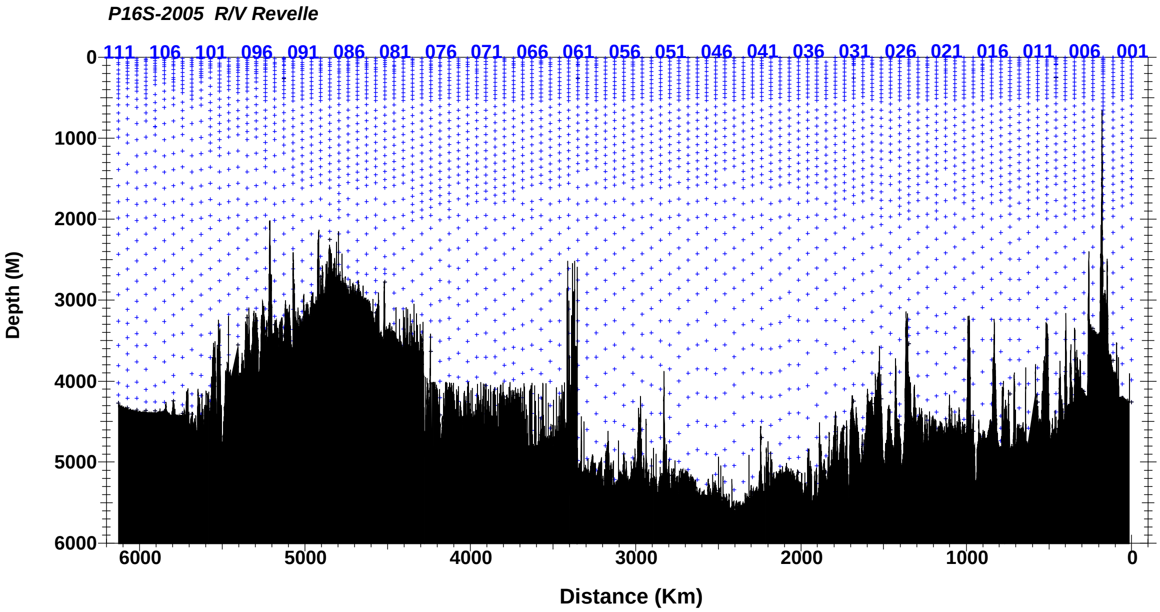

Figure 1.0 Sample distribution, stations 1-111.

Notes on the CTDO/rosette/LADCP program

We modified the three vertical sampling scheme that Paul Robbins (SIO) devised for the CO2/Repeat Hydrography trans-Pacific section (P02). This scheme provides over multiple stations the most information for various properties and the optimum information for objective mapping schemes. The three different vertical sampling schemes were used in strict rotation. The three vertical sampling scheme is given below:

Bottle Depths P16S, 2005

Scheme #1		**Scheme #2**		**Scheme #3**	
surface		surface		surface	
(25)		35		(15)	
50		70		40	
(75)		(90)		85	
100		120		135	
150		(140)		(160)	
200		170		185	
250		220		235	
300		270		285	
350		320		335	
400		370		385	
450		420		435	
500		470		485	
600		520		570	
700		640		670	
800		740		770	
900		840		870	
1000		940		970	
1100		1040		1070	
1200		1140		1170	
1300		1240		1270	
1400		1340		1370	
1500		1440		1470	
1600		1540		1570	
(1700)		*(1640)*		*(1670)*	
1800		1740		1770	
(1900)		*(1840)*		*(1870)*	
2000		1940		1970	
2250		2100		2170	
2500		2350		2420	
2750		2600		2670	
3000	**Z < 4400**	2850		2920	**Z < 4400**
3400	(3250)	3100	**Z < 4300**	3250	(3170)
3800	(3500)	3500	(3350)	3650	(3420)
4200	(3750)	3900	(3600)	4050	(3670)
4600	(4000)	4300	(3850)	4450	(3920)
5000	(4250)	4700	(4100)	4850	(4170)
5400	(bottom)	5200	(bottom)	5250	(bottom)
bottom-200		5600		bottom-200	
bottom		bottom-200		bottom	
		bottom			

Depending on water depth, bottles depths given in () were added where possible. Additional bottle depth were added in the upper 200m for the organic measurements whenever possible. The bottle scheme was modified (shown below) at the southern end of the section (south of 45°S) to improve bottle sample resolution below 3000m and above 200m.

Bottle Depths P16S, 2005 (modified deep bottle spacing)

Scheme #1		**Scheme #2**		**Scheme #3**	
surface		surface		surface	
25		35		15	
50		70		40	
75		90		85	
100		120		135	
150		140		160	
200		170		185	
250		220		235	
300		270		285	
350		320		335	
400		370		385	
450		420		435	
500		470		485	
600		520		570	
700		640		670	
800		740		770	
900		840		870	
1000		940		970	
1100		1040		1070	
1200		1140		1170	
1300		1240		1270	
1400		1340		1370	
1500		1440		1470	
1600		1540		1570	
(1700)		*(1640)*		*(1670)*	
1800		1740		1770	
(1900)		*(1840)*		*(1870)*	
2000		1940		1970	
2250		2100		2170	
2500		2350		2420	
2750		2600		2670	
3000	**Z < 4400**	2850		2920	**Z < 4400**
3300	(3250)	3100	**Z < 4300**	3250	(3170)
3600	(3500)	3400	(3350)	3550	(3420)
3900	(3750)	3700	(3600)	3850	(3670)
4200	(4000)	4050	(3850)	4150	(3920)
4550	(4250)	4400	(4100)	4500	(4170)
4900	(bottom)	4750	(bottom)	4850	(bottom)
bottom-100m		5050		bottom-100m	
bottom		bottom-100m		bottom	
		bottom			

Finally, south of the Pacific-Antarctic Ridge bottle spacing between 2000m and 1000m was increased to 200m, and decreased near the bottom to 100m to resolve subtle property changes in Antarctic Bottom Water within the Amundsen Basin.

LADCP/CTD/rosette casts were performed with a package consisting of a 36-bottle rosette frame (ODF), a 36-place pylon (SBE32) and 36 10-liter Bullister bottles (ODF). Underwater electronic components consisted of a Sea-Bird Electronics (SBE) 9plus CTD (ODF #381) with dual pumps, dual temperature (SBE3plus), dual conductivity (SBE4), dissolved oxygen (SBE43), transmissometer (Wetlabs C-Star) and fluorometer (Seapoint Sensors); an SBE35RT Digital Reversing Thermometer, RDI LADCP (Broadband 150khz) and a Simrad 807 altimeter.

The CTD was mounted vertically in an SBE CTD frame attached to the bottom center of the rosette frame. All SBE4 conductivity and SBE3plus temperature sensors and their respective pumps were mounted vertically as recommended by SBE. Pump exhausts were attached to outside corners of the CTD cage and directed downward. The entire cage assembly was then mounted on the bottom ring of the rosette frame, offset from center to accommodate the pylon, and also secured to frame struts at the top. The SBE35RT temperature sensor was mounted vertically and equidistant between the T1 and T2 intakes. The altimeter was mounted on the inside of a support strut adjacent to the bottom frame ring. The transmissometer and fluorometer were mounted horizontally along the rosette frame adjacent to the CTD. The LADCP was vertically mounted inside the bottle rings on the opposite side of the frame from the CTD with one set of transducers pointing down.

The rosette system was suspended from a UNOLS-standard three-conductor 0.322" electro-mechanical sea cable.

The *R/V Revelle's* forward Markey winch was used for Stations 1-27. Operations were switched to the aft Markey before station 28 when grease from the forward winch wire was found to be dripping on the rosette.

A sea cable retermination was made at station 70 when the sea state caused a kink in the wire. Mechanical reterminations were required at stations 63 and 69, also because of rough seas. An additional mechanical retermination was made after the winch operator two-blocked the rosette at the start of (aborted) cast 89/2.

The deck watch prepared the rosette 10-20 minutes prior to each cast. All valves, vents and lanyards were checked for proper orientation. The bottles were cocked and all hardware and connections rechecked. Once stopped on station, the LADCP was turned on and the rosette moved into position onto the starboard deck an air-powered cart and tracks. As directed by the deck watch leader, the CTD was powered-up and the data acquisition system started. Two stabilizing tag lines were threaded through rings on the rosette frame, and syringes were removed from the CTD sensor intake ports. The deck watch leader directed the winch operator to raise the package, the boom and rosette were extended outboard and the package quickly lowered into the water. The tag lines were removed and the package was lowered to 10 meters. The CTD console operator then directed the winch operator to bring the package close to the surface, pause for typically 10 seconds and begin the descent.

Each rosette cast was usually lowered to within 10 meters of the bottom.

Each bottle on the rosette had a unique serial number. This bottle identification was maintained independently of the bottle position on the rosette and was used for sample identification. A leak was discovered on bottle 16 at Station 75; bottle 16 was replaced with bottle 37 during stations 79 and 80. Bottle 16 was placed back in service beginning station 81, after repairs were made. Bottles 33 and 35 were lost at station 89/2 when the rosette was two-blocked. They were replaced with bottles 37 and 38; bottle 38 was never actually sampled. No other bottles were replaced on this cruise, although various parts on bottles were occasionally changed or repaired.

Recovering the package at the end of the deployment was essentially the reverse of launching, with the additional use of poles and snap-hooks to attach tag lines for added safety and stability. The rosette was moved into the CTD hangar for sampling. The bottles and rosette were examined before samples were taken, and anything unusual was noted on the sample log.

Routine CTD maintenance included soaking the conductivity and CTD DO sensors in fresh water between casts to maintain sensor stability. Rosette maintenance was performed on a regular basis. O-rings were changed as necessary and bottle maintenance was performed each day to insure proper closure and sealing. Valves were inspected for leaks and repaired or replaced as needed.

C.2. Underwater Electronics Packages

CTD data were collected with a SBE9plus CTD (ODF #381). The instrument provided pressure, dual temperature (SBE3), dual conductivity (SBE4), dissolved oxygen (SBE43), transmissometer (Wetlabs C-Star), fluorometer (Seapoint Sensors) and altimeter (Simrad 807) channels. The CTD supplied a standard Sea-Bird format data stream at a data rate of 24 frames/second (fps).

P16S 2005 Rosette Underwater Electronics.

Sea-Bird SBE32 36-place Carousel Water Sampler	S/N 3216715-0187
Sea-Bird SBE35RT Digital Reversing Thermometer	S/N 35-0035
Sea-Bird SBE9plus CTD	S/N 09P9852-0381
Paroscientific Digiquartz Pressure Sensor	S/N 58952
Sea-Bird SBE3plus Temperature Sensor	S/N 03P-4213 (Primary)
Sea-Bird SBE3plus Temperature Sensor	S/N 03P-4226 (Secondary)
Sea-Bird SBE4C Conductivity Sensor	S/N 04-2659 (Primary)
Sea-Bird SBE4C Conductivity Sensor	S/N 04-2319 (Secondary)
Sea-Bird SBE43 DO Sensor	S/N 43-0275 (1/3-11/2)
Sea-Bird SBE43 DO Sensor	S/N 43-0185 (12/1-111/2)
Wetlabs C-Star Transmissometer	S/N 327DR (owned by TAMU)
Seapoint Sensors Fluorometer	S/N 2486
Simrad 807 Altimeter	S/N 4077
RDI Broadband 150khz LADCP	S/N 1546 (1, 11-111); 1394 (2-10)
LADCP Battery Pack	

The CTD was outfitted with dual pumps. Primary temperature, conductivity and dissolved oxygen were plumbed on one pump circuit and secondary temperature and conductivity on the other. The sensors were deployed vertically. The primary temperature and conductivity sensors (T1 #03P-4213 and C1 #04-2659) were used for reported CTD temperatures and conductivities on all casts. The secondary temperature and conductivity sensors were used for calibration checks.

The SBE9plus CTD and the SBE35RT Digital Reversing Thermometer were both connected to the SBE32 36-place pylon providing for single-conductor sea cable operation. Two of three sea cable conductors were connected together for signal. The third conductor was not used. The sea cable armor was used for ground (return). Power to the SBE9plus CTD (and sensors), SBE32 pylon, SBE35RT and Simrad altimeter was provided through the sea cable from the SBE11plus deck unit in the main lab.

D. CTD MEASUREMENTS

D.1. Real-time CTD Data Acquisition System

The CTD data acquisition system consisted of an SBE-11plus deck unit and four networked generic PC workstations running Fedora 2 Linux. Each PC workstation was configured with a color graphics display, keyboard, trackball, 120 GB disk, and DVD+RW drives. Two of the four systems also had 8 additional RS-232 ports via a Rocketport PCI serial controller. The systems were networked through a 100BaseTX ethernet switch, which was also connected to the ship's network. These systems were available for real- time operational and CTD data displays, and provided for CTD and hydrographic data management and backup. Hardcopy capability was provided by an HP 1600CM network printer and by the ship's networked printers.

One of the workstations was designated the CTD console and was connected to the CTD deck unit via RS-232. The CTD console provided an interface for controlling CTD deployments as well as real-time operational displays for CTD and rosette trip data, GPS navigation, bathymetry and the CTD winch.

CTD deployments were initiated by the console watch after the ship stopped on station. The watch maintained a console operations log containing a description of each deployment, a record of every attempt to close a bottle and any pertinent comments. The deployment software presented a short dialog instructing the operator to turn on the deck unit, to examine the on screen raw data display for stable CTD data, and to notify the deck watch that this was accomplished. When the deck watch was ready to put the rosette over the side, the console watch was notified and the CTD data acquisition started. The deployment software display changed to indicate that a cast was in progress. A processed data display appeared, as did a rosette bottle trip display and control for closing bottles. Various real- time plots were initiated to display the progress of the deployment. GPS time and position, and uncorrected Knudsen bottom depth were automatically logged at 1 second resolution during the cast. Both raw and processed (2 Hz time-series) CTD data were automatically backed up by one of the other workstations via ethernet.

Once the deck watch had deployed the rosette, the winch operator immediately lowered it to 10 meters. The CTD pumps were configured with an 8 second startup delay, and were on by the time the rosette reached 10 meters. The console operator checked the CTD data for proper sensor operation, then instructed the winch operator to bring the package to the surface, pause for 10 seconds, and descend to a target depth (wire-out). Sometimes the near-surface pause and yoyo were omitted due to sea state. The lowering rate was normally 60 meters/minute for this package, depending on sea cable tension and sea state.

The console watch monitored the progress of the deployment and quality of the CTD data through interactive graphics and operational displays. Additionally, the watch decided where to trip bottles on the up cast, noting this on the console log. The altimeter channel, CTD depth, wire-out and bathymetric depth were monitored to determine the distance of the package from the bottom. The on-screen winch and altimeter displays allowed the watch to refine the target wire-out relayed to the winch operator and safely approach to within 10 meters of the bottom.

Bottles were closed on the upcast by operating a "point and click" graphical trip control button. The data acquisition system responded with trip confirmation messages and the corresponding CTD data in a rosette bottle trip window on the display. All tripping attempts were noted on the console log. The console watch then directed the winch operator to raise the package up to the next bottle trip location. The console watch was also responsible for creating a sample log for the deployment which was used to record the correspondence between rosette bottles and analytical samples taken.

After the last bottle was tripped, the console watch directed the deck watch to bring the rosette on deck. Once on deck, the console watch terminated the data acquisition, turned off the deck unit and assisted with rosette sampling.

D.2. CTD Data Processing

ODF CTD processing software consists of over 30 programs running in a Linux/Unix run-time environment.

Raw CTD data are initially converted to engineering units, filtered, response-corrected, calibrated and decimated to a more manageable 0.5 second time-series. The laboratory calibrations for pressure, temperature and conductivity are applied at this time.

Once the CTD data are reduced to a standard format time-series, they can be manipulated in various ways. Channels can be additionally filtered. The time-series can be split up into shorter time-series or pasted together to form longer time-series. A time-series can be transformed into a pressure- series, or into a larger-interval time-series. Adjustments to pressure, temperature and conductivity determined from comparisons to other sensors and to check samples are maintained in separate files and are applied whenever the data are accessed.

