Cruise Report
Last Updated 2000.05.25

WOCE Designation:
I4-I5W-I7C

Expocode:
316N145_9

Chief Scientist:
John Toole

Master:
Carl Swanson

Ship:
Knorr

Port of Call:
Louis, Mauritius - Durban,
South Africa – Port Louis, Mauritius

Cruise Dates:
June 11 - July 11, 1995

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1. Overview:

This leg of the Indian Ocean WHP study focussed on the southwest region of this ocean, where the southward directed Agulhas Current is born, and where dense waters that filter through fractures in the Southwest Indian Ridge form a northward directed deep boundary current east of Madagascar. Both represent major circulation features of the Indian Ocean; the Agulhas, one of the 3 or 4 largest currents on the globe, being the western boundary current of the southern hemisphere subtropical gyre, the DWBC being responsible for renewing the bottom waters of the Madagascar, Mascarene and Somali Basins to the north.

The I4-5W-7C cruise was planned in coordination with the preceding and following legs of the expedition, in light of previous hydrographic sampling in the region. The I4 leg across the Mozambique Channel extended the I3 section work (from Australia to Madagascar) to the African shelf. A meridional segment along Long. 54 30' between 33 30' and 19 S joins a French section running south to the Antarctic continent (I7S) to the U.S. line I7 beginning NW of Mauritius and extending to the Arabian Peninsula. Quasi-zonal section work along approximately 32S across the Agulhas Current, a reoccupation of the western end of a 1987 pre-WOCE section, was aligned with a British moored current meter array that is midway in it's deployment. Lastly, together with the western segment of the I3 section west of Long. 54 30'E, our sampling program defined a closed box of hydrographic casts, suitable for applying conservation statements to aid in deducing the absolute circulation.

A total of 134 full-water-column CTD/O2 stations were occupied on the track shown in Figure 1.1, with water samples collected at up to 36 levels during the up-casts. Samples were analyzed aboard for salinity, dissolved oxygen, silica, nitrate, nitrite, phosphate, CFC-11 and -12, total carbon and alkalinity, and chlorophyll. Samples were drawn (and in some cases extracted) for shore-side analysis of 3 He, 3 H, 14 C and barium. A Lowered Acoustic Doppler Current Profiling (LADCP) system was mounted aboard the underwater package and returned full-depth profiles of direct velocity measurements. Five-minute vector averaged upper ocean velocity data was acquired with a hull-mounted ADCP, and intake temperature, salinity and surface meteorology was logged at 1-minute interval by the Knorr's underway system. Lastly, due to the efforts of Prof. W.Krauss (I.f.M. Kiel) and R.Peterson, a suite of 40 surface drifters was made available for deployment along our cruise track. These instruments were drogued at 100-m with a 'holey sock' type drag element.

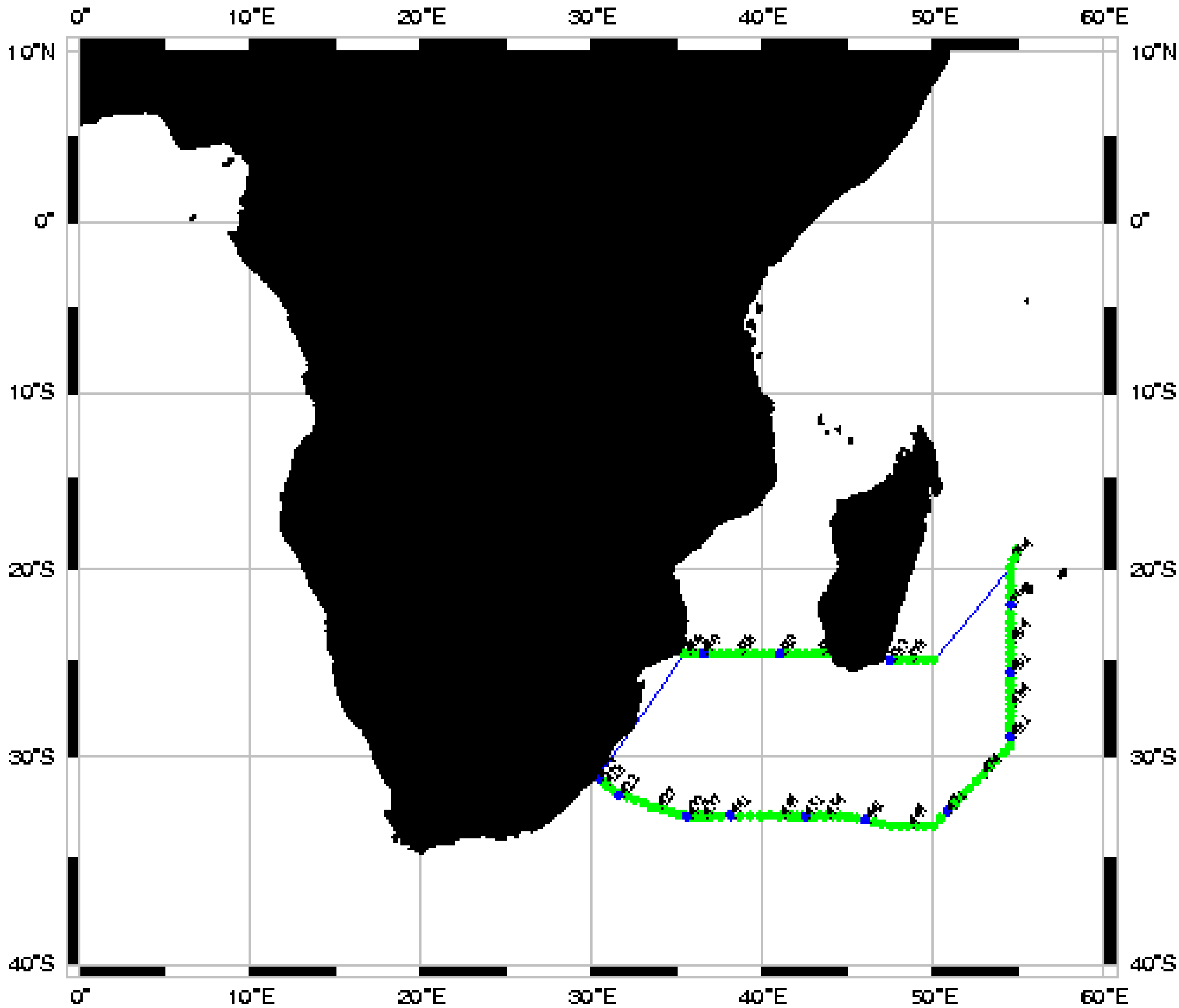


Figure 1.1. Station positions and cruise track for Indian Ocean WHP Leg I4-5W-7C

The scientific party consisted of 27 technicians and scientists, representing 10 laboratories and 4 countries.

Table 1.1. Scientific party aboard Knorr cruise 145-9: WHP line I4-5W-7C with major responsibility and home institution.

Emidio Andre	IIP	watch stander
Marie-Claude Beaupre	SIO/ODF	nutrient analyst
Scot Birdwhistell	WHOI	tritium/shallow helium
Steve Covey	UW	CFC analyst
Frank Delahoyde	SIO/ODF	technician in charge
Albert Fischer	MIT/WHOI	ADCP/LADCP
Scott Hiller	SIO/ODF	electronics technician/salts
Alistair Hobday	SIO/UCSD	watch stander
Jules Hummon	SOEST/UH	ADCP/LADCP
Rhonda Kelly	SIO/ODF	nutrient analyst
Tonalee Key	Princeton	14 C, underway CO2
Ernie Lewis	BNL	CO2
Leonard Lopez	SIO/ODF	oxygen analyst
Jean Maharavo	CNRO	watch stander
Kevin Maillet	RSMAS/U.M.	CFC analyst
Joanna Muench	WHOI	watch stander
David Muus	SIO/ODF	watch leader/bottle data
Ron Patrick	SIO/ODF	oxygen analyst
Ray Peterson	SIO	co-PI
Linda Pikanowski	BNL/SHML	CO2
Noasy Tovo		
Razakafoniaino	CNRO	watch stander
Michael Thatcher	WHOI	SSSG technician
John Toole	WHOI	chief scientist
Jim Wells	SIO/ODF	watch leader/salts
Ralf Weppernig	LDEO	deep helium
Rick Wilke	BNL	CO2
Michelle Zotz	BNL	CO2

WHOI: Woods Hole Oceanographic Institution
SIO: Scripps Institution of Oceanography
ODF: Oceanographic Data Facility
IIP: Instituto de Investigacao Pesqueira, Mozambique
UW: University of Washington
MIT: Massachusetts Institute of Technology
UCSD: University of California at San Diego
SOEST: School of Ocean and Earth Science and Technology
UH: University of Hawaii
Princeton: Princeton University

BNL: Brookhaven National Laboratory
CNRO: Centre National de Recherches Oceanograpiques, Madagascar
RSMAS: Rosenstiel School of Marine and Atmospheric Sciences
UM: University of Miami
SHML: Sandy Hook Marine Laboratory

2. Cruise Summary:

The I4-5W-7C leg was staged from Port Louis, Mauritius. Little in the way of cruise set-up in port was required since the same principal technical groups that supported the preceding I3 leg would also man ours (excepting the CFC analysis group). Chief concern for the leg lay with the state of the two conducting cables aboard, used to support the CTD/rosette work. One wire was very rusty and had a broken strand at approximately 4000 m along its length. However this cable had three functional conductors. (Normal SIO/ODF operations utilize all three: two to power the CTD instrumentation and acquire data, one to communicate and power the rosette.) The second, newer, wire had only two functional conductors (as reported by the I3 investigators.) Provision had been made by the WHOI Port Office to ship a third wire and drum to Durban, South Africa and for us to stop enroute between the I4 and I5W legs and pick it up. Operations began with the underwater instrumentation mounted on the older wire. A disappointment prior to sailing was the failure of a P-Code key for the GPS receiver to initiate full-accuracy positioning information. The cruise began with dithered navigation data as the chief source of navigation information.

The vessel departed on schedule at 0900 local on June 11 (GMT+4). Our first work consisted of a station (574) at 20S 54 30'E, a (near) reoccupation of a station from the previous leg (and site of one of the last stations to be occupied on our leg. Repeated stations were done to document short-term variability.) At the suggestion of the I3 investigators, a short section along 25S at the SW tip of Madagascar was added to the sampling plan to investigate the meridional extent of a curious thermocline velocity structure they observed at 20S. The vessel transited to 25S 50E, arriving June 13 0500Z, and we proceeded to occupy a 10-station full-depth section into the Madagascar coast (stations 575-584 with end station in 95 m of water). Along the section surface drifters and ALACE's were deployed. From there we transited around the southern end of the island to the start of the I4 line along 24 40'S. Enroute, vessel testing in advance of an upcoming U.S. Coast Guard inspection was carried out. At the completion of this activity, the vessel's bow thruster failed to stow correctly. The unit was retracted manually, but was deemed inoperable and not repairable at sea. Normal hydrographic station keeping does not require the bow thruster.

The I4 leg was commenced at 2025Z on June 15 with station 575 in 970 m of water within 1 nmi of the Madagascar beach. Stations were worked westward at maximum horizontal spacing of 30 nmi. Headwinds kicked up mid-way across the Channel making progress uncomfortable and a bit slower than usual (9 knots versus 11). During station 605 as the underwater frame was held at the surface in preparation for the lowering, a ship roll induced a major snap load on the sea cable. On recovery after the station a kink was discovered in the wire approximately 10 m above the package. The initial plan was to shift operations to the other cable but it was found to have only one functioning conductor. (Somehow a conductor failed between when this cable was used on I3 and our attempted use on I4 as it just sat on the drum!) After a retermination of the older wire, operations continued without incident. The I4 line was completed at 1800 on June 19 with a station in 100 m of water 2 nmi from the Mozambique coast. The I4 line consists of stations 585 to 610; drifters and ALACE's were also deployed along the section.

The planned stop in Durban, South Africa was the next order of business. We arrived at the pilot station at 0800 local on June 21 and were secured dockside by 1100. The replacement drum and wire was installed in place of the cable with failed conductors by 1500. The ship's engineering staff, with the support of field engineers from Lipps, worked to attempt repair of the bow thruster. In the end they were not successful but as noted above, this had no effect on subsequent science operations. After a night in Durban, the vessel returned to sea at 0800 local on June 22, and proceeded south to the start of the I5W line. Just prior to sailing, a replacement GPS unit arrived and was installed. This unit reported full P-Code position information.

Enroute to station 611, the ship was diverted west of the rhumb line to deploy surface drifters upstream of the I5W line. The coastal station site was reached at 1500 on June 22 whereupon station work was resumed. As noted above, this segment of the cruise reoccupied stations collected in 1987. A subset of these stations were also occupied by the Baldridge (A.Ffield, chief scientist) in March of this year. The I5W WHP station line was shifted approximately 1 nmi southwest of the 1987 section to avoid fouling current meter moorings deployed by H.Bryden (Rennell Centre, Southampton) in an array across the Agulhas Current. During station 619 communication between the underwater rosette pylon and the laboratory became intermittent. In this state triggering of water samples was impossible and the up-cast was terminated. This time the problem was ultimately narrowed to the wiring harness connecting the underwater instrumentation to the sea cable (i.e. not the cable itself). Cast 2 (with full suite of water samples on upcast) was run on the back-up wire while the new wire was reterminated. Operations then shifted back to the new wire for the balance of the cruise.

An extreme drop in bottom depth between stations 636 and 637 was responsible for the chief scientist missing a wrap on the echo sounder recording. Station 637 was actually terminated approximately 750 m above the bottom. Cast 1 of station 638 was also short by this distance. When the error was discovered, the ship was directed back to the site of station 638 whereupon cast 2 was taken to within 10 m of the bottom. Stations 637 and 638 were separated by less than 10 nmi, the missed bottom data at 637 was deemed acceptable.

Westerly winds 25 knots and higher built in during June 30 and in the early evening of the 1st the strong cold front responsible passed over the ship. Sustained winds increased to over 30 knots with gusts to 40-50 knots. As the winds were behind the vessel on transits, time between stations was not affected. However, the large seas that built forced slow winch operations to minimize shock loading the wire. Conditions grew marginal, but operations were not halted as with time the seas abated. The southeasternmost station, 669, was completed on July 2 shortly after the front passage, and the cruise track turned northeast (as the wind veered southwest). This marked the point where the present cruise diverged from the 1987 section.

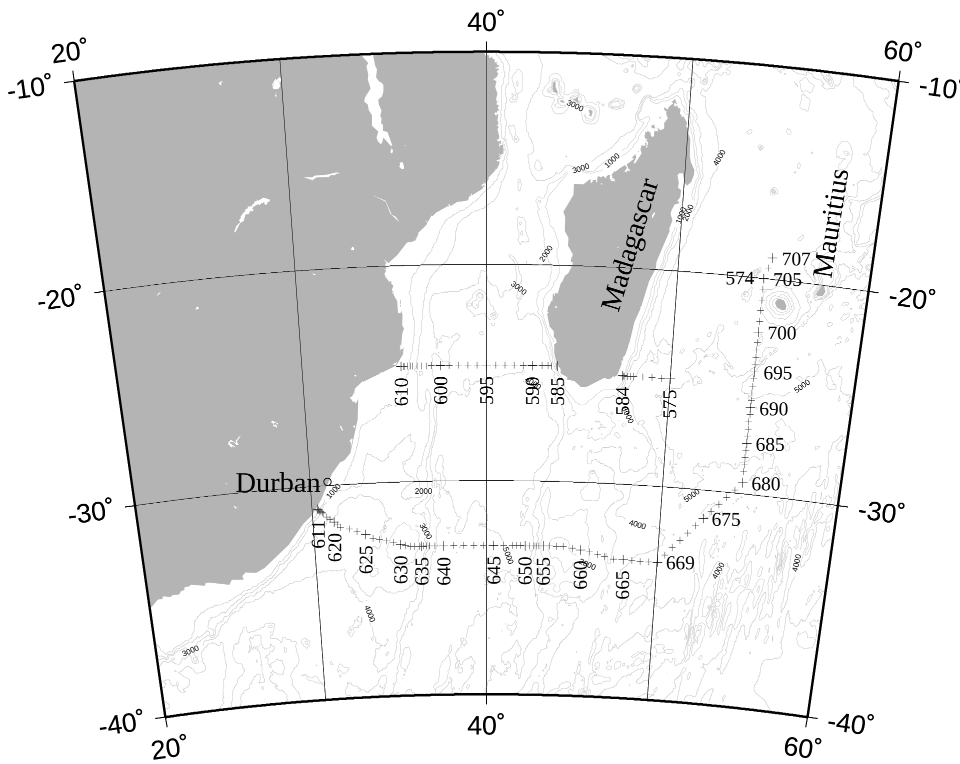
The vessel track ran northeast to station 680 at 29 30'S 54 30'E, and subsequently turned due north. Given that no time had been lost to weather on the cruise (the only delay being the 1 day in Durban), and station times and transit speeds had been fast, it was decided to increase station resolution across the Madagascar Basin. The Baldridge cruise in March documented two features warranting closer study: a westward directed jet of bottom water presumably originating at the Atlantic II Fracture Zone (Swallow and Pollard, Deep-Sea Res., 35, 1437-1440, 1988) and a subtropical convergence front; both around 29-24S. Station spacing was reduced to 20 nmi between 29 and 23 S.