The CTD data acquisition software acquired and processed the data in real- time, providing calibrated, processed data for interactive plotting and reporting during a cast. The 24 Hz CTD data were filtered, response- corrected and decimated to a 2 Hz time-series. Sensor correction and calibration models were applied to pressure, temperature, and conductivity. Rosette trip data were extracted from this time-series in response to trip initiation and confirmation signals. All data were stored on disk and were additionally backed up via ethernet to a second system. At the end of the cast, various consistency and calibration checks were performed and a 2 db pressure-series of the down cast was generated and subsequently used for reports and plots.

CTD data were examined at the completion of deployment for potential problems. Data from the two CTD temperature sensors were examined, compared with SBE35RT Digital Reversing Thermometer data and checked for sensor drift. CTD conductivity sensors were compared and calibrated by examining differences between CTD and check-sample conductivity values. The CTD dissolved oxygen sensor data were calibrated to check-sample data. Additionally, deep theta-salinity and theta-O2 comparisons were made between down and up casts as well as with adjacent deployments.

The initial 10-meter yoyo in each deployment, where the package was lowered and then raised back to the surface to start the SBE pumps, was omitted during the generation of the 2 db pressure-series.

Density inversions can be induced in high-gradient regions by ship- generated vertical motion of the rosette. Detailed examination of the raw data shows significant mixing can occur in these areas because of "ship roll". To minimize density inversions, a "ship-roll" filter which disallowed pressure reversals was applied during the generation of the 2 db pressure-series down-cast data.

The sensors were exposed to below-freezing air temperatures during the last few stations. Water in the pump tubes near the sensors at least partially froze before the casts at stations 108 and 109. The pump tubes were cleared with warm water prior to deployment, and none of the sensors appear to have been adversely affected.

Two CTD casts are reported for stations 9, 31, 61 and 93. The rosette was lowered to approximately 250m on the first cast at each station to collect water for CDOM only. These shallow casts were not processed beyond the initial block-averaging and automated post-cast processing. The second cast reported at each of these stations was the standard deep cast.

D.3. CTD Laboratory Calibration Procedures

Laboratory calibrations of the CTD pressure, temperature and conductivity sensors were used to generate Sea-Bird conversion equation coefficients applied by the data acquisition software at sea.

CTD #381 with pressure transducer #58952 was used for P16S-2005.

Pressure calibrations were last performed on CTD #381 at the ODF Calibration Facility (La Jolla) on 16 November 2004. The Paroscientific Digiquartz pressure transducer was calibrated in a temperature-controlled water bath to a Ruska Model 2400 Piston Gauge Pressure Reference.

The SBE3plus temperature sensors (primary S/N 03P-4213, secondary S/N 03P-4226) were calibrated at ODF on 16 November 2004.

The primary and secondary SBE4 conductivity sensors (S/N 04-2659 and S/N 04-2319) were both calibrated on 16 November 2004 at SBE.

The SBE35RT Digital Reversing Thermometer (S/N 35-0035) was calibrated on 15 September 2004 at ODF.

D.4. CTD Shipboard Calibration Procedures

CTD #381 was used for all P16S 2005 casts. The CTD was deployed with all sensors and pumps aligned vertically, as recommended by SBE. Secondary temperature and conductivity (T2 & C2) sensors served as calibration checks for the reported primary temperature and conductivity (T1 & C1) on all casts. The SBE35RT Digital Reversing Thermometer (S/N 35-0035) served as an independent temperature calibration check. In-situ salinity check samples collected during each CTD cast were used to calibrate the conductivity sensors.

D.4.1. CTD Pressure

Pressure sensor conversion equation coefficients derived from the pre- cruise pressure calibration for CTD #381 (Pressure S/N 58952) were applied to raw pressure data during each cast. Out-of-water pressure values were running 1.0-1.2 decibars at cast start, and 0.6-0.7 decibars at cast end. The pressure was offset by -0.7 decibars at the surface, sloping to 0 correction at 5000 decibars, for stations 1-57. After air and sea-surface temperatures cooled off, the offset was reduced to -0.5 decibars at the surface (sloping to 0 at 5000 decibars) for stations 58-87, and to -0.3 decibars at the surface (sloping to 0 at 3000 decibars) for stations 88-111.

Start and end pressures were tabulated for each cast to check for calibration shifts. The start pressures were between 0 and 0.6 decibars, and the end pressures were between 0 and -0.2 decibars.

The post-cruise CTD #381 pressure calibration results are pending.

D.4.2. CTD Temperature

Temperature sensor conversion equation coefficients were derived from the pre-cruise calibrations and applied to raw primary and secondary temperature data. The primary (T1, S/N 03P-4213) and secondary (T2, S/N 03P-4226) SBE3plus temperature sensors were used the entire cruise without replacement.

Two independent metrics of calibration accuracy were examined. The primary and secondary temperatures were compared at each rosette trip, and the SBE35RT (S/N 35-0035) temperatures were compared to primary and secondary temperatures at each rosette trip.

The T1 sensor appeared to have a slow, steady drift with station number, relative to the SBE35RT: +0.5 to +1.0 m°C from stations 1-111. The T2 sensor was less stable, starting 1.0 m°C high, drifting to 0, then back to 0.8 m°C high. The sensor calibration histories were examined, and the SBE35RT was deemed most likely of the 3 to be correct. Offsets were calculated from SBE35RT-T1 differences, using data below 1500 decibars. The offsets, shifting slightly for each station, were applied to T1 data. There did not appear to be any residual pressure effect on the T1 or SBE35 sensors. The T2 sensor was not corrected.

Figures 1.7.2.0 and 1.7.2.1 show T1-T2 residual differences after shipboard correction of T1 only. The shipboard-final T1 and SBE35RT comparisons are summarized in figures 1.7.2.2 and 1.7.2.3.

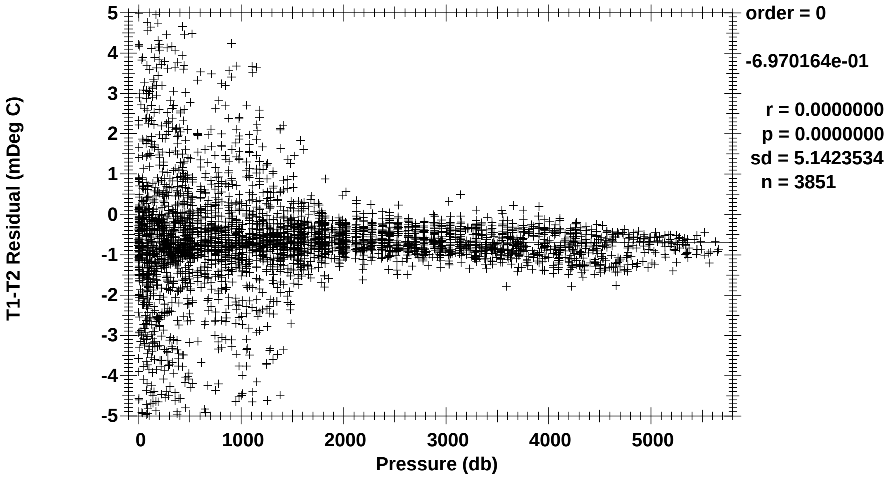

Figure 1.7.2.0 Primary and secondary temperature differences by pressure, all pressures.

Post-cruise calibrations for all the temperature sensors are pending.

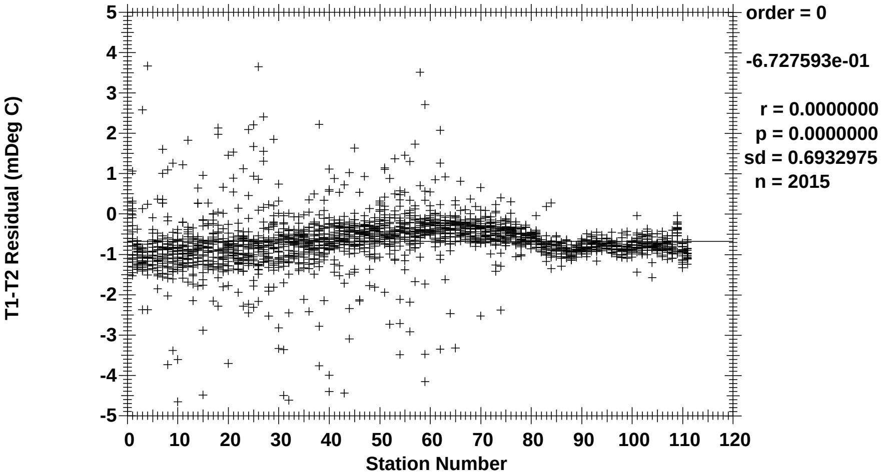

Figure 1.7.2.1 Primary and secondary temperature differences by cast, p>1000db.

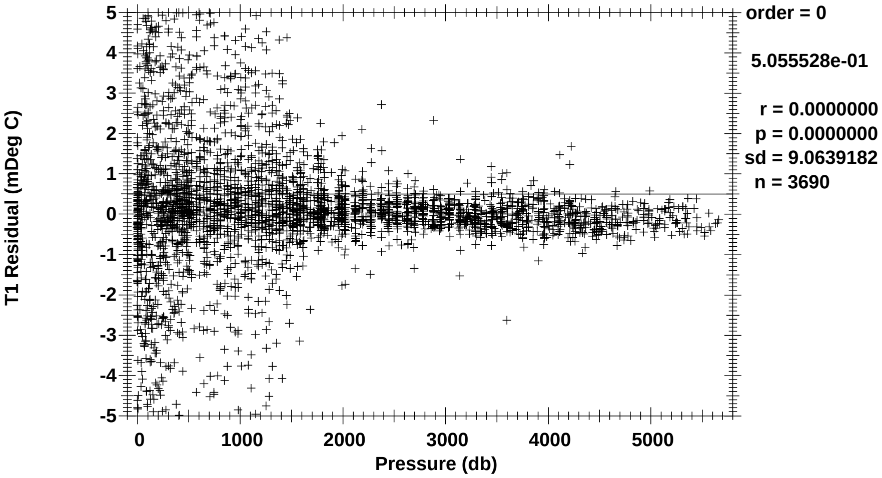

Figure 1.7.2.2 T1 and SBE35RT temperature differences by pressure, all pressures.

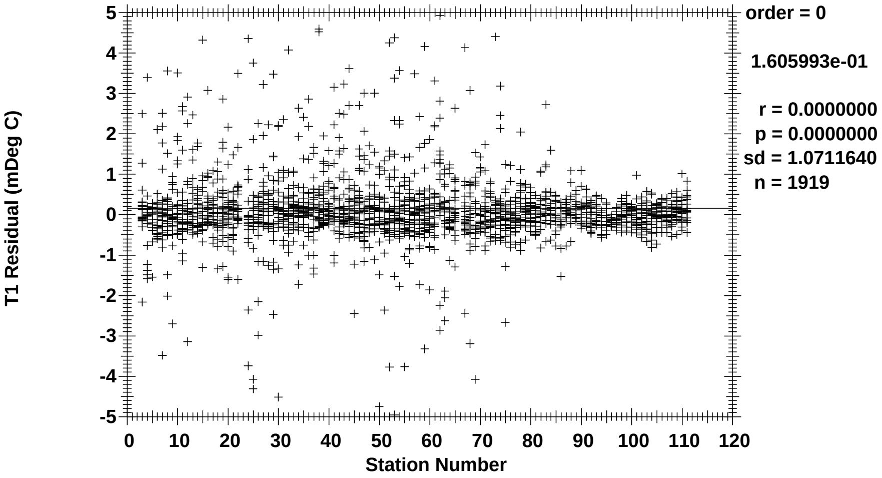

Figure 1.7.2.3 T1 and SBE35RT temperature differences by cast, p>1000db.

D.4.3. CTD Conductivity

Conductivity sensor conversion equation coefficients were derived from the pre-cruise calibrations and applied to raw primary and secondary conductivities.

The same primary (C1 - S/N 04-2659) and secondary (C2 - S/N 04-2319) SBE4 conductivity sensors were used on all of P16S 2005 . C1 was used for all reported CTD conductivities; C2 was used as a calibration check on the primary sensor.

Comparisons between the primary and secondary sensors, and between sensors and check sample conductivities, were used to derive conductivity sensor corrections. The average C1-C2 differences were about +0.001 mS/cm at the start of the cruise, increased to +0.0015 by station 25, then dropped to +0.0005 by station 40. The differences abruptly shifted at station 50, after the sensors were cleaned with Triton X (according to SBE specs). After a few more stations, the averages stabilized a bit, varying between +0.001 and +0.0015 mS/cm for the rest of the cruise. Another cleaning with Triton X between stations 92 and 93 appeared to have no effect on either C1 or C2 data. The bottle-C1 average values were less consistent, and varied more than 0.002 mS/cm.

The differences between sensors and bottles were considered at the same time as deep theta-salinity overlays of consecutive stations were examined for both T1C1 and T2C2 sensor pairs. C1 offsets were adjusted by as much as ±0.0005 mS/cm for a few casts to provide deep theta-salinity consistency, and had the effect of "normalizing" some of the differences between sensors and bottle data. A second-order pressure-dependent slope was fit to the adjusted bottle-C1 differences, omitting stations 1-20 to eliminate any possibility of residual Autosal suppression issues at the shallow end. The resulting correction (on the order of +0.001 mS/cm at 0 decibars, -0.001 mS/cm at 3500 decibars and -0.0006 mS/cm at 5700 decibars) was applied to all C1 data. C2 data were not corrected.

Shipboard overlays of deep theta-salinity profiles were checked for cast-to-cast consistency after the corrections were applied. Stations 50-74 (after the first Triton X cleaning) were adjusted slightly, to better align the profiles and the bottle-C1 differences. Most deep profiles of adjacent casts agreed to within ±0.0001-2 mS/cm.

The comparison of the primary and secondary conductivity sensors by station, after applying shipboard corrections, is summarized in figure 1.7.3.0.

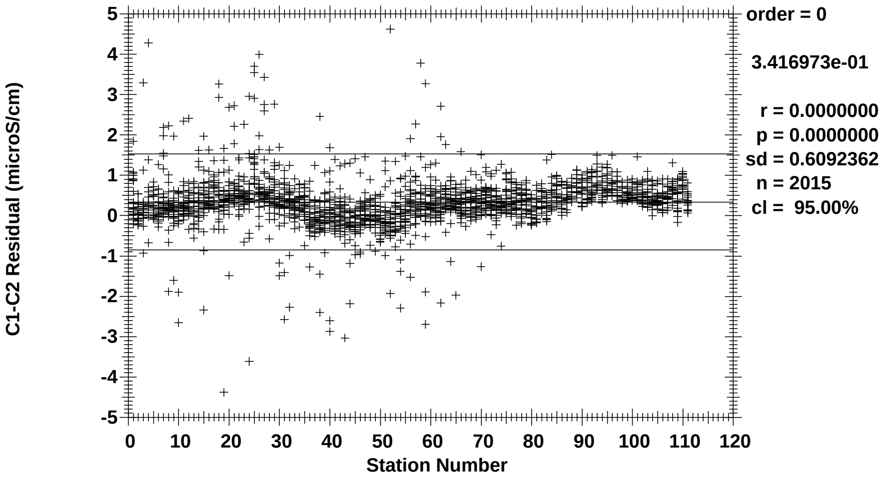

Figure 1.7.3.0 C1 and C2 conductivity differences by cast, p>1000db.

Salinity residuals after applying shipboard T1/C1 corrections are summarized in figures 1.7.3.1 through 1.7.3.3.