Station 705 at 20S 54 30'E reoccupied station 574, the first station of this cruise. In order to facilitate linking the I7C section with D.Olson's planned I7N stations, two additional stations were occupied to the northeast. Station 707 was completed at 1700 on June 10, and the vessel turned for Port Louis, Mauritius. Arrival was as scheduled on June 11 at 1000. Due to the excellent weather, good condition of the scientific and ship's equipment, and fast transit times between stations, the contingency time allocated for the cruise exceeded that needed (the 1 day in Durban). A total of 20 stations beyond that originally planned were occupied with the available time.

Reports of the individual scientific teams:

World Ocean Circulation Experiment
Indian Ocean I4/I5W/I7C
R/V Knorr Voyage 145 Leg 9
11 June 1995 - 11 July 1995
Port Louis, Mauritius - Port Louis, Mauritius
Expocode: 316N145/9

Chief Scientist: Dr. John M. Toole
Woods Hole Oceanographic Institution



I4/I5W/I7C Cruise Track

Oceanographic Data Facility (ODF)
Final Cruise Report
31 March 2000

Data Submitted by:

Oceanographic Data Facility
Scripps Institution of Oceanography
La Jolla, CA 92093-0214

DESCRIPTION OF MEASUREMENT TECHNIQUES AND CALIBRATIONS

1. Basic Hydrography Program

The basic hydrography program consisted of salinity, dissolved oxygen and nutrient (nitrite, nitrate, phosphate and silicate) measurements made from bottles taken on CTD/rosette casts, plus pressure, temperature, salinity and dissolved oxygen from CTD profiles. 136 CTD/rosette casts were made at 134 stations, usually to within 5-10 meters of the bottom. Two CTD casts are reported at stations 619 and 638. Station 619 cast 1 was aborted at ~2700m on the down-cast because communication with the pylon was lost. The problem was narrowed down to the rosette harness, which was changed out prior to station 619 cast 2. The ocean bottom depth on the PDR was mis-read prior to station 637 cast 1, so stations 637 and 638 cast 1 were 750m shallower than intended. The error was noticed while the ship was transiting toward station 639, so the ship returned to station 638. Station 638 cast 2 was then lowered to the correct maximum depth; station 637 was not repeated.

The ship departed from Port Louis, Mauritius on June 11, 1995. Station 574 was completed ~4 miles east of I3 station 548. Stations 575-584 were done along 25°S from 50°E to the east coast of Madagascar. Stations 585-610 (I4) were occupied along 24°40′S, from the west coast of Madagascar to the South African coast. The ship was diverted to Durban, S.Africa, for a 1-day port stop. Various ship repairs were attempted and a new drum/wire were picked up to replace the Port-winch cable, which had a bad conductor. Stations 611-669 (I5W) were along a line roughly eastward from the South African coastline at ~31°S, to 33°30′S 50°E. Stations 670-679 ran in a northeasterly direction to link up with the I7C line. Stations 680-705 (I7C) were done along 54°30′E from 29°30′S to 20°S, where station 705 was done at the same location as station 574. Stations 706-707 (also I7C) were done slightly northeastward of the I7C line to link up with the upcoming I7N line at 55°E. The cruise returned to Port Louis on July 11, 1995.

4017 bottles were tripped resulting in 4010 usable bottles. No insurmountable problems were encountered during any phase of the operation. The resulting data set met and in many cases exceeded WHP specifications. The distribution of samples is illustrated in Figures 1.0 through 1.2.

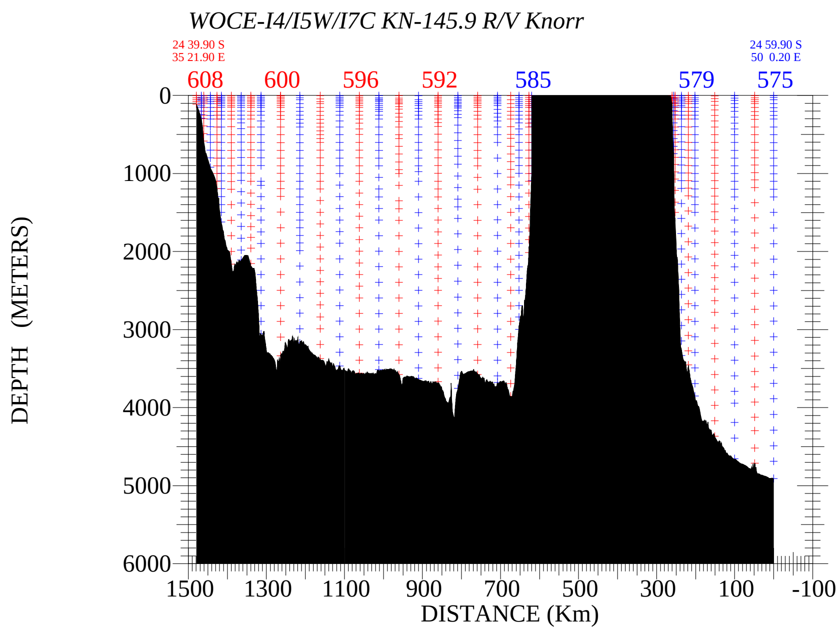


Figure 1.0 Transit-1 + I4 sample distribution, stas 575-610

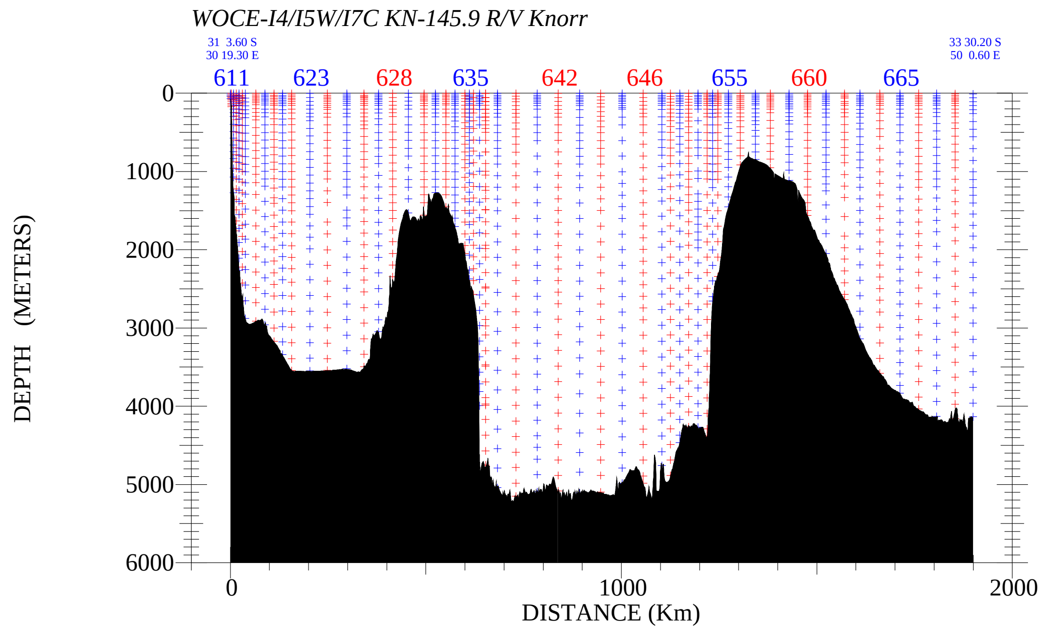


Figure 1.1 I5W sample distribution, stas 611-669

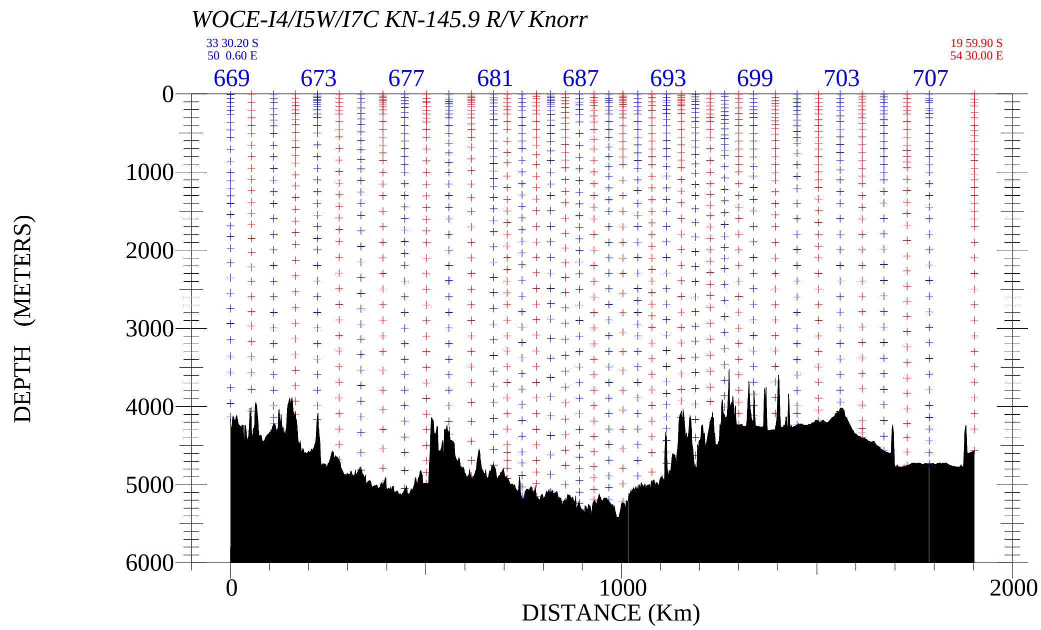


Figure 1.2 Transit-2 + I7C sample distribution, stas 670-707 + 574

2. Water Sampling Package

Hydrographic (rosette) casts were performed with a rosette system consisting of a 36-bottle rosette frame (ODF), a 36-place pylon (General Oceanics 1016) and 36 10-liter PVC bottles (ODF). Underwater electronic components consisted of an ODF-modified NBIS Mark III CTD (ODF #1) and associated sensors, SeaTech transmissometer (TAMU), RDI LADCP (UofH), Benthos altimeter and Benthos pinger. The CTD was mounted horizontally along the bottom of the rosette frame, with the transmissometer, a SensorMedics dissolved oxygen sensor and an FSI secondary PRT sensor deployed next to the CTD. The LADCP was vertically mounted to the frame inside the bottle rings. The altimeter provided distance-above-bottom in the CTD data stream. The pinger was monitored during a cast with a precision depth recorder (PDR) in the ship's laboratory. The rosette system was suspended from a three-conductor 0.322" electro-mechanical cable. Power to the CTD and pylon was provided through the cable from the ship. Separate conductors were used for the CTD and pylon signals. The transmissometer, dissolved oxygen, secondary temperature and altimeter were interfaced with the CTD, and their data were incorporated into the CTD data stream. Deep Sea Reversing Thermometers (DSRTs) were used occasionally on this leg to monitor for CTD pressure or temperature drift.

The deck watch prepared the rosette approximately 45 minutes prior to each cast. All valves, vents and lanyards were checked for proper orientation. The bottles were cocked and all hardware and connections rechecked. Time, position and bottom depth were logged by the console operator at arrival on station. The rosette was deployed from the starboard side of the main deck. Each rosette cast was lowered to within 5-10 meters of the bottom, unless the bottom returns from both the pinger and altimeter were extremely poor. Stations 637 and 638, casts 1, were lowered to a little more than 750m off the bottom due to an error in reading the PDR output from a steep underway section.

Bottles on the rosette were each identified with a unique serial number. Usually these numbers corresponded to the pylon tripping sequence, 1-36, where the first (deepest) bottle tripped was bottle #1. There were three stations where the bottles were tripped in a special sequence for freon blank checks. The trip sequences, deepest to shallowest, for these stations were bottles 18-36, then 1-17, at station 691; and bottles 30-36, then 1-29, at stations 692 and 693.

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

Recovering the package at the end of deployment was essentially the reverse of the launching with the additional use of air-tuggers for added stabilization. The rosette was moved into the starboard-side (forward) hangar for sampling. The bottles and rosette were examined before samples were taken, and any extraordinary situations or circumstances were noted on the sample log for the cast.

Routine CTD maintenance included soaking the conductivity and CTD O_2 sensors in distilled water between casts to maintain sensor stability. The rosette was stored in the rosette room between casts to insure the CTD was not exposed to direct sunlight or wind in order to maintain the internal CTD temperature near ambient air temperature.

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

The transmissometer windows were cleaned prior to deployment approximately every 20 casts. The air readings were noted in the TAMU transmissometer log book after each cleaning. Transmissometer data were monitored for potential problems during every cast.

The R/V Knorr's starboard CTD winch was used during stations 574 through 610. A broken armor strand at about 4000m on this wire was inspected on up-casts deeper than 4000 meters, and re-taped as needed.

New CTD wire had been installed on the port winch at the start of the I3 leg, but it developed a short in one conductor during I3. An attempt was made to use it after station 605, while the starboard wire was being reterminated, but a short had developed in another conductor in the port wire. A new drum/wire were installed on the port winch during the Durban port stop.

The new port wire was used for the rest of the leg with one exception. A communication problem with the pylon caused station 619 cast 1 to be aborted. After two attempts to restart the cast, it was assumed the wire needed reterminating. The rosette was switched to the starboard wire, and another cast attempt failed. The problem was narrowed down to the rosette harness, and the 5th attempt at station 619 was successful (called cast 2). The rosette was switched back to the port wire after this cast.

After the last I4/I5W/I7C cast (station 707), the broken-strand starboard wire was paid out to 3800m, then rinsed off during recovery. Approximately 1500m of wire were cut off, and this drum/wire were replaced with new wire during the leg-end port stop in Port Louis. The old starboard wire was stowed in the hold as a spare.

3. Underwater Electronics Packages

CTD data were collected with a modified NBIS Mark III CTD (ODF #1). This instrument provided pressure, temperature, conductivity and dissolved O_2 channels, and additionally measured a second temperature (FSI temperature module/OTM) as a calibration check. Other data channels included elapsed-time, altimeter, several power supply voltages and transmissometer. The instrument supplied a 15-byte NBIS-format data stream at a data rate of 25 Hz. Modifications to the instrument included revised pressure and dissolved O_2 sensor mountings; ODF-designed sensor interfaces for O_2, FSI PRT and transmissometer; implementation of 8-bit and 16-bit multiplexer channels; an elapsed-time channel; instrument ID in the polarity byte and power supply voltages channels.

Table 3.0 summarizes the winches and serial numbers of instruments and sensors used during I4/I5W/I7C.