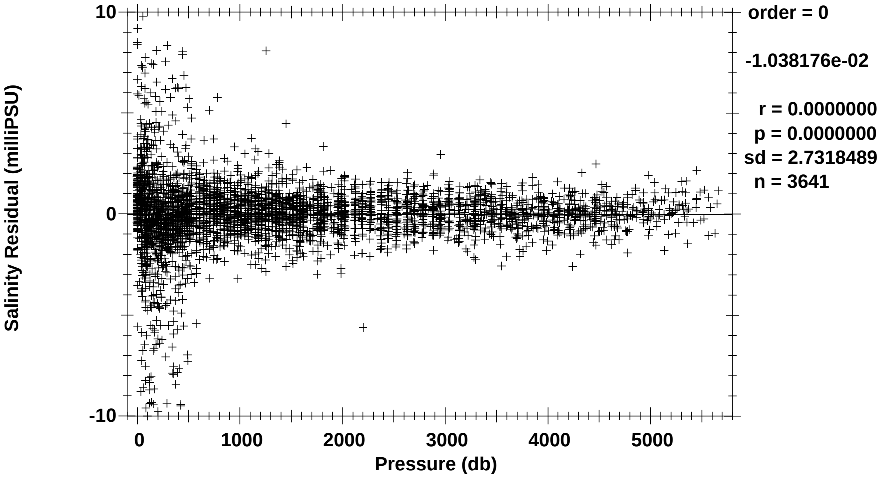

Figure 1.7.3.1 salinity residuals by pressure, all pressures.

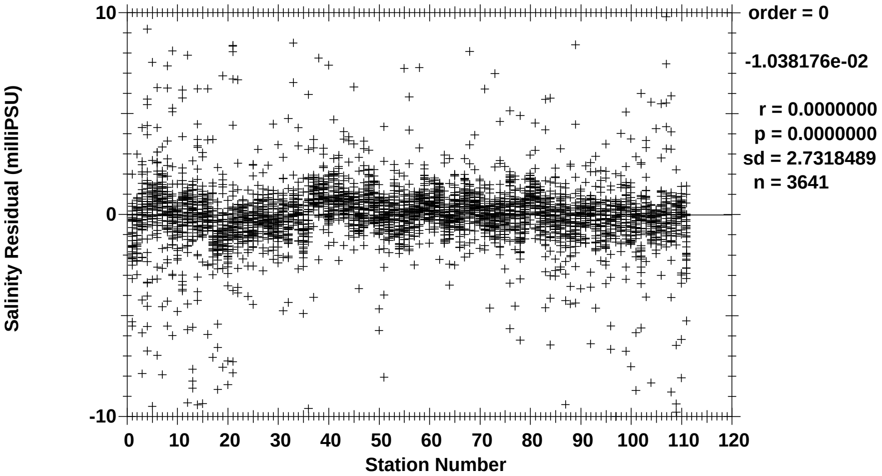

Figure 1.7.3.2 salinity residuals by cast, all pressures.

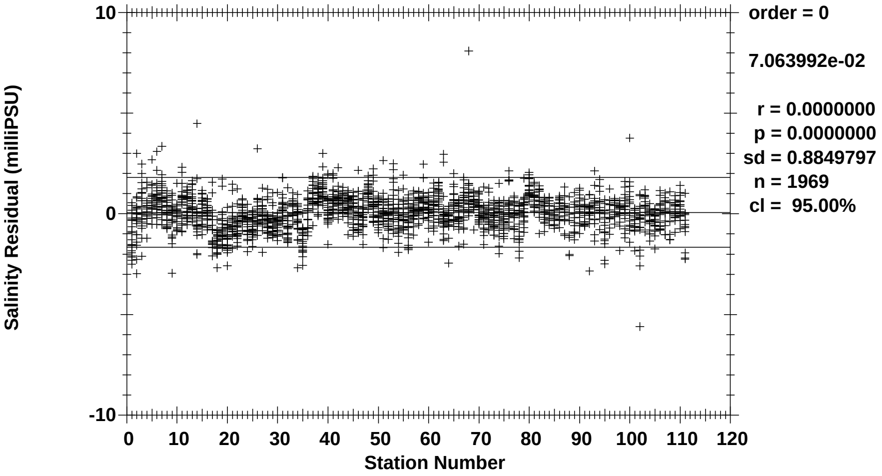

Figure 1.7.3.3 salinity residuals by cast, p>1000db.

Figure 1.7.3.3 represents an estimate of the deep salinity accuracy for the CTD/sensors used during P16S-2005. The 95% confidence limit is ±0.0018 PSU relative to bottle salts.

Post-cruise calibrations of the conductivity sensors by Sea-Bird are pending. These calibrations will not account for any pressure effects on the sensors.

D.4.4. CTD Dissolved Oxygen

Two SBE43 dissolved O_2 (DO) sensor were used during this cruise: S/N 43-0275 for stations 1-11 and 43-0185 for stations 12-111. The sensor was plumbed into the P/T1/C1 intake line in a vertical configuration after C1 and before P1 (as specified by SBE).

The first DO sensor (43-0275) offset and cut out repeatedly during station 1. The cable between the CTD and sensor was replaced before station 2. A cursory check of data during the next few casts showed that problem to be fixed, but the sensor apparently had other major problems. Its sensitivity decreased rapidly for the next few stations, until the raw signal was low and shapeless by station 11. The CTD oxygen data for stations 1 and 11 were deemed unusable and are not reported. For the casts in between, only stations 5 and 6 somewhat fit the bottle data from surface to bottom. Because of the poor fits and obvious problems with the sensor, stations 2-10 CTD oxygen data are reported, but all coded questionable or bad.

The second sensor (43-0185) was installed prior to station 12 and performed reliably for the rest of the cruise. Standard and blank values for bottle oxygen data were smoothed and applied prior to fitting the CTD oxygen profiles.

The DO sensor calibration method used for this cruise was to match down-cast CTD O_2 data to up-cast bottle trips along isopycnal surfaces, then to minimize the residual differences between the *in-situ* check sample values and CTD O_2 using a non-linear least-squares fitting procedure. Since this technique only calibrates the down-cast, only the 2 db pressure series down-cast data contain calibrated CTD O_2.

The coefficients for the deep casts were used for the shallow casts on the four 250m "CDOM" casts (9/1, 31/1, 61/2 and 93/1), which had no bottle data; the CTD oxygen for those shallow casts are reported as uncalibrated.

Figures 1.7.4.0, 1.7.4.1 and 1.7.4.2 show the residual differences between bottle and calibrated CTD O_2 for all pressures where both CTD and bottle oxygen data are coded "acceptable". Figure 1.7.4.3 shows the residual differences for pressures deeper than 1000 db.

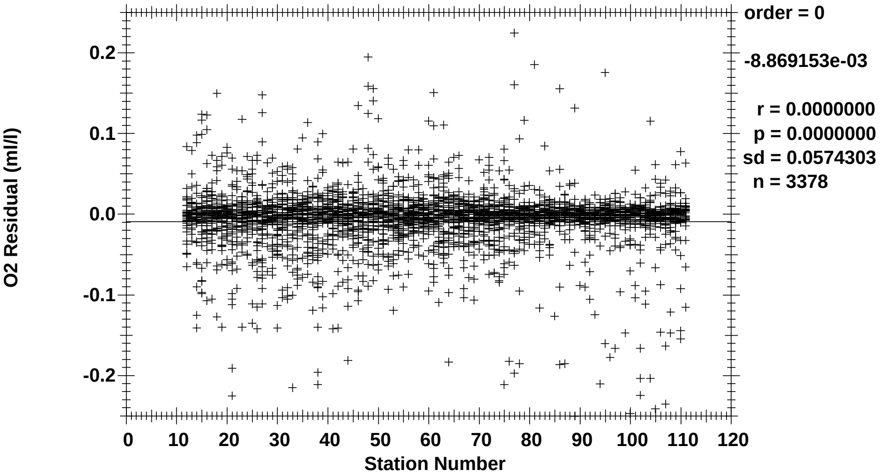

Figure 1.7.4.0 O_2 residuals by station number, all pressures.

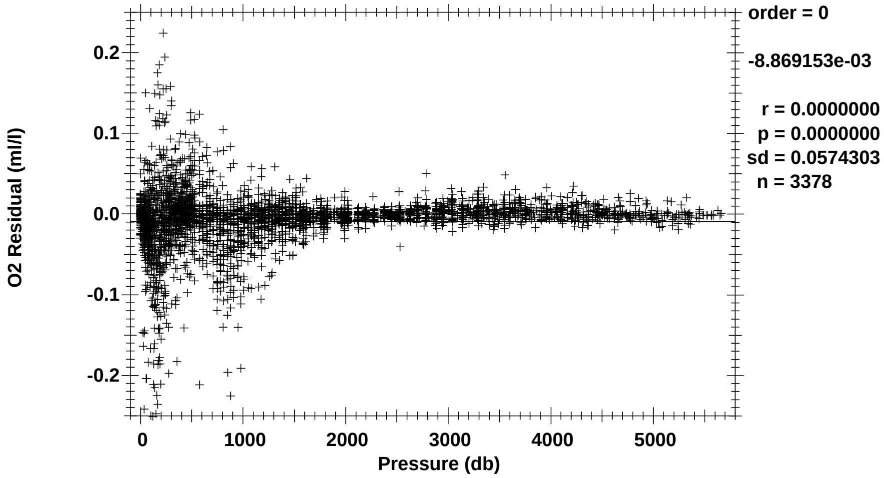

Figure 1.7.4.1 O_2 residuals by pressure, all pressures.

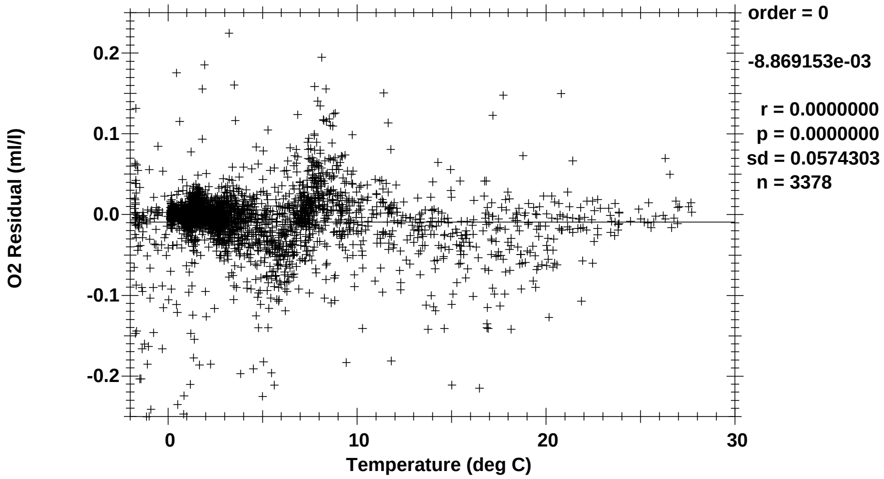

Figure 1.7.4.2 O_2 residuals by temperature, all pressures.

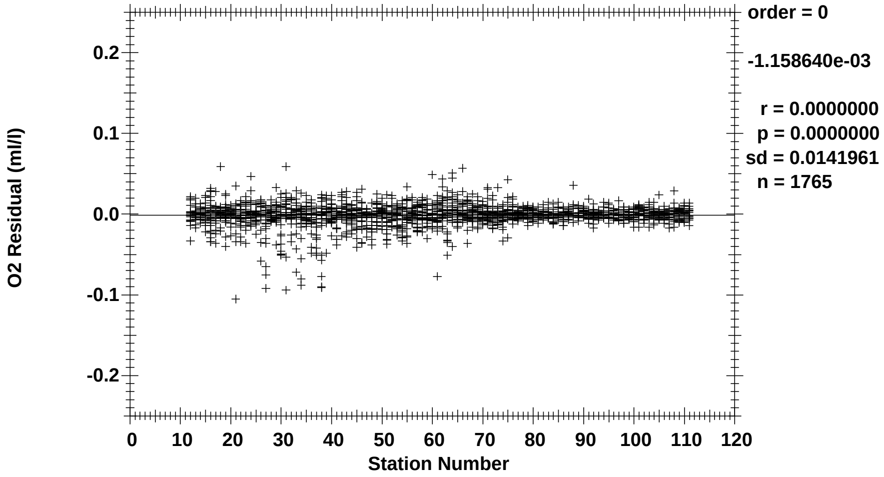

Figure 1.7.4.3 O_2 residuals by station number, p>1000db .

The standard deviations of 0.0574 ml/l for all oxygens and 0.0142 ml/l for deep oxygens are only intended

The standard deviations of 0.0574 ml/l for all oxygens and 0.0142 ml/l for deep oxygens are only intended as indicators of how well the up-cast bottle O_2 and down-cast CTD O_2 match. ODF makes no claims regarding the precision or accuracy of CTD dissolved O_2 data.

The general form of the ODF O_2 conversion equation for Clark cells follows Brown and Morrison [Brow78] and Millard [Mill82], [Owen85]. ODF models membrane and sensor temperatures with lagged CTD temperatures and a lagged thermal gradient. *In-situ* pressure and temperature are filtered to match the sensor response. Time-constants for the pressure response τ_p, two temperature responses τ_{Ts} and τ_{Tf}, and thermal gradient response τ_{dT} are fitting parameters. The thermal gradient term is derived by low-pass filtering the difference between the fast response (T_f) and slow response (T_s) temperatures. This term is SBE43-specific and corrects a non-linearity introduced by analog thermal compensation in the sensor. The O_c gradient, dO_c/dt, is approximated by low-pass filtering 1st-order O_c differences. This gradient term attempts to correct for reduction of species other than O_2 at the sensor cathode. The time-constant for this filter, τ_{og}, is a fitting parameter. Dissolved O_2 concentration is then calculated:

$$O_{2ml/l} = [c_1 O_c + c_2] \cdot f_{sat}(S,T,P) \cdot e^{(c_3 P_l + c_4 T_f + c_5 T_s + c_6 \frac{dO_c}{dt} + c_7 dT)} \qquad (1.7.4.0)$$

where:

$O_{2ml/l}$ = Dissolved O_2 concentration in ml/l;
O_c = Sensor current (μamps);
$f_{sat}(S,T,P)$ = O_2 saturation concentration at S,T,P (ml/l);
S = Salinity at O_2 response-time (PSUs);
T = Temperature at O_2 response-time (° C);
P = Pressure at O_2 response-time (decibars);
P_l = Low-pass filtered pressure (decibars);
T_f = Fast low-pass filtered temperature (° C);
T_s = Slow low-pass filtered temperature (° C);
$\frac{dO_c}{dt}$ = Sensor current gradient (μamps/secs);
dT = low-pass filtered thermal gradient ($T_f - T_s$).

E. BOTTLE SAMPLING

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

- CFCs
- ^{3}He
- O_2
- Dissolved Inorganic Carbon (DIC)/Total Alkalinity
- ^{14}C
- ^{15}N
- Dissolved Organic Carbon, (DOC)/Dissolved Organic Nitrogen (DON)
- Tritium
- Nutrients
- Salinity
- Chromophoric Dissolved Organic Material (CDOM)
- Chlorophyll
- Bacteria Growth Rate
- Carbohydrates
- Particulate Absorption Spectra and Microsporin Like Amino Acids
- High-Pressure Liquid Chromatography Phytoplankton Pigments

The correspondence between individual sample containers and the rosette bottle from which the sample was drawn was recorded on the sample log for the cast. This log also included any observations and comments about the condition of the rosette and bottles. One member of the sampling team was designated the sample cop, whose sole responsibility was to maintain this log and insure that sampling progressed in the proper drawing order.

Normal sampling practice included opening the drain valve and then the air vent on the bottle, indicating an air leak if water escaped. This observation together with other diagnostic comments (e.g., "lanyard caught in lid", "valve left open") that might later prove useful in determining sample integrity were routinely noted on the sample log. Drawing oxygen samples also involved taking the sample draw temperature from the bottle. The temperature was noted on the sample log and was sometimes useful in determining leaking or mis-tripped bottles.

Once individual samples had been drawn and properly prepared, they were distributed for analysis. Oxygen, nutrient and salinity analyses were performed on computer-assisted (PC) analytical equipment networked to the data processing computer for centralized data management.