<table>
<tr><th>Station(s)</th><th>ODF
CTD†
ID#</th><th>SensorMedics
Oxygen
Sensor**</th><th>SeaTech
Transmissometer
(TAMU)</th><th>Winch*</th></tr>
<tr><td>574-610</td><td rowspan="6">1</td><td rowspan="4">3-3-10 or 4-05-16 (A)</td><td rowspan="6">151D</td><td>Stbd.</td></tr>
<tr><td>611-619/1</td><td>Port</td></tr>
<tr><td>619/2</td><td>Stbd.</td></tr>
<tr><td>620-669</td><td rowspan="3">Port</td></tr>
<tr><td>670-697</td><td>4-05-18 (B)</td></tr>
<tr><td>698-707</td><td>3-3-10 or 4-05-16 (A)</td></tr>
<tr><td colspan="5">*NOTE: New wire was installed on Port winch in Durban, between stas 610/611.
New wire was installed on Stbd. winch after last cast,
at end-leg portstop.
**NOTE: Records say 3-3-10 was the first/last oxygen sensor used during I4,
but 4-05-16 replaced it early in I3 leg and was on rosette at end
of I3. 3-3-10 was working well when it was replaced during I3,
so it could indeed be that sensor.</td></tr>
</table>

† ODF CTD #1 sensor serial numbers:

NBIS MKIIIB CTD (ODF-ID#)	Pressure Paine Model 211-35-440-05 strain gage/0-8850psi	Temperature		Conductivity NBIS Model 09035-00151
		PRT1 Rosemount Model 171BJ	PRT2 FSI OTM	
1	131910	14304	OTM/1322T	5902-F117

Table 3.0 I4/I5W/I7C Instrument/Sensor Serial Numbers

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

The O_2 sensor was deployed in a pressure-compensated holder assembly mounted separately on the rosette frame and connected to the CTD by an underwater cable. The O_2 sensor interface was designed and built by ODF using an off-the-shelf 12-bit A/D converter. The transmissometer interface was a similar design.

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

The General Oceanics (GO) 1016 36-place pylon was used in conjunction with an ODF-built deck unit and external power supply instead of a GO pylon deck unit. This combination provided generally reliable operation and positive confirmation. The pylon emitted a confirmation message containing its current notion of bottle trip position, which could be useful in sorting out mis-trips. The acquisition software averaged CTD data corresponding to the rosette trip as soon as the trip was initiated until the trip confirmed, typically 3±0.5 seconds on I4/I5W/I7C.

There were 6 random bad trip confirmations during I4/I5W/I7C; 3 of these were noticed in a timely manner by the console operator. One trip level was redone using the next bottle in line, resulting in the original bottle being open at the surface. The pylon was re-positioned for the other two levels, and both bottles were re-tripped successfully at or near their intended nominal depths. The other 3 bad trip confirmations resulted in open bottles at the end of the cast. Bad confirmations and their effects on bottle trips are documented in Appendix D.

4. Navigation and Bathymetry Data Acquisition

Navigation data were acquired from the ship's Magnavox MX GPS receiver via RS-232. A replacement Trimble GPS unit, which reported full P-code position information, was installed during the Durban port stop, between stations 610 and 611. Data were logged automatically at one-minute intervals by one of the Sun SPARCstations. Underway bathymetry was logged manually from the 12 kHz Raytheon PDR at five-minute intervals, then corrected according to Carter [Cart80] and merged with the navigation data to provide a time-series of underway position, course, speed and bathymetry data. These data were used for all station positions, PDR depths and bathymetry on vertical sections.

5. CTD Data Acquisition, Processing and Control System

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

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

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

Once the deck watch had deployed the rosette and informed the console operator that the rosette was at the surface (also confirmed by the computer displays), the console operator or watch leader provided the winch operator with a target depth (wire-out) and maximum lowering rate, normally 60 meters/minute for this package. The package then began its descent, building up to the maximum rate during the first few hundred meters, then optimally continuing at a steady rate without any stops during the down-cast.

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

The deck watch leader assisted the console operator by monitoring the rosette's distance to the bottom using the difference between the rosette's pinger signal and its bottom reflection displayed on the PDR. Around 200 meters above the bottom, depending on bottom conditions, the altimeter typically began signaling a bottom return on the console. The winch speed was usually slowed to ~30 meters/minute during the final approach. The winch and altimeter displays allowed the watch leader to refine the target depth relayed to the winch operator and safely approach to within 5-10 meters of the bottom.

Bottles were closed on the up-cast by pointing the console trackball cursor at a graphic firing control and clicking a button. The data acquisition system responded with the CTD rosette trip data and a pylon confirmation message in a window. A bad or suspicious confirmation signal typically resulted in the console operator repositioning the pylon trip arm via software, then re-tripping the bottle, until a good confirmation was received. All tripping attempts were noted on the console log. The console operator then instructed the winch operator to bring the rosette up to the next bottle depth. The console operator was also responsible for generating the sample log for the cast.

After the last bottle was tripped, the console operator directed the deck watch to bring the rosette on deck. Once the rosette was on deck, the console operator terminated the data acquisition and turned off the CTD, pylon and VCR recording. The VCR tape was filed. Usually the console operator also brought the sample log to the rosette room and served as the *sample cop*.

6. CTD Data Processing

ODF CTD processing software consists of over 30 programs running under the Unix operating system. The initial CTD processing program (ctdba) is used either in real-time or with existing raw data sets to:

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

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

ODF data acquisition software acquired and processed the CTD data in real-time, providing calibrated, processed data for interactive plotting and reporting during a cast. The 25 Hz data from the CTD were filtered, response-corrected and averaged to a 2 Hz (0.5-second) time-series. Sensor correction and calibration models were applied to pressure, temperature, conductivity and O_2. Rosette trip data were extracted from this time-series in response to trip initiation and confirmation signals. The calibrated 2 Hz time-series data, as well as the 25 Hz raw data, were stored on disk and were available in real-time for reporting and graphical display. At the end of the cast, various consistency and calibration checks were performed, and a 2.0-db pressure-series of the down-cast was generated and subsequently used for reports and plots.

CTD plots generated automatically at the completion of deployment were checked daily for potential problems. The two PRT temperature sensors were inter-calibrated and checked for sensor drift. The CTD conductivity sensor was monitored by comparing CTD values to check-sample conductivities, and by deep theta-salinity comparisons between down- and up-casts as well as adjacent stations. The CTD O_2 sensor was calibrated to check-sample data.

A few casts exhibited conductivity offsets due to biological or particulate artifacts. Some casts were subject to noise in the data stream caused by sea cable or slip-ring problems, or by moisture in the interconnect cables between the CTD and external sensors (i.e. O_2). Intermittent noisy data were filtered out of the 2 Hz data using a spike-removal filter. A least-squares polynomial of specified order was fit to fixed-length segments of data. Points exceeding a specified multiple of the residual standard deviation were replaced by the polynomial value.

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

The first few seconds of in-water data were excluded from the pressure-series data, since the sensors were still adjusting to the going-in-water transition. However, some casts exhibited up to a 0.03 sigma theta drop during the top 10 db of the water column. A time-series data check verified these density features were probably real: the data were consistent over many frames of data at the same pressures. Appendix C details the magnitude of the larger density drops for the casts affected.

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

When the down-cast CTD data have excessive noise, gaps or offsets, the up-cast data are used instead. CTD data from down- and up-casts are not mixed together in the pressure-series data because they do not represent identical water columns (due to ship movement, wire angles, etc.). The up-cast was used for station 625 cast 1 because of excessive 0.02 mS/cm conductivity drops over 8-46 db sections at shallow through deep pressures on the down-cast, probably caused by sensor fouling. The up-cast had some dropout problems of shorter duration that were easily filtered.

There is an inherent problem in the internal digitizing circuitry of the NBIS Mark III CTD when the sign bit for temperature flips. Raw temperature can shift 1-2 millidegrees as values cross between positive and negative, a problem avoided by offsetting the raw PRT readings by ~1.5°C. The conductivity channel also can shift by 0.001-0.002 mS/cm as raw data values change between 32767/32768, where all the bits flip at once. This is typically not a problem in shallow to intermediate depths because such a small shift becomes negligible in higher gradient areas.

Raw CTD conductivity traversed 32767/32768 at ~1300±350 db (~3.85±0.3°C theta) during I4/I5W/I7C casts. There is no apparent salinity shift seen during this leg because the +0.001 PSU effect typical of the digitizing problem is lost in the higher gradients at these depths vs deeper water.

Appendix C contains a table of CTD casts requiring special attention. I4/I5W/I7C CTD-related comments, problems and solutions are documented in detail.

7. CTD Laboratory Calibration Procedures

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

Pressure and temperature calibrations were performed on CTD #1 at the ODF Calibration Facility in La Jolla. The pre-cruise calibrations were done in December 1994, before five consecutive ODF WOCE legs in the Indian Ocean, and the post-cruise calibrations were done in September 1995.

The CTD pressure transducer was calibrated in a temperature-controlled water bath to a Ruska Model 2400 Piston Gage pressure reference. Calibration data were measured pre-/post-cruise at -1.42/+0.01°C to a maximum loading pressure of 6080 db, and 30.41/31.24°C to 1400/1190 db. Figures 7.0 and 7.1 summarize the CTD #1 laboratory pressure calibrations performed in December 1994 and September 1995.

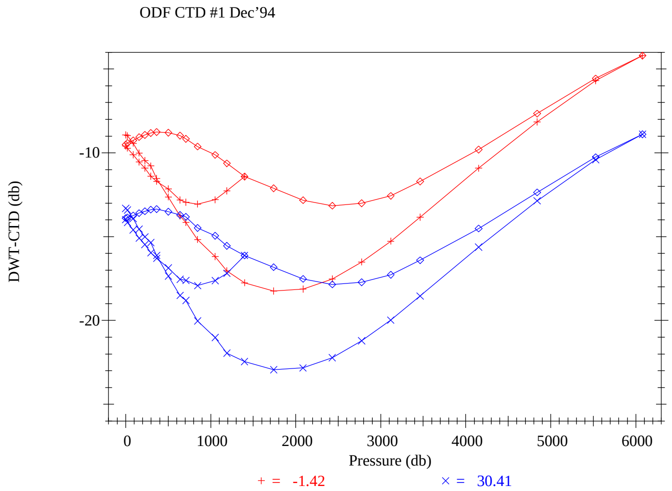


Figure 7.0 Pressure calibration for ODF CTD #1, December 1994.

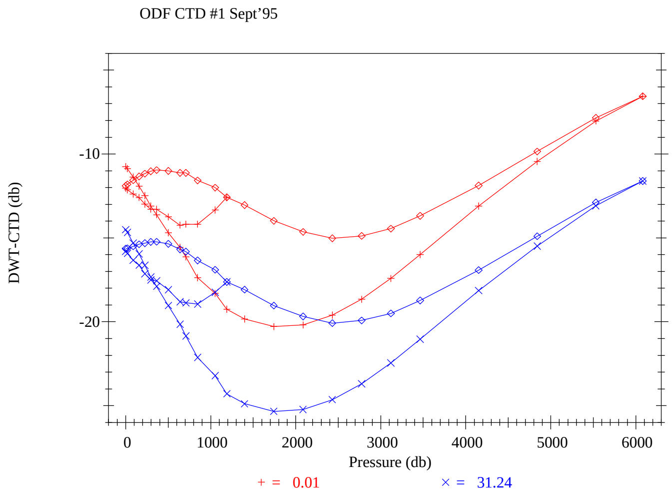


Figure 7.1 Pressure calibration for ODF CTD #1, September 1995.

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

CTD PRT temperatures were calibrated to an NBIS ATB-1250 resistance bridge and Rosemount standard PRT in a temperature-controlled bath. The primary and secondary CTD temperatures were offset by ~1.5 and ~2°C to avoid the 0-point discontinuity inherent in the internal digitizing circuitry. Standard and PRT temperatures were measured at 9 or more different bath temperatures between -1.5 and 31.3°C, both pre- and post-cruise. Figures 7.2 and 7.3 summarize the laboratory calibrations performed on the CTD #1 primary PRT during December 1994 and September 1995.

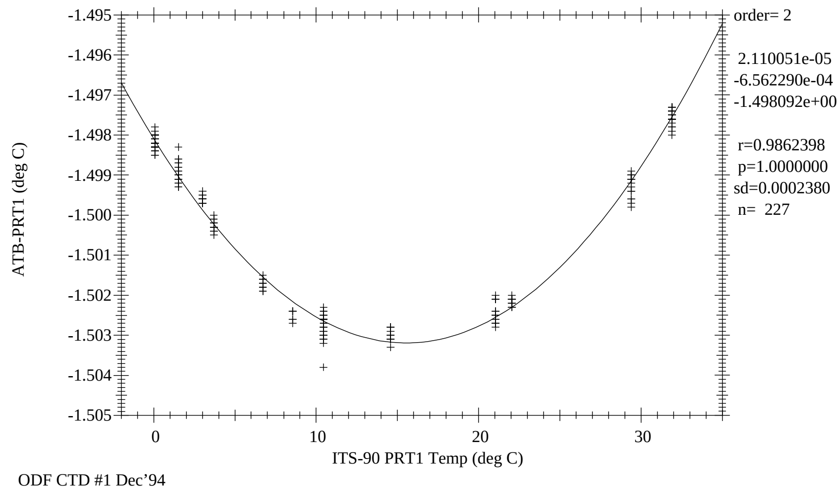


Figure 7.2 Primary PRT Temperature Calibration for ODF CTD #1, December 1994.

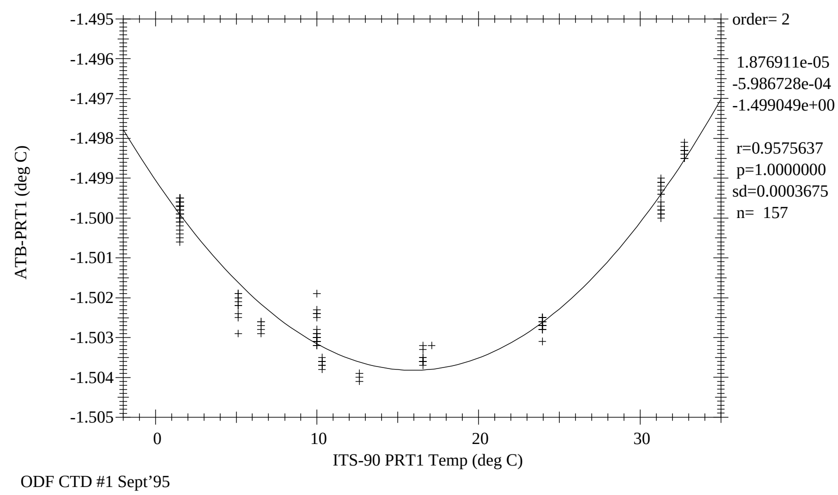


Figure 7.3 Primary PRT Temperature Calibration for ODF CTD #1, September 1995.

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

8. CTD Calibration Procedures

This cruise was the fourth of five consecutive Indian Ocean WOCE legs using ODF CTD #1 exclusively. A redundant PRT sensor was used as a temperature calibration check while at sea. CTD conductivity and dissolved O_2 were calibrated to *in-situ* check samples collected during each rosette cast.

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

8.1. CTD #1 Pressure

The pressure sensor was checked for shifts during the Mauritius port stop prior to I4/I5W/I7C. A Paroscientific DigiQuartz secondary pressure reference was used as a pressure calibration transfer standard. No shifts in the CTD pressure calibration from the pre-cruise laboratory calibration were noted during this check.

There was a pre- to post-cruise (5 legs over 7.5 months) shift of -2.4 db at shallow and deep pressures in the cold-bath laboratory calibrations for pressure. The warm-bath pressure correction shifted by -1.8 db. Half of the closure between warm/cold calibrations can be accounted for by different temperatures of the pre-/post-cruise calibrations. There were no significant slope differences between pre- and post-cruise pressure calibrations.

In order to determine when the pressure shift occurred, start-of-cast out-of-water pressure and temperature data from the 5 consecutive ODF legs were compared with similar data from the pre- and post-cruise laboratory calibrations for temperature. The pressure data from the I4/I5W/I7C leg shifted ~0.8 db compared to pre-cruise laboratory data at all temperatures. A -0.8 db offset was applied to the entire pre-cruise pressure calibration. These revised calibration data, plus the dynamic thermal-response correction, were applied to I4/I5W/I7C CTD #1 pressures.

Down-cast surface pressures were automatically adjusted to 0 db as the CTD entered the water; any difference between this value and the calibration value was automatically adjusted during the top 50 decibars. Residual pressure offsets at the end of each up-cast (the difference between the last corrected pressure in-water and 0 db) averaged 0.75 db, thus indicating no problems with the final pressure corrections. Figure 8.1.0 shows the offset pre-cruise laboratory calibration used to correct I4/I5W/I7C CTD #1 pressure data.