E.1. Bottle Data Processing

Water samples collected and properties analyzed shipboard were managed centrally in a relational database (PostgreSQL-7.4.6-2) run on one of the Linux workstations. A web service (OpenAcs-5.1.3 and AOLServer-4.0.9-3) front-end provided ship-wide access to CTD and water sample data. Web- based facilities included on-demand arbitrary property-property plots and vertical sections as well as secure data uploads and downloads.

The Sample Log (and any diagnostic comments) was entered into the database once sampling was completed. Quality flags associated with sampled properties were set to indicate that the property had been sampled, and sample container identifications were noted where applicable (e.g., oxygen flask number). Each Sample Log was also scanned and made available as a JPEG file on the website.

Analytical results were provided on a regular basis by the various analytical groups and incorporated into the database. These results included a quality code associated with each measured value and followed the coding scheme developed for the World Ocean Circulation Experiment (WOCE) Hydrographic Programme (WHP) [Joyc94].

Various consistency checks and detailed examination of the data continued throughout the cruise. The comments from the Sample Logs and individual data point checking are included in the Appendix of this documentation.

E.2. Salinity Analysis

Equipment and Techniques

Two Guildline Autosal Model 8400A salinometers (S/N 57-396 & S/N 48-266/backup), located in the aft hydro lab, were used for all salinity measurements. The salinometers were modified by ODF to contain an interface for computer-aided measurement. The water bath temperatures were set and maintained at a value near the laboratory air temperature. They were set to 21°C for stations 1-18 and 25-34 analyses, then switched to 24°C for stations 19-24 and 35-111.

The salinity analyses were performed after samples had equilibrated to laboratory temperature, usually within 8-26 hours after collection. The salinometers were standardized for each group of analyses (usually 1-3 casts, up to ~84 samples) using at least two fresh vials of standard seawater per group. Salinometer measurements were made by computer, where the analyst was prompted by software to change samples and flush.

Sampling and Data Processing

3699 salinity measurements were made and approximately 220 vials of standard water (SSW) were used. 547 additional samples were taken by the Trace Metals group and analyzed by STS/ODF.

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

PSS-78 salinity [UNES81] was calculated for each sample from the measured conductivity ratios. The difference (if any) between the initial vial of standard water and the next one run as an unknown was applied as a linear function of elapsed run time to the data. The corrected salinity data were then incorporated into the cruise database. The estimated accuracy of bottle salinities run at sea is usually better than +/-0.002 PSU relative to the particular standard seawater batch used. The 95% confidence limit for residual differences between the bottle salinities and calibrated

CTD salinity relative to SSW batch P-144 was +/-0.0055 PSU for all salinities, and +/-0.0018 PSU for salinities deeper than 1000db.

Three adjustments other than bath temperature changes were made to the Autosal. After station 20 salinity was run, it was discovered that the amplifier gain for proper balance between suppression ranges had not been adjusted. This was changed, and stations 1-20 salinities were recalculated. A minor adjustment was made to the Autosal before station 47, and maintenance was performed on the air pump before station 92 was run.

Laboratory Temperature

The temperature in the salinometer laboratory varied from 17.8 to 24.0°C, during the cruise. The air temperature change during 80 of the 110 sample runs was less than +/-0.4°C 25 runs had a temperature difference of +/-0.5°C to +/-0.9°C.

Standards

IAPSO Standard Seawater (SSW) Batch P-144 was used to standardize all salinity measurements.

E.3. Oxygen Analysis

Equipment and Techniques

Dissolved oxygen analyses were performed with an ODF-designed automated oxygen titrator using photometric end-point detection based on the absorption of 365nm wavelength ultra-violet light. The titration of the samples and the data logging were controlled by PC software. Thiosulfate was dispensed by a Dosimat 665 buret driver fitted with a 1.0 ml buret. ODF used a whole-bottle modified-Winkler titration following the technique of Carpenter [Carp65] with modifications by Culberson et al. [Culb91], but with higher concentrations of potassium iodate standard (~0.012N) and thiosulfate solution (~55 gm/l). Pre-made liquid potassium iodate standards were run once a day approximately every 4 stations, unless changes were made to system or reagents. Reagent/distilled water blanks were determined every day or more often if a change in reagents required it to account for presence of oxidizing or reducing agents. The auto-titrator performed well.

Sampling and Data Processing

3892 oxygen measurements were made. Samples were collected for dissolved oxygen analyses soon after the rosette was brought on board. Using a Tygon and silicone drawing tube, nominal 125ml volume-calibrated iodine flasks were rinsed 3 times with minimal agitation, then filled and allowed to overflow for at least 3 flask volumes. The sample drawing temperatures were measured with a small platinum resistance thermometer embedded in the drawing tube. These temperatures were used to calculate µM/kg concentrations, and as a diagnostic check of bottle integrity. Reagents were added to fix the oxygen before stoppering. The flasks were shaken twice (10-12 inversions) to assure thorough dispersion of the precipitate, once immediately after drawing, and then again after about 20 minutes.

The samples were analyzed within 1-2 hours of collection, and the data incorporated into the cruise database.

Thiosulfate normalities were calculated from each standardization and corrected to 20°C. The 20°C normalities and the blanks were plotted versus time and were reviewed for possible problems.

The sample drawing temperature thermometer during this leg was functional and calibrated at the beginning of the expedition.

A noisy endpoint was occasionally acquired during the analyses, usually due to small waterbath contaminations. These endpoints were checked and recalculated using STS/ODF designed software.

The blanks and thiosulfate normalities for each batch of thiosulfate were smoothed (linear fits) in four groups during the cruise and the oxygen values recalculated.

Volumetric Calibration

Oxygen flask volumes were determined gravimetrically with degassed deionized water to determine flask volumes at STS/ODF's chemistry laboratory. This is done once before using flasks for the first time and periodically thereafter when a suspect volume is detected. The volumetric flasks used in preparing standards were volume-calibrated by the same method, as was the 10 ml Dosimat buret used to dispense standard iodate solution.

Standards

Liquid potassium iodate standards were prepared and bottled in sterile glass bottles at STS/ODF's chemistry laboratory prior to the expedition. The normality of the liquid standard was determined at ODF by calculation from weight. A single standard batch was used during P16S 2005. Potassium iodate was obtained from Acros Chemical Co. and was reported by the supplier to be >99.4% pure. All other reagents were "reagent grade" and were tested for levels of oxidizing and reducing impurities prior to use.

E.4. Nutrient Analysis

Equipment and Techniques

Nutrient analyses (phosphate, silicate, nitrate and nitrite) were performed on an ODF-modified 4-channel Technicon AutoAnalyzer II, generally within one to two hour after sample collection. Occasionally samples were refrigerated up to 4 hours at ~4°C. All samples were brought to room temperature prior to analysis.

The methods used are described by Gordon et al. [Gord92]. The analog outputs from each of the four colorimeter channels were digitized and logged automatically by computer (PC) at 2-second intervals.

Silicate was analyzed using the technique of Armstrong et al. [Arms67]. An acidic solution of ammonium molybdate was added to a seawater sample to produce silicomolybdic acid which was then reduced to silicomolybdous acid (a blue compound) following the addition of stannous chloride. Tartaric acid was also added to impede PO4 color development. The sample was passed through a 15mm flowcell and the absorbance measured at 660nm.

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

Phosphate was analyzed using a modification of the Bernhardt and Wilhelms [Bern67] technique. An acidic solution of ammonium molybdate was added to the sample to produce phosphomolybdic acid, then reduced to phosphomolybdous acid (a blue compound) following the addition of dihydrazine sulfate. The reaction product was heated to ~55°C to enhance color development, then passed through a 50mm flowcell and the absorbance measured at 820nm.

Sampling and Data Processing

3806 nutrient samples were analyzed. 547 additional samples were taken by the Trace Metals group and analyzed by STS/ODF.

Nutrient samples were drawn into 45 ml polypropylene, screw-capped "oak- ridge type" centrifuge tubes. The tubes were cleaned with 10% HCl and rinsed with sample 2-3 times before filling. Standardizations were performed at the beginning and end of each group of analyses (typically one cast, up to 36 samples) with an intermediate concentration mixed nutrient standard prepared prior to each run from a secondary standard in a low- nutrient seawater matrix. The secondary standards were prepared aboard ship by dilution from primary standard solutions. Dry standards were pre- weighed at the laboratory at ODF, and transported to the vessel for dilution to the primary standard. Sets of 7 different standard concentrations were analyzed periodically to determine any deviation from linearity as a function of absorbance for each nutrient analysis. A correction for non-linearity was applied to the final nutrient concentrations when necessary. A correction for the difference in refractive indices of pure distilled water and seawater was periodically determined and applied where necessary. In addition, a "deep seawater" high nutrient concentration check sample was run with each station as an additional check on data quality. The pump tubing was changed 3 times.

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

Nutrients, reported in micromoles per kilogram, were converted from micromoles per liter by dividing by sample density calculated at 1 atm pressure (0 db), in situ salinity, and a per-analysis measured laboratory temperature.

Standards

Primary standards for silicate (Na_2SiF_6) and nitrite ($NaNO_2$) were obtained from Johnson Matthey Chemical Co.; the supplier reported purities of >98% and 97%, respectively. Primary standards for nitrate (KNO_3) and phosphate (KH_2PO_4) were obtained from Fisher Chemical Co.; the supplier reported purities of 99.999% and 99.999%, respectively. The efficiency of the cadmium column used for nitrate was monitored throughout the cruise and ranged from 99-100%.

No major problems were encountered with the measurements. The temperature of the laboratory used for the analyses ranged from 21.6°C to 25.8°C, but was relatively constant during any one station (+/-1.5°C).

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E.5. Dissolved Inorganic Carbon (DIC)

The DIC analytical equipment was set up in a seagoing container modified for use as a shipboard laboratory. The analysis was done by coulometry with two analytical systems (PMEL-1 and PMEL-2) operated simultaneously on the cruise by Dr. Christopher Sabine (PMEL) and Miss Justine Afghan (SIO). Each system consisted of a coulometer (UIC, Inc.) coupled with a SOMMA (Single Operator Multiparameter Metabolic Analyzer) inlet system developed by Ken Johnson (Johnson et al., 1985,1987,1993; Johnson, 1992) of Brookhaven National Laboratory (BNL). In the coulometric analysis of DIC, all carbonate species are converted to CO2 (gas) by addition of excess hydrogen to the seawater sample, and the evolved CO2 gas is carried into the titration cell of the coulometer, where it reacts quantitatively with a proprietary reagent based on ethanolamine to generate hydrogen ions. These are subsequently titrated with coulometrically generated OH-. CO2 is thus measured by integrating the total change required to achieve this.

The coulometers were each calibrated by injecting aliquots of pure CO2 (99.995%) by means of an 8-port valve outfitted with two sample loops (Wilke et al., 1993). The instruments were calibrated at the beginning of each station with a set of the gas loop injections. Subsequent calibrations were run either in the middle or end of the cast if replicate samples collected from the same Niskin, which were analyzed at different stages of analysis, were different by more than 2 µmol kg^{-1}.

Secondary standards were run throughout the cruise on each analytical system; these standards are Certified Reference Materials (CRMs) consisting of poisoned, filtered, and UV irradiated seawater supplied by Dr. A. Dickson of Scripps Institution of Oceanography (SIO), and their accuracy is determined shoreside manometrically. On this cruise, the overall accuracy and precision for the CRMs on both instruments was -1.7±0.8 µmol kg^{-1} (n=63) and -2.4±0.7 µmol kg^{-1} (n=64) for PMEL-1 and PMEL-2 respectively. Preliminary DIC data reported to the database have not yet been corrected to the Batch 67 CRM value, but a more careful quality assurance to be completed shoreside will have final data corrected to the secondary standard on a per instrument basis.

Samples were drawn from the Niskin-type bottles into cleaned, precombusted 300- mL Pyrex bottles using silicone tubing. Bottles were rinsed three times and filled from the bottom, overflowing half a volume, and care was taken not to entrain any bubbles. The tube was pinched off and withdrawn, creating a 3-mL headspace, and 0.2 mL of 50% saturated HgCl2 solution was added as a preservative. The sample bottles were sealed with glass stoppers lightly covered with Apiezon-L grease, and were stored at room temperature for a maximum of 24 hours prior to analysis.

DIC values were reported for 2882 samples or approximately 75% of the tripped bottles on this cruise. Full profiles were completed at odd numbered stations on whole degrees, with replicate samples taken from the surface, oxygen minimum, and bottom depths. On the even numbered (half degree) stations, as many samples as possible were drawn based on the current sample throughput; replicates were collected from the surface and bottom bottles. Typical even numbered stations had between 8 and 20 bottles sampled.

Duplicate samples were drawn from 256 bottles and interspersed throughout the station analysis for quality assurance of the coulometer cell solution integrity. The average of the absolute value of the difference between duplicates was 1 µmol kg^{-1} for both systems. No systematic differences between the replicates were observed.

The only significant problem encountered on this cruise was a failure of the gas loop calibration system on PMEL-2 during the final week of running stations. The problem was noted when calibrations started giving unusually low calibration values that also produced unusually low CRM results. The problem was isolated to the gas sample valve but could not be repaired without significant loss of sample analysis time. Instead, we manually entered a calibration factor based on the mean value obtained from the previous month's worth of calibrations. The manually entered calibration factor was confirmed by analyzing CRMs with every station, comparing replicate samples between PMEL- 1 and PMEL-2, and careful inspection of deep water values analyzed on the two systems. We do not believe this problem has compromised the data in any way.

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E.6. Alkalinity Analysis

Samples were collected and analyzed for alkalinity by personnel from the laboratory of Andrew G. Dickson, Scripps Institution of Oceanography. Samples were collected from all Niskins at the odd numbered stations. Two samples were collected and analyzed from Niskin bottle 1 (the deep bottle), Niskin 18 (an intermediate depth bottle) and Niskin 36 (or bottle tripped at the surface). On the even numbered stations, from 10 to 36 samples were collected along with two duplicate bottles from the surface and bottom bottles. Sampling on the even numbered stations was done in conjunction with samples collected for the analysis of dissolved inorganic carbon (D.I.C.).

Samples of ~280 mls were collected in pyrex bottles with 20 mm serum style closures. Bottles were rinsed three times before sample collection. After collection, 57 microliters of a saturated mercuric chloride solution were added to inhibit biological activity. An approximately 108 ml sample was delivered into a jacketed beaker using a calibrated glass syringe. The beaker was connected to a bath set to 22.5 degree C. ~0.1 molar HCl in ~0.6M NaCl (batch prepared December 2, 2004) was used to titrate the sample as follows: while the sample was being stirred gently, an initial aliquot of ~2.7 mls of acid was added to the sample using a Dosimat 665 titrator. Immediately after this addition the sample was stirred vigorously while CO2 free air was bubbled into the solution at 200 mls/min. After 4 minutes, the titration was completed by the addition of 20 increments of 0.04 mls of the acid. During the course of the titration, the emf of the solution was monitored using a Ross-Orion combination pH electrode. At each titration point, the volume of solution added, the voltage and the temperature of the sample were recorded. The titration data were processed using a modified Gran plot.

The accuracy of the system was monitored using Batch 67 certified reference materials for D.I.C. and alkalinity supplied by the Dickson laboratory. A standard solution was run at least twice before and after each station.

Preliminary results for all analyses have been reported to Kristin Sanborn of the Oceanographic Data Facility (ODF), SIO, UCSD.

Some additional notes:

1. A saturated solution of mercuric chloride was provided by the Dickson laboratory for all programs requiring mercuric chloride on this cruise: D.I.C. (which used a 50% saturated solution) alkalinity, C-14, and CDOM (experiments of Stuart Goldberg-UC Santa Barbara).
2. To maintain pace with the D.I.C. program, members of the alkalinity analysis team were relieved of sampling responsibilities. This was turned over to others available for station sampling. Without this help, 15 to 20 fewer samples would have been analyzed per day.
3. Equipment operated up to expectations with the following exceptions: the spare bath was substituted into the system when the first bath stopped working; it was thought that one of the stirring units was causing some electrical problems and this unit was replaced.
4. The computer system experienced several crashes requiring restarting.

E.7. CFC-11, CFC-12, and CFC-113

Sample Collection

All samples were collected from depth using 10 liter Niskin bottles. These had been cleaned prior to the cruise, and all o-rings, seals and taps were removed, washed in deacon solution and propan-2-ol, then baked out in a vacuum oven for 24 hours. Of the original 36 bottles initially used, two were lost and replaced, and one was temporarily replaced, repaired and returned. None of the Niskin bottles used showed a CFC contamination throughout the cruise. All bottles in use remained inside the CTD hanger between casts. All spare bottles were stored on a spare rosette under a tarp, sitting on the main deck.

CFC sampling was conducted first at each station, according to WOCE protocol. This reduces contamination by air introduced at the top of the Niskin bottle as water was being removed. A water sample was collected directly from the Niskin bottle petcock using a 100 ml ground glass syringe which was fitted with a three-way stopcock that allowed flushing without removing the syringe from the petcock. Syringes were flushed several times and great care was taken to avoid contamination by air bubbles. Duplicate samples were randomly collected, nominally from every CTD cast. Duplicates were not taken when time was constrained due to a backlog of analyses. Air samples, pumped into the system using an Air Cadet pump, were run about every 2 - 4 days from a Dekoron air intake hose mounted high on the foremast. These samples were used to check CFC saturation levels in the surface water.

Equipment and technique

Chlorofluorocarbons CFC-11, CFC-12, and CFC-113 were measured on 111 stations for a total of 3,078 samples. Halocarbon analyses were performed on a gas chromatograph (GC) equipped with an electron capture detector (ECD). Samples were introduced into the GC-EDC via a purge and dual trap system. The samples were purged with nitrogen and the compounds of interest were trapped on a main Porapack N trap held at ~ -20°C with a Vortec Tube cooler. After the sample had been purged and trapped for several minutes at high flow, the gas stream was stripped of any water vapor via a magnesium perchlorate trap prior to transfer to the main trap. The main trap was isolated and heated by direct resistance to 140°C. The desorbed contents of the main trap were back-flushed and transferred, with helium gas, over a short period of time, to a small volume focus trap in order to improve chromatographic peak shape. The focus trap was also Porapak N and is held at ~ -20°C with a Vortec Tube cooler. The focus trap was flash heated by direct resistance to 155°C to release the compounds of interest onto the analytical pre-column. The analytical pre-column was held in-line with the main analytical column for the first 3 minutes of the chromatographic run. After 3 minutes, all of the compounds of interest were on the main column, and the pre-column was switched out of line and back-flushed with a relatively high flow of nitrogen gas. This prevented later eluting compounds from building up on the analytical column, eventually eluting and causing the detector baseline signal to increase.

The syringes were stored in a flow-through seawater bath and analyzed within 8 -12 hours after collection. Bath temperature was recorded continuously for use in calculating the mass of water analyzed. Every ten measurements were followed by a purge blank and a standard, gas2.68ml. Time permitting, the surface sample was held after measurement and was sent through the process in order to "restrip" it to determine the efficiency of the purging process.

Calibration

For accuracy, the standard, S39, was cross-calibrated to the SIO-98 absolute calibration scale. A 19 point calibration curve was run every 4-9 days for all three halocarbons. Estimated accuracy is +/- 2%. Precision for CFC-12, CFC-11 and CFC-113 is smaller than 1%.

Contamination and Problems

In large part, sample collection and measurement were very successful. The integration of the computer software with the GC-EDC system hardware made the procedure almost completely automated. A few problems were encountered initially. Failure of some of the optoisolator circuitry occurred, which required replacement. The bow air line filled with moisture transitioning from the warm humid outside air to the cold, dry air-conditioned Main Lab, flooding the magnesium perchlorate trap associated with the pump sample line. Installation of an additional water trap in line just before the magnesium perchlorate trap cured the problem. The rough seas played havoc with the particular brand of PC laptop computers integrated with the GC system, and they crashed several times, resulting in occasional sample losses. Two of the glass syringes appeared to be contaminated with CFC-11 and CFC-113, respectively, and were removed from service. How they were affected was not discovered, but since no other syringes were contaminated, the situation appeared isolated. To our knowledge, there were no other occurrences of contamination.

Final Comments

Samples from all 111 CTD stations were analyzed for CFCs, although the throughput rate of the analytical system necessitated selectively not sampling some Niskin bottles on most casts. The data set was minimally compromised by this procedure by selecting depths in mid-waters of relatively uniform hydrography. The results of this cruise are preliminary and may change by a small percentage after final scrutiny by the principal investigator.

E.8. Trace Metals

Water Column Profiles

Sea water samples for on board trace metal determinations were collected using 12 L Go-Flo bottles on a 12-place rosette system equipped with a SeaBird 911 CTD and oxygen sensor and a Wet Labs FL-1 fluorometer. The rosette package was deployed from the stern of the ship with the Go-Flo bottles in the open configuration using a 4 conductor Kevlar cable sheathed in polyurethane. The package was lowered at ~ 50 m/min to 10-30m below the target depth of the deepest bottle. As the package was raised back through the water column the Go-Flo bottles were tripped individually at pre-assigned depths while the package was moving at ~ 10-20 m/min. The depths that the bottles were tripped was one of three sampling patterns that were designed to match the three sampling schemes used by the main hydrography program.

Upon package recovery the Go-Flo bottles were taken from the rosette into the trace metal sampling van for sub-sampling. Unfiltered sub-samples were collected directly from each bottle for salinity and nutrient determinations and also to ensure that each Go-Flo bottle had closed at the correct depth. Unfiltered samples were collected from every third station for archive purposes at UH and FSU. Filtered sub-samples were collected from each bottle through a 47mm in-line Nuclepore polycarbonate track-etched disc filters, 0.4 µm, after attaching the bottles to a 10 psi filtered air supply.

Filtered samples were collected from each depth for ship-board analysis of dissolved Fe and Al using the University of Hawaii flow-injection system. Unfiltered and filtered subsamples were collected for return to FSU for analysis of iron by Fe-57 isotope dilution Inductively-Coupled Plasma Mass Spectrometry (ICPMS).

During the cruise a total of 46 stations were occupied, yielding a total of 552 samples. A complete data set for dissolved Fe and Al was obtained from the UH FIA analytical system. In addition dissolved Mn was determined at many of the stations. Dissolved Fe concentrations were extremely low throughout the section with values dropping from 0.5 nM near Tahiti to 60 pM at 56°S. Values remained at these extremely low levels all the way to 71°S. Deep water Fe levels, also showed a southerly decrease. Values of 1nM around Tahiti quickly decreased to less than 0.5 nM by 36°S. These low deep water values persisted all the way to southernmost station, reflecting the lack of surface water Fe to be vertically transported to the deep waters by biological processes. Dissolved Al also showed relatively low values throughout the transect. Surface waters near Tahiti were relatively enriched with values of ~ 3-4 nM, these values dropped rapidly to the south with another maximum of 3-4 nM around 30°S. Thereafter surface values dropped again reaching ~1nM by 40°S and then stayed extremely low to 71°S. Implied mean dust deposition to the surface ocean calculated from these Al values ranges from 0.2 to 0.4 g mineral dust m -2 yr -1 between 16°S and 34°S. Poleward of 40°S dust estimates drop to 0.010 -0.050 g mineral dust m -2 yr -1., among the lowest seen anywhere in the oceans. Deep and mid water Al values follow a similar trend with the mid water enrichment seen at the beginning of the transit disappearing by 37°S, and deep waters resembling surface water values by ~ 54°S

Mn data show uniformly low values (< 0.1 nM--our methodological zero) in deep water throughout the section. Surface waters show values of 0.5 to 1 nM in the upper 100m from 16°S to 30°S, south of this latitude values decrease rapidly and are close to the methodological zero from 54°S to 68°S.

Initial results of the on board Fe, Al and Mn determinations have already been submitted to the shipboard data base. Final data will be submitted to the data base by February 20th, 2006.

E.9. DOM Biogeochemistry and Global CDOM

Project Title:	Biogeochemistry of Dissolved Organic Matter (DOM)
PI:	C. Carlson, University of California, Santa Barbara
Support:	NSF

Project Goals

Our goal is to evaluate dissolved organic carbon (DOC) and nitrogen (DON) concentrations over a variety of spatial sections of the repeat hydrography program. During the P16S cruise, A type casts were specifically targeted in order to overlap with the TCO2 sampling program.

Activities on P16S

The Carlson group collected samples for dissolved organic carbon and nitrogen (DOC/DON) analyses. The samples were collected by Meredith Meyers of the University of California, Santa Barbara. These samples will be processed at shore based laboratories to ensure the highest quality data set. Dr. Carlson will be responsible for analysis of these DOM samples. On the P16S cruise, samples were collected from 24-36 depths for every other station. The depths and station from which these samples were collected coincided with samples and depths collected for dissolved inorganic carbon (DIC). DOC and DON samples were passed through an inline filter holding a combusted GF/F filter attached directly to the Niskin for samples in the top 500m of each cast. This was done to eliminate particles > 0.7 µm from the sample. Samples were collected at sea and stored frozen at -20°C and transported frozen to UCSB.

Data for DOC will be available in approximately ~9-12 months from their arrival at UCSB. Additional time may be required to complete DON samples.

Instruments and Methods

Samples will be analyzed via the high temperature combustion technique using Shimadzu TOC-V systems with total nitrogen chemiluminescent detection. Samples will be sparged of inorganic carbon by acidification with HCl and sparging with CO2 free gas for several minutes. A minimum of triplicate injections of 100µl of sample will be injected onto a Pt alumina combustion catalyst heated to 680°C. The CO2 signal will then be detected with a non-dispersive infrared detector. Total nitrogen is converted to NOx and detected via chemiluminescence.

E.10. Project Title: Chromophoric DOM: an Ignored Photoactive Tracer of Geochemical Processes

PI's: D. Siegel, N. Nelson, C. Carlson, University of California, Santa Barbara
Support: NSF (2/3) and NASA

Project Goals

Our goals are to determine chromophoric dissolved organic matter (CDOM) distributions along a variety of CO2/Clivar Repeat Hydrography survey and to quantify and parameterize CDOM production and destruction processes with the goal of mathematically constraining the cycling of CDOM. CDOM is a poorly characterized organic matter pool that interacts with sunlight, leading to the production of climate-relevant traces gases, attenuation of solar ultraviolet radiation in the water column, and has impacts on ocean color that can be quantified using satellite imagery. We believe that the global distribution of CDOM is controlled by microbial production and solar bleaching in the upper water column. We are testing these hypotheses using a combination of field observations and controlled experiments. We are also interested in the deep sea reservoir of CDOM and its origin and connection to surface waters and are making the first large scale surveys of CDOM abundance in the deep ocean.

Activities on P16S

We collected seawater samples for absorption spectroscopy on one deep ocean cast (24-36 depths) each day. CDOM is typically quantified for as the absorption coefficient at a particular wavelength or wavelength range (we are using 325nm). We determined CDOM at sea by measuring absorption spectra (280- 730 nm) of 0.2 um filtrates using a liquid wavelength spectrophotometer with a 200cm cell. We concurrently collected samples for prokaryotic abundance and production rates, and carbohydrates to compare the distribution of these quantities to that of DOM (see above) and CDOM. In surface waters (300m) we are also estimating microbial productivity of field samples by measuring the uptake of bromo-deoxyuridine (BrdU), a non radiotracer assay. On selected stations (n=10), DNA was collected for further molecular analyses to indentify bacterial community structure. This in situ prokaryotic community will be compared to that which developed in incubation experiments used to assess CDOM production (see below).

Because of the connections to light availability and remote sensing, we collected samples for pigment analysis (HPLC), mycosporine-like amino acids (MAAs) and particulate absorption (AP) (spectrophotometric) from the surface intake 1x day. Sea and sky-state permitting, we deployed a Satlantic free-fall profiling spectroradiometer (SPMR) once daily between 1000 and 1400 local on the starboard side midships. An additional spectroradiometer mounted to the 02 deck provided surface solar irradiance measurements as a reference for the underwater light cast. Details of cast times and locations are presented below.

Dates, start times and locations of SPMR profiles

Date	Start Time (UTC)	Station #
011005	2032	002
011105	2132	006
011205	2032	010
011305	2213	014
011405	2222	017
011505	2111	021
011605	2305	025
011705	2144	028
011905	2137	035
012005	2151	039
012105	2306	042
012205	2132	045
012305	2212	049
012405	2255	052
012505	2022	055
012605	2311	059
020205	2316	081
020305	2328	085
020605	2304	096
020805	2116	106

Chlorophyll-a (fluorometric) samples were collected daily for the upper 200m at the same station at which a radiometer profile was executed (typically from a B cast). Fluorometric chlorophyll analyses were done at sea following a 24-hour extraction protocol.

Process Experiments: At selected stations we collected extra seawater for a) microbial culture experiments carried out at sea and b) solar bleaching experiments carried out later on shore. Water was collected from short casts within the surface 250m from stations 009, 031, 061, 093. In these experiments we examine the rate of CDOM production relative to microbial productivity in culture. The quantum yield of photolytic destruction of CDOM in the surface and 80m from these "experimental casts" will be determined in laboratory experiments utilizing a solar simulator.

MICROBIAL GROWTH EXPERIMENTS

Four microbial cultures were conducted over the course of the cruise with water collected from 4 shallow casts to 250m. Experiments were conducted with water collected from 20, 32, 46, and 62°S. Each experiment comprised 5 different treatments of varying organic matter mixture and was incubated at in situ temperatures over the course of 5-15 days. The objective was to monitor microbial biomass production, DOM consumption, shifts in the microbial community and temporal variability of CDOM through the microbial growth curves. Culture activity was monitored by microscopic direct counts. Preliminary results suggest that all treatments, except unamended deep controls, showed significant growth. Further analysis of CDOM, DOM, and molecular composition of the prokaryotic community will be conducted in the laboratory.

F. Aerosol Sampling Program

Aerosol samples were collected each day (24-hour integrated) using the FSU aerosol sampling tower. Wind sector and wind speed control was used to immediately shut off the sampling when the wind brings ship's exhaust towards the bow. Bulk aerosols were collected on 47 mm, 0.4 µm polycarbonate filters for shore-based analysis of total trace elements using energy dispersive X-ray fluorescence (Joe Resing, University of Washington and NOAA/PMEL). Replicate samples on 0.45 µm polypropylene filters were leached with DI water or surface seawater to measure soluble Fe(II) (ship-board), and for shore-based analysis of total soluble Fe and Al, and soluble anions and cations.

Three-day integrated samples of size-fractionated aerosols were collected using a Micro Orifice Uniform Deposition Impactor (MOUDI). Size cutoffs of 3.1, 1.0, 0.56, and 0.056 µm were used. Those filters were also leached with DI water for shore-based analysis of total soluble Fe and Al, and soluble anions and cations. Due to flooding of the aerosol pumps on 29-JAN-05, we were reduced to deploying only two filters per day, and the MOUDI sampling was halted. After installing our backup pump, aerosol sampling re-commenced on 1-FEB-05.

The soluble aerosol Fe(II) concentrations ranged from 0.1-5.3 pmol/m3 of filtered air. These concentrations cannot be placed in perspective until after the shore-based analysis of total aerosol Fe and total soluble aerosol Fe has been completed. From visual inspection of the aerosol filters, it is clear that the total aerosol loads in the atmosphere between Tahiti and Antarctica are extremely low.

Results from the aerosol sampling program will be submitted to the data base by February 20th 2006.

Appendix: Comments for Bottle Data

This appendix contains remarks for deleted samples, missing samples, PI data comments, and WOCE codes other than 2 from this cruise. 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 re-reading of charts (i.e. nutrients). Comments from the Sample Logs and the results of ODF's investigations are included in this report. Units stated in these comments are degrees Celsius for temperature, Practical Salinity Units for salinity, and unless otherwise noted, milliliters per liter for oxygen and micromoles per liter for Silicate, Nitrate, Nitrite, and Phosphate. The first number before the comment is the cast number (CASTNO) times 100 plus the bottle number (BTLNBR).