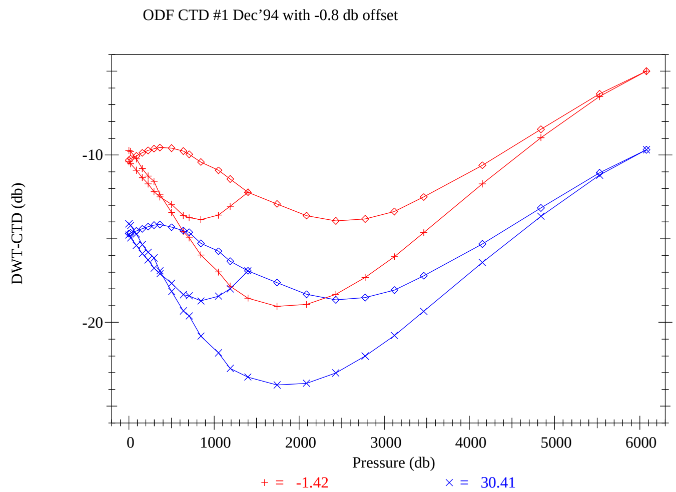


Figure 8.1.0 I4/I5W/I7C Pressure correction for ODF CTD #1: December 1994 calibration offset by -0.8 db.

The entire 10-month pre- to post-cruise laboratory calibration shift for the pressure sensor on CTD #1 was less than half the magnitude of the WOCE accuracy specification of 3 db. I4/I5W/I7C CTD pressures should be well within the desired standards.

8.2. CTD #1 Temperature

An FSI PRT sensor (PRT2) was deployed as a second temperature channel and compared with the primary PRT channel (PRT1) on all casts to monitor for drift. The response times of the primary and secondary PRT sensors were matched, then preliminary corrected temperatures were compared for a series of standard depths from each CTD down-cast.

The FSI PRT used during the last half of I9N was deployed as the secondary PRT throughout the next 3 legs, including I4/I5W/I7C. The differences between the CTD #1 primary PRT and the FSI PRT drifted slowly during I9N, then stabilized at about -0.01°C by the end of that first leg. The non-zero difference was attributed to drift in the FSI PRT sensor, since a stable conductivity correction indicated no shift in the primary PRT. There was no appreciable drift noted in the PRT1-PRT2 differences during I4/I5W/I7C or either of the two previous legs; the differences remained stable, within 0.001°C of the differences observed at the end of I9N. Figure 8.2.0 summarizes the comparison between the primary and secondary PRT temperatures.

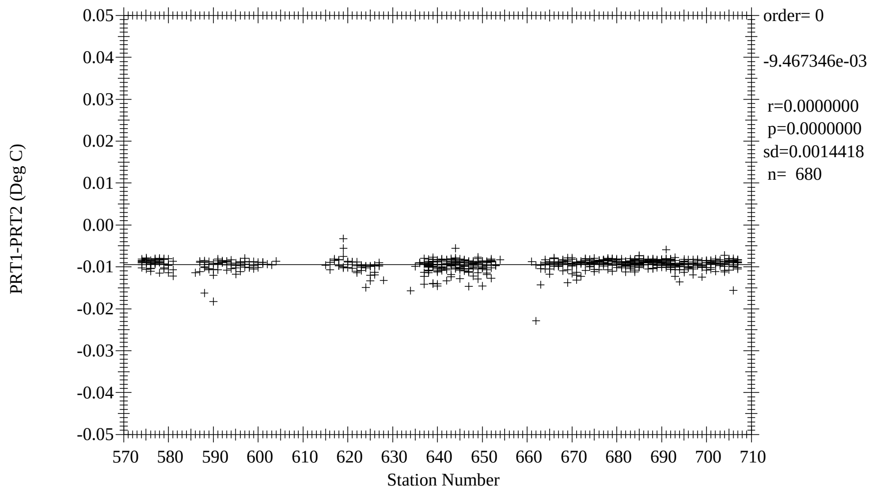


Figure 8.2.0 I4/I5W/I7C Shipboard comparison of CTD #1 primary/secondary PRT temperatures, pressure > 2000 db.

The primary temperature sensor laboratory calibrations indicated a -0.001°C shift at 0°C, a -0.0006°C shift at mid-range temperatures, and a -0.0014°C shift at 32°C from pre- to post-cruise. The pre- and post-cruise temperature calibrations were equally weighted and combined to generate an average temperature correction, which was applied to all CTD casts done during the 5 legs between calibrations. Figure 8.2.1 summarizes the average of the pre-/post-cruise laboratory temperature calibrations for CTD #1.

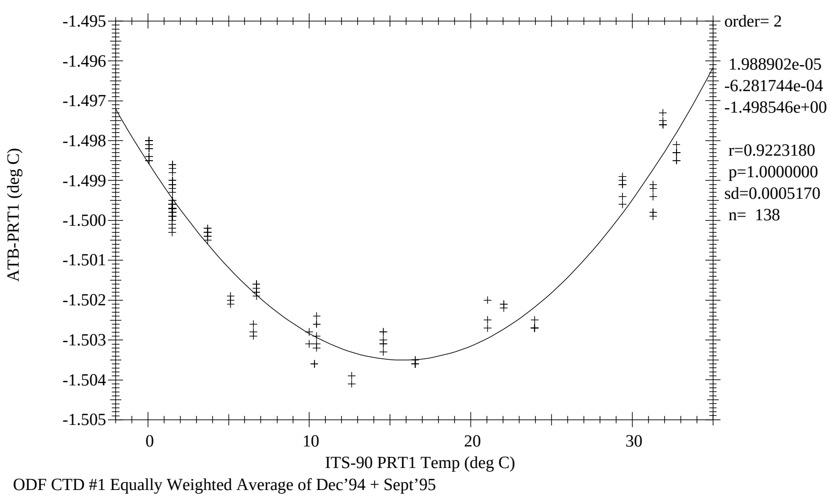


Figure 8.2.1 WOCE95 Primary temperature correction for ODF CTD #1, Dec.94/Sept.95 equally weighted average.

The 10-month pre- to post-cruise laboratory calibration shift for the primary temperature sensor on CTD #1 was about half the magnitude of the WOCE accuracy standard of 0.002°C. Since an average of the two calibrations was applied to the data, I4/I5W/I7C CTD temperatures should be well within the WOCE accuracy specifications.

The secondary FSI temperature sensors either failed or drifted during I9N, the first leg of the 5 consecutive ODF legs, far more than the primary sensor drifted during the 10 months between laboratory calibrations. The FSI PRT sensors seemed to monitor their own drift better than that of the primary temperature sensor mounted permanently on CTD #1. Any comparison of their pre- and post-cruise calibrations was deemed pointless.

8.3. CTD #1 Conductivity

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

Due to small shifting in CTD conductivity, probably caused by organic matter, the conductivity sensor was swabbed with distilled water prior to I9N/station 269, then remained stable through the next two legs and the start of I4/I5W/I7C. Beginning with station 597, there were problems with intermittent small-scale shifts between casts, up to -0.002-3 mS/cm in the CTD conductivity signal. The problem increased to a continuous -0.005-6 mS/cm shift during station 624, from about 2400 db on the down-cast until the surface up-cast. During station 625, the shifting was intermittent: -0.020 mS/cm in multiple 8-46 db segments on the down-cast, and many 2-5 db segments on the up-cast. It is assumed the shifting was again caused by organic contamination of the sensor, and that the sensor was cleaned after station 625. The shifting problems seemed to be resolved for subsequent casts, and the conductivity offset stabilized near the start-leg value for the last 80 casts of I4/I5W/I7C.

Conductivity differences above and below the thermocline were fit to CTD conductivity for all 5 legs together to determine the conductivity slope. The conductivity slope gradually increased from stations 148 (I9N) to 800 (I7N), after which the conductivity sensor was soaked in an RBS cleaning solution and then swabbed with distilled water. Figure 8.3.0 shows the individual preliminary conductivity slopes for stations 148-800.

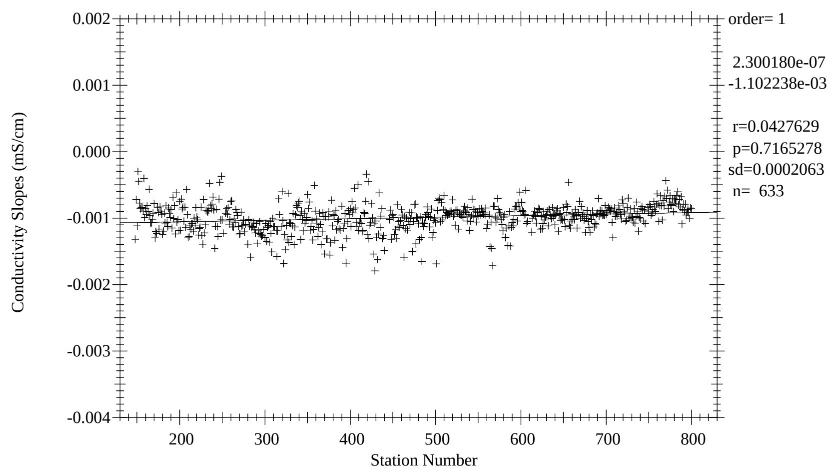


Figure 8.3.0 CTD #1 prelim. conductivity slopes for WOCE95 stations 148(I9N) through 800(I7N).