Station 1

214	Three readings before two agreed. Used the last reading, appears that cell may not have been flushed enough after a low conductivity sample run.
301	Leave as is, within the accuracy of measurement. Adjusted beginning F1 factors for no3 and re-processed. N:P data looks good. Oxygen for bottles 1 and 2 appears a little high, but agrees with historical data. Leave as is. At the first stations, decreasing gradually as we moved south, from 150-500 meters NO3 is a little low relative to PO4. This is exactly as expected from the subsurface water masses in that region, which have experienced denitrification. The effect is subtle, but consistent.
301-336	SBE35 not reset prior to cruise, buffer filled up. Data lost. Oxygen signal offset/cut out multiple times during cast, cable to sensor replaced after cast; CTD oxygen unusable.
303-304	PO4 about 0.02 low with respect to NO3. Code 3 or leave as code 2? Nutrient analyst rechecked peaks, data are acceptable, leave as code 2.
308-318	PO4 about 0.02 low with respect to NO3. Code 3 or leave as code 2? Nutrient analyst rechecked peaks, data are acceptable, leave as code 2.
314	Pylon latch broken; no samples.
324	Leaky bottom when vented, major leak flowing freely from bottom; o-ring came out. Got salinity and nutrient samples. No other samples were drawn. Salinity too high, contaminated. Footnote bottle 3, leaking, samples bad.
325	Oxygen appears high compared with CTD and with Station 2. Reviewed data with JHS, code oxygen questionable, 4, there were some bubble problems reported while doing standards until Station 15.
330	Salinity low compared with CTD, no analytical problem noted. Salinity is acceptable.
335	Pylon latch broken; no samples.

Station 2

101	It was discovered that oxygen analyst was rinsing the acid tube with DI water before adding acid to sample. The practice was found to have happened on Stations 2, 3, 6, and bottles 1-24 on 7. These stations were reviewed with this consideration with JHS and were found not to be a problem.
101-108	Oxygen signal odd, sensor replaced after station 11; CTD oxygen questionable.
104	Sdiff D-C = 0.004; SALT a little high for deep water with low gradient; outside 0.003 spec so change code to 4? Code salinity 4, bad.
105	Oxygen sample was overtitrated and backtitrated. Data are acceptable.
106	Oxygen sample was overtitrated and backtitrated. Data are acceptable.
109	Oxygen signal offset, sensor replaced after station 11; CTD oxygen bad.
110-117	Oxygen signal odd, sensor replaced after station 11; CTD oxygen questionable.
112	Nutrient samples were not drawn in error.
118-136	Oxygen signal odd/offset several times top 1200db, sensor replaced after station 11; CTD oxygen bad.

127	Sdiff D-C = -0.021; probably related to incompletely flushed Niskin. Leave as code 2.
134	Oxygen appears high as compared with CTD and station profiles, reviewed data with JHS; decided to code data 3, questionable. There were some bubble problems reported while doing standards until Station 15, this could account for an error. Salinity appears high as compared with CTD, no analytical problem noted. Salinity is acceptable.
135	Bottom end cap leaking, code 3 - no sample.
Station 3	
101	High bottom nutrients are unusual but PO4, NO3, and SIO3 show the same feature. O2 is higher at bottom, which is opposite the usual tendency compared to nutrient change. Probably leave as Code 2. Nutrient analyst rechecked peaks, data are acceptable. It was discovered that oxygen analyst was rinsing the acid tube with DI water before adding acid to sample. The practice was found to have happened on Stations 2, 3, 6, and bottles 1-24 on 7. These stations were reviewed with this consideration with JHS and were found not to be a problem.
101-124	Oxygen signal odd/high, sensor replaced after station 11; CTD oxygen questionable.
103	Is 103 O2 a little high? Or is 102 O2 a little low? Comparison to CTDO suggests 103 is a little high. Code 3, questionable. Nutrients seem high -not yet investigated. JHS: Nutrients look okay.
110	Sample was overtitrated and backtitrated. Oxygen is acceptable.
125-136	Oxygen signal offset several times top 600db, sensor replaced after station 11; CTD oxygen bad.
136	Salinity and nutrients not drawn per sampling schedule.
Station 4	
101-124	Oxygen signal response problems, sensor replaced after station 11; CTD oxygen questionable.
102	Sdiff D-C = -0.007; bottle salt is low; code 4.
125-136	Oxygen signal odd/response problems, sensor replaced after station 11; CTD oxygen bad.
Station 5	
101-133	Oxygen signal low/response problems, sensor replaced after station 11; CTD oxygen questionable.
116	Oxygen may be 0.02 high. JHS review: This is very small and there is no reason to suspect the value. Oxygen is acceptable.
121	Release valve not tight. JHS: No CTDO of sufficient quality to compare with the bottle O2. No CFC sample. But CTDS vs. SALT OK considering the gradient, and nutrients are on the local gradient. Thus can keep bottle as code 2.
129	Salinity is low compared with CTD, no analytical problem noted. Salinity is acceptable.
130	Salinity is low compared with CTD, no analytical problem noted. Salinity is acceptable.
Station 6	
101	Nutrients high? JHS: No CTDO of sufficient quality to compare with bottle O2 (bottle oxygen is somewhat high and could possibly be code 3). Nutrients look okay. It was discovered that oxygen analyst was rinsing the acid tube with DI water before adding acid to sample. The practice was found to have happened on Stations 2, 3, 6, and bottles 1-24 on 7. These stations were reviewed with this consideration with JHS and were found not to be a problem.
101-136	Oxygen signal low/response problems, sensor replaced after station 11; CTD oxygen questionable.

104	Oxygen appears 0.02 high. O2 profile matches NO3 and PO4 profiles, i.e. NO3 and PO4 are slightly low this bottle. So oxygen is correct for water mass.
134	Spigot was pushed in before sampling began. Salinity and oxygen are acceptable. JHS review: No CTDO of sufficient quality to compare with the bottle O2. CFC OK for gradient. CTDS vs. SALT OK considering the gradient, and nutrients are on the local gradient. Thus can keep bottle as code 2.
136	No salinity, oxygen or nutrients; surface samples for CDOM program.

Station 7

101	It was discovered that oxygen analyst was rinsing the acid tube with DI water before adding acid to sample. The practice was found to have happened on Stations 2, 3, 6, and bottles 1-24 on 7. These stations were reviewed with this consideration with JHS and were found not to be a problem. Oxygen may be low. JHS review: This O2 more or less matches near-bottom O2 at station 009, on similar slope near ridge, and near-bottom O2 at 008 is only a small amount higher. O2 is more or less consistent with oceanography and can be left code 2, acceptable.
101-130	Oxygen signal low/response problems, sensor replaced after station 11; CTD oxygen questionable.
102	Oxygen may be low. JHS review: This O2 more or less matches near-bottom O2 at station 009, on similar slope near ridge, and near-bottom O2 at 008 is only a small amount higher. O2 is more or less consistent with feasible oceanography and can be left code 2, acceptable.
111	Nutrients seem low. JHS: The nutrients do not look low. But the bottle oxygen does look low and does not fit the gradient. Unfortunately there is no CTDO of sufficient quality to check, though the CTDO profile available shows no feature at this level. The SALT-CTDS difference is OK, so it does not appear to be a bottle problem. Probably consider code 3 or 4 for oxygen, code 2 for bottle, nutrients, and salt. O2 low by > 0.07 ml/l; should change QC to 3 or 4. No analytical problem noted, code as 3, questionable.
125	Oxygen could be high. JHS review: It is true that the value looks high, but by how much is difficult to state. CTDO down trace does not show a peak near this depth, though does show broad maximum. Oxygen section shows reasonable connection to higher-oxygen waters immediately to the south of station 007. Oxygen is acceptable.
130	Oxygen could be high. JHS review: It is true that the value looks high, but by how much is difficult to state. CTDO down trace does not show a peak near this depth. But bottle oxygen section shows reasonable connection to higher-oxygen waters immediately to the south and north of station 007. Oxygen is acceptable.
131-136	Oxygen signal low/response problems, sensor replaced after station 11; CTD oxygen bad.
135	Salinity high compared with CTD. No analytical problems, okay as is. Oxygen could be high. CTDO down trace does show a peak near this depth. Bottle oxygen is reasonable. Oxygen is acceptable.

Station 8

101-130	Oxygen signal low/response problems, sensor replaced after station 11; CTD oxygen questionable.
111	O2 high by ca. 0.07 ml/l; should change QC code to 3 or 4? No analytical problem noted, code 3, questionable.
131-136	Oxygen signal low/response problems, sensor replaced after station 11; CTD oxygen bad.
133	Thio bubbles!. Oxygen appears to be high, code as 3, questionable. Nutrients seem high. JHS review: The nutrients do not look high. They appear to fit the local structure. But the O2 looks high. Unfortunately there is no CTDO of sufficient quality to check,

though the CTDO profile available shows only a weak maximum feature near this level. The SALT-CTDS difference is OK, so it does not appear to be a bottle problem. Probably consider code 3 or 4 for oxygen, code 2 for bottle, nutrients, and salt.

Station 9

101	Special DOM Cast; no salinity, oxygen, nutrients.
301	Oxygen flask 1464 got titrated VERY slowly - unable to reach endpoint. Sample was lost.
301-318	Oxygen signal very low/response problems, sensor replaced after station 11; CTD oxygen questionable.
305	Sdiff D-C = 0.006; bottle salt too high; code 4.
319-336	Oxygen signal very low/response problems, sensor replaced after station 11; CTD oxygen bad.
329	Bottle salinity high compared to CTD, salinity agrees with station profiles, gradient area. Salinity is acceptable.

Station 10

201-222	Oxygen signal very low/response problems, sensor replaced after station 11; CTD oxygen questionable.
202	Oxygen is high compared to 201. CTDO does not show this feature and suggests 202 is high. Code 3, questionable.
208	Sample lost, forgot to add acid.
218	Didn’t close properly. A bungy cord from the LADCP system got caught on the top cap. Salinity and oxygen high; low for po4 and no3; real. Code bottle leaking and samples bad.
221	Bottles appear to have been switched in the case. Samples were analyzed correctly; agrees with CTD and station profiles.
222	Salinity bottles appear to have been switched in the case. Samples were analyzed correctly; agrees with CTD and station profiles.
223-236	Oxygen signal very low/response problems, sensor replaced after station 11; CTD oxygen bad.
226	Salinity slightly high compare with CTD, gradient, agrees with adjoining station profiles.

Station 11

201-236	Oxygen signal very low/response problems, sensor replaced after station 11; CTD oxygen unusable.
221	Salinity appears high compared with CTD. No analytical problems noted, salinity agrees with station profiles.

Station 12

101	CTDO2 Processor: 3-minute stop near 4780db down: rawoxy signal dropped, okay after despike. Code CTDO 7, despiked.
121	Bottle O2 higher than CTD O2 by 0.465. No CTDO max was seen at this level in the down trace, and there were no nutrient lows at this level. (However, other O2 extrema which were seen in both CTDO and bottle data at this cast do not have matching nutrient features, so that is not definitive.) Examine oxygen records. Possibly code 3 for this O2 value? No analytical problem noted, does not fit bottle data station profiles comparison. Code as 3, questionable.
122-129	Odd O2 structure here, but is sensible on vertical section. Leave as code 2.

Station 14

201	Oxygen-Acid not purged+bubbles in thio, sample bad.

210	Bottle salinity is about 0.001 low compared with the rest of the station and the CTD. No analytical problem found.
232	Leaking at bottom, problem with o-ring. Oxygen as well as other parameters appear reasonable.

Station 15

205	Bottle salt high by 0.006 relative to CTDS. Code 4, bad.
219	Salinity high compared to CTD and station profiles, no analytical problems noted. Code salinity 3, questionable.
232	Slow leak from bottom end cap when air vent is open. JHS: Bottle salt, O2, and nutrients appear reasonable for local conditions. Keep code 2 for bottle and these parameters.
235	Bottle salt low by 0.11 relative to CTDS1/CTDS2. High gradient. Salinity is the same as bottle 34, suspect drawing error. Salinity is bad.

Station 16

106	Oxygen could be high. JHS review: It is a little higher than the CTD oxygen, but by approximately the same amount as bottles 103, 104, 107, 108, 109, and 110. Hence there appears to be no problem with the bottle oxygens. Oxygen is acceptable.
125	Very slow bottom cap leak when air vent and spigot are opened. Data are acceptable.

Station 17

212-201	Possibly low for both po4 and no3, data checked and appear acceptable. JHS review: Agree that both PO4 and NO3 appear to be low for these bottles with respect to nearby stations. No other deep feature of NO3 and PO4 sections quite like this. No matching feature in O2 section, though SIO3 section also shows somewhat low concentrations for these bottles at this station. Interesting. Nutrient analyst should determine if these remain code 2 (probably), or become code 3.
236	Tripping of bottle delayed because there were particles floating on the surface.

Station 20

126	Three attempts for a good reading. Could not resolve high salinity, salinity should be coded 4, bad.

Station 22

102	PO4 low by 0.01. This is a very small offset, but these last three casts all show this effect, whereas previous stations do not. NO3/PO4 relationship suggests that it is the PO4 which is low on 2, rather than high on 1, or rather than NO3 being high. Is this an indicator of rust on spring or other contaminant in 2? Analyst rechecked data found no problems. Before Station 25, bottle was inspected and grease was found on the inside top cap.
123	Large nutrient spike not reflected in O2 profile. Either nutrients were accidentally drawn from 117 (an excellent match), the sample was contaminated, or (?). Code 4, bad. Nutrient analyst rechecked peak, sample must have been contaminated.

Station 23

202	PO4 low by 0.01. This is a very small offset, but these last three casts all show this effect, whereas previous stations do not. NO3/PO4 relationship suggests that it is the PO4 which is low on 2, rather than high on 1, or rather than NO3 being high. Is this an indicator of rust on spring or other contaminant in 2? Analyst rechecked data found no problems. Before Station 25, bottle was inspected and grease was found on the inside top cap.

Station 24

102	PO4 low by 0.01. This is a very small offset, but these are the last three casts for which I have data and all show this effect, whereas previous stations do not. NO3/PO4 relationship suggests that it is the PO4 which is low on 2, rather than high on 1, or rather than NO3 being high. Is this an indicator of rust on spring or other contaminant in 2? Grease was found on the inside of the top cap. Analyst rechecked data found no problems. Before Station 25, bottle was inspected and grease was found on the inside top cap.
132	Slow leak. JHS: Bottle salt, O2, and nutrients appear reasonable for local conditions. Keep code 2 for bottle and these parameters.

Station 25

306	Oxygen program error - no oxygen data.
314	Top vent open, freon and helium did not sample. Oxygen as well as other samples are acceptable.

Station 26

103	Nutrients were not drawn, found nutrient sampling tube empty when sample run started.
116	Salinity: Three attempts for a good reading. JHS: Bottle salt 0.038 lower than CTD salt. Slight problem during analyses; salinity was rerun, rerun value was more realistic, 0.003 higher than CTD, code salinity bad.
131	Samples may be compromised because lanyard was hooked on top cap during recovery. JHS: Bottle salt, O2, and nutrients appear reasonable for local conditions. Keep code 2 for bottle and these parameters.
132	Salinity is low compared with CTD, no analytical problems noted. Salinity is acceptable.

Station 27

110	Salinity high compared with CTD, looks okay on station profile. Within limits of measurements, no analytical problems noted.
112	Salinity high compared with CTD, looks okay on station profile. Within limits of measurements, no analytical problems noted.
117-118	Bottles 17 and 18 tripped at same pressure. Samples were not taken from bottle 18.
130	Low for all nutrients and high for o2 recheck peaks data is real. Although there is a significant bottle minus CTD oxygen difference, this occurs in a level of the CTD down cast marked by fine structure. Leave bottle O2 as code 2.

Station 28

101	Suspect SSW wrong; was taken from an unopened box and it was warmer than the salinometer bath. Changed ending SSW value so there was no machine drift.
118	Nutrient data taken from salinity bottle, data are bad. NO3 is maybe 0.4 (or a little more?) low with respect to PO4. No matching signal seen in PO4, SiO3, or O2. Within precision so keep code 2 but perhaps examine peak? Nutrient sample taken from salt bottle. Nutrients are bad.

Station 30

112	Nutrient analyst: Low for po4 and no3 high for sil and O2 rechecked peak data is real. JHS review: NO3 and PO4 are significantly lower than samples above and below, and SiO3 is same as sample above. O2 is significantly higher than samples above and below. Bottle salt is 0.03 off. There is no trace of an intrusive feature at this level in the down CTDO cast data. Therefore all non-CTD parameters for this bottle should be code 4 and the bottle should be coded 3, leaking.

Station 34	
132	Bottle has slow leak. Oxygen as well as other parameters are acceptable. (2 trips triggered at 250m; btl 32 one level deeper than planned - mcj)
133-136	2 trips triggered at 250m; btls 32-36 one level deeper than planned. No surface bottle.
136	Sample was overtitrated and backtitrated. Oxygen is acceptable. Lost nutrient samples, sample spilled.
Station 35	
128	Salinity was not suppose to be drawn from 28 nor 33. They appear to have been drawn, but 28 was too high. Sampler must have turned the bottle right side up in the box. 33 sample appears to be okay. Code salinity 4, bad.
Station 36	
120-121	Bottle salinity is high compared with CTD and station profile. Salinity from 20 appears to have been drawn from 19 and 21 appears to have been drawn from 20. Code salinity 4, bad.
123	Sample was overtitrated and backtitrated. Oxygen is acceptable.
Station 37	
203-209	CTDO2 Processor: ctdoxy up to 0.03 ml/l low compared to bottles in this area. Code CTDO 3, questionable.
207	Bottom vent is sticky.
222	Stopcock is leaking. Bottle salinity is acceptable. JHS: Bottle salt, O2, and nutrients appear reasonable for local conditions. Keep code 2 for bottle and these parameters.
Station 38	
121	Four attempts for a good reading. Tried the first reading, still a little high with CTD and station profiles, suspect salinity crystal. Code salinity 3, questionable.
Station 39	
329	po4 and no3 seem high vs. pot temp. recheck data 329=328 exactly for all nuts? real? JHS: Nutrients not literally _exactly_ the same for all nuts in the data file, but that is a fine point. Oxygen has decent gradient and nutrients do not fit nutrient gradient. Looks like a double draw on nutrients, with both drawn from number 28. Code 3 for nutrients.
Station 40	
112	Four attempts for a good reading. Apparently there was a salt crystal that made the readings climb. Tried the first reading and the salinity is still too high, although it did bring it to within the accuracy of the measurement. Code salinity 4, bad.
Station 41	
103-106	CTDO2 Processor: ctdoxy up to 0.03 ml/l low compared to bottles in this area. Code CTDO 3, questionable.
Station 46	
101	Bottom salinity appears a little high compared to CTD. No analytical problem noted. "Leak" checked the bottle and integrity appears good. Looks like bottle 1 "fits" at bottle 2 and bottle 2 came from bottle 1; switched and 1 looks good, 2 too high. JHS review: The salinity gradient near bottom is about 0.001 per 200 meters, the approximate spacing between 101 and 102. This is too small of a gradient to definitively make a judgement that the salt bottles were switched. Leave both salts as is, and leave both as code 2.
106	SiO3 value seems high vs pot temp and adjacent stations. JHS review: The SIO3 section contours through this and neighboring stations are almost identical in form to the CTDS contours from the full-resolution CTD data. SIO3 is thus correct for water mass. SiO3 are acceptable.

107 SiO3 value seems high vs pot temp and adjacent stations. JHS review: The SIO3 section contours through this and neighboring stations are almost identical in form to the CTDS contours from the full-resolution CTD data. SIO3 is thus correct for water mass. SiO3 are acceptable.

108 Value seems high vs pot temp and adjacent stations. JHS review: The SIO3 section contours through this and neighboring stations are almost identical in form to the CTDS contours from the full-resolution CTD data. SIO3 is thus correct for water mass. SiO3 are acceptable.

Station 47

205-208 CTDO2 Processor: ctdoxy up to 0.04 ml/l low compared to bottles in this area; but same small inflections near 4000db also on upcast. Code CTDO 3, questionable.

Station 48

103-107 CTDO2 Processor: ctdoxy up to 0.03 ml/l low compared to bottles in this area. Code CTDO 3, questionable.

106 SiO3 value seems high vs pot temp and adjacent stations, 106-108. JHS review: The SIO3 section contours through this and neighboring stations are almost identical in form to the CTDS contours from the full-resolution CTD data. SIO3 is thus correct for water mass. SiO3 is acceptable.

116 Three attempts for a good reading. High compared with CTD also. There must have been a salt crystal, the first reading did not make the salinity lower. Code salinity 3, questionable.

133 Salinity and oxygen appears low compared with CTD and station profile. JHS review: Bottle is in fine structure zone. Salt is OK. Salinity and oxygen are acceptable. JHS re-review: The D-C salt difference (0.024) is large enough to be suspicious, even though the difference is in the correct sense for the gradient and a flushing problem. But other salinity samples in this gradient do not show such a large offset from the CTD salinity. Hence this bottle salt may be a code 3 (questionable).

135 CTDC2 high by 0.25mS/cm relative to CTDC1. High gradient. CTDT2 high by 0.25deg.C relative to CTDT1. High gradient. Salinity appears high compared with CTD and station profile, oxygen looks reasonable. JHS review: Salt difference is OK for this layer. Salinity is acceptable.

Station 50

107 Top valve left open. JHS review: All bottle parameters appear to be okay.

135 CTDT2 high by 0.08deg.C relative to CTDT1/RefT. High gradient. Code secondary temperature 3, questionable.

Station 51

102 O2 value low vs pot temp, no analytical problem noted. JHS review: Bottle O2 is only about 0.010-0.014 ml/l low base on bottle-minus-CTDO above and below. Within specs. Oxygen is acceptable.

Station 52

101 Sample was overtitrated and backtitrated. Agrees with station profile and CTD, oxygen is acceptable. Three attempts for a good reading. Agrees with CTD data and station profile, salinity is acceptable.

104-107 CTDO2 Processor: ctdoxy up to 0.03 ml/l low compared to bottles in this area. Code CTDO 3, questionable.

107 Top valve slightly open. Oxygen as well as other parameters are acceptable.

109 Six attempts for a good reading. Tried the first reading, salinity still too high, must have had a salt crystal. Code salinity 4, bad.

113	Sample was overtitrated and backtitrated. Agrees with station profile and CTD, oxygen is acceptable.
115	Sample was overtitrated and backtitrated. Agrees with station profile and CTD, oxygen is acceptable.

Station 53

235	Four attempts for a good reading. Used first reading, salinity still very high, must have gotten a salt crystal. Code salinity 4, bad.

Station 55

112	Salinity appears a little high compared to CTD, gradient, data is acceptable.

Station 56

108	Bottle salinity is low compared with CTD, also low on stations comparisons. No analytical problems noted, code salinity 3, questionable.
129	Oxygen sample lost (perhaps improperly pickled and no endpoint).

Station 59

130	Top vent screw was not tight, open. Oxygen is acceptable.

Station 60

108	High for all nuts recheck peaks, real, data good. NO3 and PO4 108 and 109 are nearly identical. SIO3 lower on 109 than 108. Bottle salt and CTDS are nearly the same at both bottles. O2 on 109 is code 4 so cannot be used for check. No neighboring stations show this structure. Bottle 109 is nominal at 3144 db and 108 at 3348 db. CTDS and CTDO on down trace at station 060 show low-oxygen, low-salinity deep intrusion/finestructure in pressure range 3032-3560 db. Conclusion is that the samples from both 108 and 109 (except for O2 on 109) are all correct for oceanography and thus code 2.
109	ABORT. Could not come up with end point flask 1001 - did not titrate, nor overtitrate (pickling problem?). Oxygen sample lost.
123	Top vent open. JHS review: Bottle data looks okay.
124	Top vent open. JHS review: Bottle data looks okay.
136	Bottle tripped at about 700 meters, suspect that the carousel "latch" let loose. Code bottle 4 and all samples bad, did not trip as scheduled. Low for o2 high for nuts, niskin mistrip.

Station 61

201	Special CDOM cast, 9 bottles, no salinity, oxygen or nutrients.
317-318	Oxygen appears high as compared with station profiles. Vertical sections indicate a subtle, but similar feature in Sio3 and salinity. JHS review: At first these two oxygen values appeared suspicious. In several different types of plots, they did stand out. But the excellent agreement with the CTDS section indicated that we just crossed a little eddy or whatever in the water. Oxygen is acceptable.

Station 63

101-102	Oxygen samples lost due to equipment problem.
101-103	CTDO2 Processor: odd ctdoxy rise near bottom: no bottle data or nearby cast data available to peg it down. Code CTDO 3, questionable.
109-112	Line got caught on recovery, top cap of one of the bottles. Might have been opened briefly. JHS Review: No sign of data problem in any of these bottles.
123	Spigot found partially open. JHS review: Although bottle oxygen is 0.069 ml/l higher than CTD oxygen, this is not unusual for this gradient. Data are acceptable.

136	Surface bottle tripped on the fly due to choppy seas; used shorter average for CTD trip info to omit out-of-water data. Data are acceptable.
Station 64	
101	This is another of the stations with slightly higher NO3 relative to PO4. Does this coincide with any changes in the NO3 analyses? The data remain code 2 as this is only a point of interest. Nutrient analyst: the Cd column was topped off but the std factors are reasonable on the deep check sample was good.
106	Four attempts for a good reading. Used first reading, still a little low, code salinity 4, bad.
Station 65	
107	Vent was open. JHS review: Bottle oxygen difference with CTD is same as nearby bottles, other parameters are OK too. Data are acceptable.
136	Surface bottle tripped on the fly. Data are acceptable.
Station 66	
106	Salinity appears slightly high compared to CTD and station profile. Salinity bottle was run before 7, but it does not appear that these samples were switched. The salinity for bottle 7 does not fit the CTD salinity at the bottle 6 level. JHS review: "Slightly high" appears to mean "0.001-0.002". That is normal and within spec. Data Processor: Code salinity 3, questionable.
119	Although the O2 D-C difference (0.065 ml/l) is larger than for nearby samples, this sample was taken in an intrusion (seen easily on CTD trace) and so the difference is sensible. Leave as code 2 (good).
136	Surface bottle tripped on the fly. Data are acceptable.
Station 67	
136	Surface bottle tripped on the fly. Data are acceptable.
Station 68	
117	Salinity is high compared with CTD, gradient area, salinity is acceptable.
Station 69	
116	One of these bottles, 16-21 were "caught" with hook on recovery and opened slightly. Oxygen is high on bottle 16, this may have been the "hooked" bottle. SiO3 value high, peak is real, but data is questionable. Code as 4, bad, bottle was "leaking". Nutrient analyst: Only high for SiO3. NO3 and PO4 looked good. Since it was determined that the bottle was contaminated all samples should be coded 4. Salinity is ˜0.06 high compared with CTD. Code 4, bad.
125	Spigot leaking. JHS review: Data are acceptable.
136	Three attempts for a good reading. Agreement with CTD is reasonable; salinity is acceptable. Surface bottle tripped on the fly. Data are acceptable.
Station 70	
216	Bottle 16 was found to start leaking on Station 75. JHS reviewed data specifically on Stations 70-74, checking for leaking. The bottle did not leak on this station.
236	Surface bottle tripped on the fly. Data are acceptable.
Station 71	
113	Salinity ˜0.02 high compared with CTD and station profile. No analytical problems noted, but previous observations indicated that salinity bottles are sitting in the wash of the deck. Code salinity 4, bad. Oxygen appears reasonable. JHS review: Nutrients and oxygen look reasonable.
116	Bottle 16 was found to start leaking on Station 75. JHS reviewed data specifically on Stations 70-74, checking for leaking. The bottle did not leak on this station.

136	Surface bottle tripped on the fly. Data are acceptable.

Station 72

101	Four attempts for a good reading. Tried to use first reading, still too high, salt crystal must have gotten in the sample. Code salinity 4, bad.
114	Four attempts for a good reading. Tried to use first reading, still too high, salt crystal must have gotten in the sample. Code salinity 4, bad.
116	Bottle 16 was found to start leaking on Station 75. JHS reviewed data specifically on Stations and 70-74, checking for leaking. The bottle did not leak on this station.
136	Surface bottle tripped on the fly. Data are acceptable.

Station 73

101	Air vents were sheared off when rosette hit the side of the ship. Oxygen appears to be acceptable.
116	Three attempts for a good reading. Tried to use first reading, salinity still too high, salt crystal must have gotten in the sample. Salinity is high compared with CTD. Code salinity 3, questionable. Bottle 16 was found to start leaking on Station 75. JHS reviewed data specifically on Stations 70-74, checking for leaking. The bottle did not leak on this station.
131	Oxygen and salinity show same feature as did CTD, and CTD and bottle are in reasonable agreement for fine structure. Code 2.
135	Air vents were sheared off when rosette hit the side of the ship during recovery. Oxygen appears low, salinity high, nutrients are reasonable. JHS review: Samples, including O2, show no ill effects. Code 2 for bottle and associated parameters.
136	Surface bottle tripped on the fly. Data are acceptable.

Station 74

103	Oxygen low, analytical problem, check endpoint. Code oxygen 4, bad.
112	JHS review: Note from KMS regards 113 O2 and PO4 as low and SIO3 as high, or 112 O2 as high and SIO3 as low. Examination shows good agreement between CTD and bottle oxygens on both 112 and 113; code 2. The SIO3 value at 112 does appear to be low by ca. 4 uM, for example on SIO3 vs NO3 plot. Suggest reexamination of SIO3 peaks. If there are no corrections forthcoming, consider making 112 SIO3 code 3. Nutrient analyst: The problem is bottle 113. This was noted as high. The peak was rechecked and the data is real. Leave as code 2.
113	Oxygen low compared to adjoining stations. Code oxygen 3, questionable.
116	Nutrient sample tube found empty, bottles were dumped before the error was found. Bottle 16 was found to start leaking on Station 75. JHS reviewed data specifically on Stations 70-74, checking for leaking. The bottle did not leak on this station.
124	Four attempts for a good reading. Analyst lost track of number of flushes, sample 23 was analyzed twice. Code salinity 4, bad, could actually be removed from data set.
136	Surface bottle tripped on the fly. Data are acceptable.

Station 75

116	Oxygen high, SiO3 high, NO3 and PO4 low. There were no notes that the bottle was hooked on recovery, also strange that the SiO3 is high. Bottle was inspected and replaced before Station 078, new bottle is 37, until 16 can be repaired. Code bottle leaking and samples bad.
136	Surface bottle tripped on the fly. Data are acceptable.

Station 76

101	Top cap leak. JHS review: Top cap leak. Samples, including O2, show no ill effects. Code 2 for bottle and associated parameters.
116	Bottle appears to have leaked, was eventually replaced before Station 78. Code bottle 3, leaking and samples 4, bad.

Station 77

203	Tag line hook got caught on lanyard; not certain if bottle opened. JHS review: Samples, including O2, show no ill effects. Code 2 for bottle and associated parameters.
216	Bottle leaking, either o-ring or valve. Found that the lanyard was stretched. Replaced the bottle with number 37. Code bottle 3, leaking and samples 4, bad.
229	Oxygen draw temperature lower by 0.5 from deeper bottle and 0.2 from shallower bottle. JHS review: This is in good agreement with CTD profile, which showed a T minimum at this level.

Station 78

118	Top vent left open. JHS review: Oxygen data show no unusual high value. Also, bottle sample was taken near a portion of the profile with finestructure containing relatively high oxygen, so bottle oxygen is not unusual even if slightly high. The nutrients are, however, interesting, with relatively high SIO3 yet low NO3 and PO4, an unusual combination. That type of nutrient structure is not seen at adjacent stations, but the deviations are small enough to probably leave all nutrients for this bottle as code 2. Also, leave bottle code 2. Nutrient analyst: This is not an unusual combo; deeper in the profile shows (the no3 and po4 is lower and sio3 higher). Contamination from deeper somehow??
137	Prior to this cast bottle 16 was removed from service and replaced by bottle 37.

Station 80

112	Small leak, air vent. JHS review: Bottle and all parameters are good.

Station 81

223	Oxygen flask 1326: could not open flask; Broke and replaced with flask 1033, sample lost.

Station 84

104	Bottle was open, did not trip, no samples.

Station 85

107	Vent was open. JHS review: O2 - CTDO appears to be reasonable, as so all other parameters. Code 2.
131	O2 opened the bottle before CFC sampled.

Station 87

107	Small leak on bottom end cap. JHS review: O2 minus CTDO a little larger (0.039) than for neighboring bottles (typically near 0.02-0.03). Could indicate effect of a leak. Code bottle 3, sample 4, bad.
108	Sample tube was empty, nutrient samples not drawn.

Station 88

103	Salinity low compared with CTD, no analytical problems noted. Code salinity 3, questionable.
104	Did not trip, no samples.
123	Four attempts for a good reading. Analyst got mixed up on the sample, corrected data files and salinity is acceptable.
126	Six attempts for a good reading. Analyst got mixed up on the sample, corrected data files and salinity is acceptable.

Station 89

301	Cast 1 and cast 2 were aborted. On cast 1, it was diagnosed that the pump had a problem, it was replaced with 3277 and the cast was redeployed as cast 2. On cast 2, bottles 33 and 35 were lost when package was brought out of the water just after deployment because a tag line was caught. The package was two-blocked. These bottles were replaced with 37 and 38, respectively.
319	Bottle did not trip. Trip arm cleaned after the cast.
329	Salinity high compared with CTD, no analytical problems found, agrees with adjacent stations. Primary CTD sensors contaminated by organic matter, used secondary T/S for CTD bottle values
330	Salinity high compared with CTD, no analytical problems found, agrees with adjacent stations.

Station 91

109	Bottle salinity is low compared with CTD. No analytical problem noted. Other parameters look reasonable. Code salinity 4, bad.

Station 92

102	Adjustment on autosal made the samples run a little too fast, causing high conductivity readings. Analyst corrected for the fast flow by the fifth sample. Code salinity 3, questionable.
119	Salt D-C of 0.005 is a bit large for this portion of the water column. May be code 3? Processor review: Suspect drawing error with 20, no other analytical problems noted. Code salinity 3, questionable.

Station 94

223	Large difference with CTD, gradient area, salinity is acceptable.

Station 96

304	Oxygen flask 1156, stopper 616 mixup. Code oxygen 4, bad.
305	Oxygen flask 616, stopper 1156 mixup. Code oxygen 4, bad. Salinity is high compared with CTD and station profiles. Appears to be a drawing error. Code salinity 4, bad. Other parameters appears acceptable.
312	Salinity is high compared with CTD and station profiles. Code salinity 4, bad. Other parameters appears acceptable.
328	UV noise interference; no data. Oxygen was lost.

Station 97

118	Top vent open. Oxygen as well as other data appear reasonable.
119	Three attempts for a good reading. All readings are close to one another, first reading makes salinity even higher. Code salinity 4, bad.
121	Top vent open. Oxygen as well as other data appear reasonable.

Station 98

125	Large difference with CTD, gradient area, salinity is acceptable.

Station 100

215	Salinity is high compared with CTD by about 0.002. No analytical problem noted.
229	Bottle accidentally tripped on the fly. Oxygen as well as other parameters are acceptable.

Station 101

104	Salinity appears slightly low compared with CTD and station profile. JHS review: Salt was coded 3 because it was seen as "slightly low compared with CTD and station profile". But, salinity agrees in third decimal place with CTDS and both fit profile. Change to code 2.

Station 102

103	Bottle salinity is low compared with CTD and station profiles. No analytical problems noted. Code salinity 3, questionable. JHS review: There is a small D-C salt difference (0.003 for 103). This exceeds the 0.002 standard for deep water. Okay to leave as code 3.
104	Bottle salinity is low compared with CTD and station profiles. No analytical problems noted. Code salinity 3, questionable. JHS review: There is a small D-C salt difference (0.002 for 104). But this is noticeable only because variability in the deep water is so small. The size of the difference relative to the expected data quality (which ODF appears to be routinely improving upon) would argue for a code 2. Salinity is acceptable.
105	Bottle salinity is low compared with CTD and station profiles. No analytical problems noted. Code salinity 3, questionable. JHS review: There is a small D-C salt difference (0.002 for 105). But this is noticeable only because variability in the deep water is so small. The size of the difference relative to the expected data quality (which ODF appears to be routinely improving upon) would argue for a code 2. Salinity is acceptable.
111	Bottle salinity is low compared with CTD and station profiles. No analytical problems noted. Code salinity 3, questionable.
126	Three attempts for a good reading. First reading made little difference; leave as is. Gradient, salinity is acceptable.

Station 103

107	Check endpoint; UV noise. Data was checked and recalculated. Oxygen is acceptable. Bottle salinity is high compared with CTD and station profiles. No analytical problems noted. Code salinity 3, questionable. JHS review: There is a small D-C salt difference (0.002). But this is noticeable only because variability in the deep water is so small. The size of the difference relative to the expected data quality (which ODF appears to be routinely improving upon) would argue for a code 2. Data Processor: Code salinity 3, questionable.
125	Three attempts for a good reading. Readings were very close made little difference, leave as is. Gradient, salinity is acceptable.

Station 104

205	Salinity is low compared with CTD and station profile could have been a poor seal. Code salinity 3, questionable. JHS review: There is a small D-C salt difference (0.002 for 205). But this is noticeable only because variability in the deep water is so small. The size of the difference relative to the expected data quality (which ODF appears to be routinely improving upon) would argue for a code 2.

Station 105

104	Salinity low compared to CTD and station profile. Rechecked bottles in case B and bottles appear dirty. Code salinity 3, questionable. JHS review: There is a small D-C salt difference (0.002 for 104). But this is noticeable only because variability in the deep water is so small. The size of the difference relative to the expected data quality (which ODF appears to be routinely improving upon) would argue for a code 2. Salinity is acceptable.
105	Salinity low compared to CTD and station profile. Rechecked bottles in case B and bottles appear dirty. Code salinity 3, questionable. JHS review: There is a small D-C salt difference (0.002 for 104). But this is noticeable only because variability in the deep

water is so small. The size of the difference relative to the expected data quality (which ODF appears to be routinely improving upon) would argue for a code 2. Salinity is acceptable.

Station 106

119	Leaks at bottom end cap. Oxygen as well as other parameters are acceptable.
128	Bottle salinity is high compared with CTD, gradient area salinity is okay.

Station 107

108	Salinity high compared to CTD and station profiles. No analytical problems noted. Other parameters are acceptable. Code salinity 3, questionable.
117-118	Bottles tripped together as per sampling schedule.
119	Top vent open. Oxygen as well as other samples are acceptable.

Station 108

303	Bottle salinity is low compared with CTD and station profiles Other parameters are acceptable. Code salinity 3, questionable. JHS review: A most unfortunate group of deep water bottle salts. No analytical or sampling problems, but many of the deep salts on this station are simply not up to expected data quality. There is no evidence in the CTDS profile of the salinity structure illustrated by these bottle salinities. Suggest coding salinity 4, bad.
305	Bottle salinity is low compared with CTD and station profiles Other parameters are acceptable. Code salinity 3, questionable. JHS review: A most unfortunate group of deep water bottle salts. No analytical or sampling problems, but many of the deep salts on this station are simply not up to expected data quality. There is no evidence in the CTDS profile of the salinity structure illustrated by these bottle salinities. Suggest coding salinity 4, bad.
307-309	Bottle salinity is low compared with CTD and station profiles Other parameters are acceptable. Code salinity 3, questionable. JHS review: A most unfortunate group of deep water bottle salts. No analytical or sampling problems, but many of the deep salts on this station are simply not up to expected data quality. There is no evidence in the CTDS profile of the salinity structure illustrated by these bottle salinities. Suggest coding salinity 4, bad.
311	Bottle salinity is low compared with CTD and station profiles Other parameters are acceptable. Code salinity 3, questionable. JHS review: A most unfortunate group of deep water bottle salts. No analytical or sampling problems, but many of the deep salts on this station are simply not up to expected data quality. There is no evidence in the CTDS profile of the salinity structure illustrated by these bottle salinities. Suggest coding salinity 4, bad.
312	Bottle salinity is low compared with CTD and station profiles. Other parameters are acceptable. Code salinity 3, questionable.
317	Bottle salinity is low compared with CTD and station profiles. Other parameters are acceptable. Code salinity 3, questionable.
320	Bottle salinity is low compared with CTD and station profiles. Other parameters are acceptable. Code salinity 3, questionable.

Station 110

101	Sample was overtitrated and backtitrated. Oxygen is acceptable.
103	Sample was overtitrated and backtitrated. Oxygen is acceptable.
106	Three attempts for a good reading. Used first reading, salinity crystal must have gotten in the sample. Salinity is acceptable.

108	Salinity 0.002 high compared to CTD and station profile. There was some confusion on the analyst's part and this sample was run out of order. Suspect that issue was not resolved. Code salinity 4, bad.
110	Top vent open. Oxygen is acceptable. JHS review: All parameters look normal. No effect from top vent open.
119-129	Bottles fired on the fly; large growler on starboard side. JHS review: No unusual data problems noted from closing bottles on the fly. O2 D-C differences are perhaps a small amount larger than normal, but there are no data problems warranting a code 3 or 4.
122	Five attempts for a good reading. Used first reading, salinity crystal must have gotten in the sample. Salinity is acceptable.
124	Four attempts for a good reading. Used first reading, salinity crystal must have gotten in the sample. Salinity is about 0.001 high, but within measurement limits.

Station 111

201	Tag line caught in lids and opened bottles on recovery. JHS review: No oxygen data problems noted from interference of tag line with top caps during recover. Oxygen D-C values are normal.
202	Salinity is low compared to station profile and CTD comparison. No analytical problem noted. Code salinity 4, bad.
203	Salinity is low compared to station profile and CTD comparison. No analytical problem noted. Code salinity 4, bad.
205	Tag line caught in lids and opened bottles on recovery. JHS review: No oxygen data problems noted from interference of tag line with top caps during recover. Oxygen D-C values are normal.
207	Tag line caught in lids and opened bottles on recovery. JHS review: No oxygen data problems noted from interference of tag line with top caps during recover. Oxygen D-C values are normal.
214	Salinity is low compared to station profile and CTD comparison. No analytical problem noted. Code salinity 4, bad.

Data Processing Notes

Date	Contact	Data Type	Data Status Summary
3/21/05	Johnson	CTD/BTL/SUM	Submitted Prelim. Data & CTD Report

Updated March 21, 2005

CLIVAR - P16S-2005

PRELIMINARY CTD + BOTTLE DATA AND ODF DOCUMENTATION

Preliminary CTD and Bottle data are available in both WHP90.1 format (.sum/.hyd/.ctd) and WHP-exchange format (_hy1.csv/_ct1.csv). Descriptions of both formats can be found at "http://whpo.ucsd.edu" by clicking in the "Formats" section. (Note that the filename extensions on the WHPO/CLIVAR website may be out of date.)

The files named "P16S-2005*.zip" were created with the Linux zip (v2.3) utility for the benefit of PC users. The data can be expanded into the directory "./P16S-2005" using "unzip" or "pkunzip" utilities. Note that pkunzip 2.04g/unzip 5.0p1 (or later versions) must be used to extract files produced by pkzip 2.04 or zip 2.3. Earlier versions are not compatible.

CONTENTS of the directory ./P16S-2005 (approximately 39 Mbytes expanded), broken down by .zip-file contents:

P16S-2005-hy+misc.zip (5.7 megabytes expanded)

README.P16S	comments regarding prelim. data release/documentation
P16SDoc.pdf	prelim. documentation in Adobe pdf format
P16SDoc.ps	prelim. documentation in PostScript format
P16SDoc.txt	prelim. doc. in ascii/plain text - no figures
p16s.sum	WHP90-1/rev.2 (WOCE) format station-cast description file
p16s.hyd	WHP90-1/rev.2 (WOCE) format bottle data
p16s_hy1.csv	WHP-Exchange format bottle data
p16s-tm_hy1.csv	WHP-Exchange format Trace Metal bottle data

(sss = station number cc = cast number)

P16S-2005_ctd.zip	(16.5 megabytes expanded)
p16s_ssscc.ctd	WHP90-1/rev.2 (WOCE) format CTD data (stations 1-111)
115 casts	(2 each for stas 9,31,61,93)
P16S-2005_ct1.zip	(15.7 megabytes expanded)
p16s_ssscc_ct1.csv	WHP-Exchange format CTD data (stations 1-111)
115 casts	(2 each for stas 9,31,61,93)
P16S-2005-TM_ct1.zip	(1.1 megabytes expanded)
p16s-tm_ssscc_ct1.csv	WHP-Exchange format Trace Metal CTD data 45 casts (stations 1-111)

Note that there is no Trace Metal CTD data for station 00102:
the data were lost after the cast.

(more)

Data Processing Notes

Date	Contact	Data Type	Data Status Summary
3/21/05	Johnson	CTD/BTL/SUM	Submitted Prelim. Data & CTD Report (continued)

Non-standard parameter numbers used in .sum file (samples taken but measurements not reported yet) are listed below:

101	Carbohydrates
102	CDOM (Chromophoric Dissolved Organic Material)
104	Chlorophyll
106	Represents two measurements (taken on same station/bottle): Particulate Absorption Spectra and Microsporin Like Amino Acids High-Pressure Liquid Chromatography Phytoplankton Pigments
107	Bacteria Growth Rate
111	N-15

All other parameter numbers are taken directly from Appendix G from the WHPO 90-1/rev.2 manual (see http://whpo.ucsd.edu/manuals.htm).

Bottle and CTD data and quality codes, plus calibration and processing comments and figures in the documentation, were last updated at the end of the cruise, before the ship reached port. All these data and documentation, including possible future updates to ODF data, are also available at the ODF cruise website:

http://sts.ucsd.edu/cruises/p16s/hydro

Logging in may be required in order to access the ODF data; updates to cruise data should be made directly to the CLIVAR/WHPO office.

The ".pdf" documentation file can be printed out using Adobe Acrobat Reader, freely available at the following website:
http://www.adobe.com/products/acrobat/readstep.html

The ".txt" version of the documentation is available for those who cannot use the ps/pdf versions. Note that figures in the documentation can only be printed with the ps/pdf versions and do not appear in the ascii version. Also, the ascii files are intended to be printed out at 80 lines per page with a 90-character page width - typically elite print. The right margin of the ascii version is staggered and lines do not begin with any white space at the request of PIs who wish to merge parts of the ascii file into other cruise documentation.

QUESTIONS:

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(more)

Data Processing Notes

Date	Contact	Data Type	Data Status Summary
3/21/05	Johnson	CTD/BTL/SUM	Submitted Prelim. Data & CTD Report (continued)
	Questions regarding ODF data should be directed to: Bottle: Kristin M. Sanborn STS/ODF, Mail Code 0214 SIO/UC San Diego 9500 Gilman Drive La Jolla, CA 92093-0214 phone: (858) 534-1903 email: ksanborn@ucsd.edu CTD: Mary Carol Johnson (same address) phone: (858) 534-1906 email: mary@odf.ucsd.edu		
3/22/05	Sloyan	Cruise Report	Submitted
	Attached is the Chief and Co-Chief Scientists report for P16S 2005 - CCHDO/WHPO expedition code 33RR200501 (Sloyan and Swift).		
3/31/05	Kappa	Cruise Report	ASCII and PDF Versions made
	Both Include PI and ODF reports		