The conductivity slopes for stations 148-800 were fit to station number, with outlying values (4,2 standard deviations) rejected. Conductivity slopes were calculated from the first-order fit and applied to each I4/I5W/I7C cast.

Once the conductivity slopes were applied, residual CTD conductivity offset values were calculated for each cast using bottle conductivities deeper than 1400 db. Figure 8.3.1 illustrates the I4/I5W/I7C preliminary conductivity offset residual values.

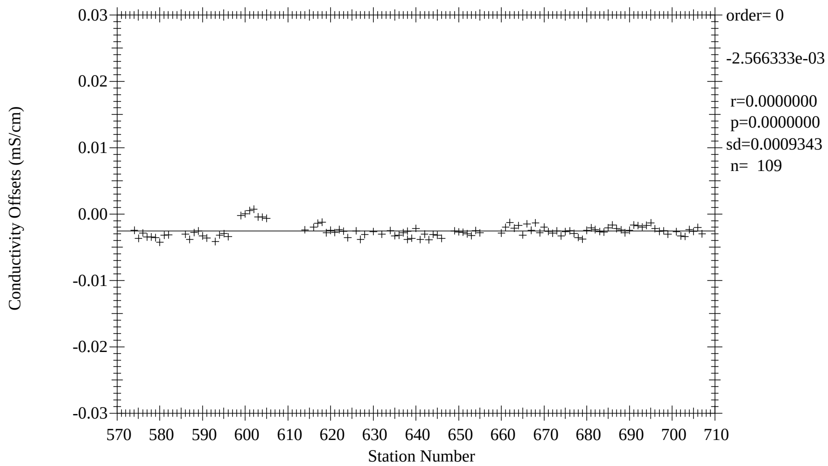


Figure 8.3.1 I4/I5W/I7C CTD #1 preliminary conductivity offsets by station number.

Casts were grouped together based on drift and/or known CTD conductivity shifts to determine average offsets. This also smoothed the effect of any cast-to-cast bottle salinity variation, typically on the order of ±0.001 PSU. 20 casts were omitted from the groups because they were shallower than 1400 db, or had too few bottles deeper than 1400 db to calculate a usable offset. 7 other casts were omitted because of known CTD shifts or bottle salinity problems. Smoothed offsets were applied to each cast, then some offsets were manually adjusted to account for discontinuous shifts in the conductivity transducer response or bottle salinities, or to maintain deep theta-salinity consistency from cast to cast. There was no apparent effect on conductivity offsets caused by CTD idle time during pre- or mid-cruise port stops or transits between WOCE lines.

After applying the conductivity slopes and offsets to each cast, it was determined that surface salinity differences were ~0.008 PSU high compared to intermediate and deep differences. After the offset adjustments were made, a mean second-order conductivity correction was calculated for stations 148-800. Figure 8.3.2 shows the residual conductivity differences used for determining this correction.

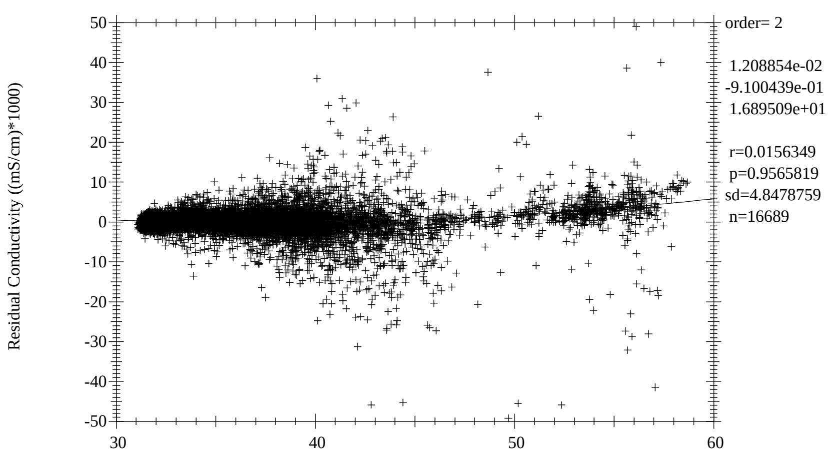


Figure 8.3.2 CTD #1 residual non-linear conductivity slope (WOCE95 stations 148 through 800).

A 4,2-standard deviation rejection of the second-order fit was performed on these differences, then the remaining values were fit to conductivity. This non-linear correction, added to the linear corrections for each cast, effectively pulled in surface differences while having minimal effect on differences below the thermocline/halocline.

The final I4/I5W/I7C conductivity slopes, a combination of the linear coefficients from the preliminary and second-order fits, are summarized in Figure 8.3.3. Figure 8.3.4 summarizes the final combined conductivity offsets by station number.

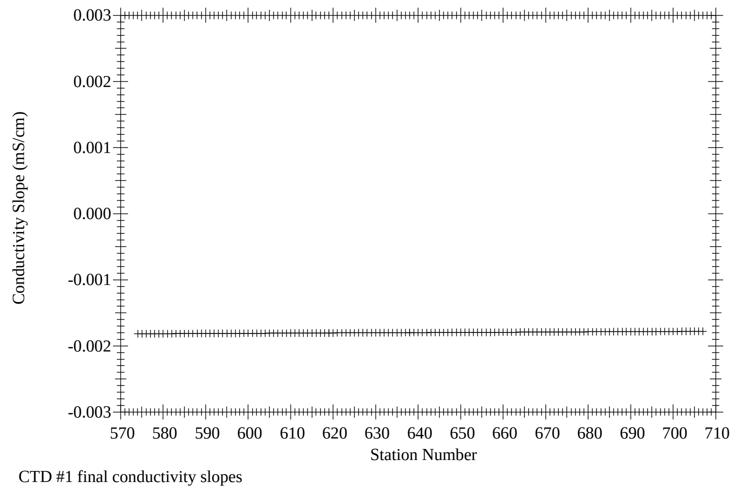


Figure 8.3.3 I4/I5W/I7C CTD #1 conductivity slope corrections by station number.

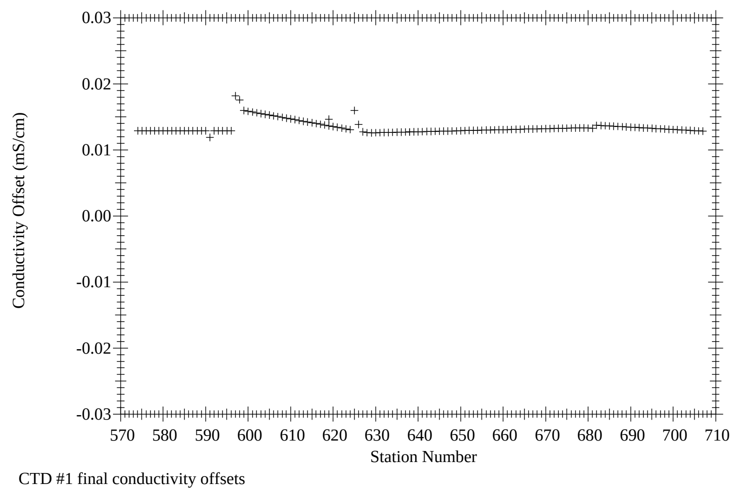


Figure 8.3.4 I4/I5W/I7C CTD #1 conductivity offsets by station number.

I4/I5W/I7C temperature and conductivity correction coefficients are also tabulated in Appendix A.

Summary of Residual Salinity Differences

Figures 8.3.5, 8.3.6 and 8.3.7 summarize the I4/I5W/I7C residual differences between bottle and CTD salinities after applying the conductivity corrections. Only CTD and bottle salinities with (final) quality code 2 were used to generate these figures.

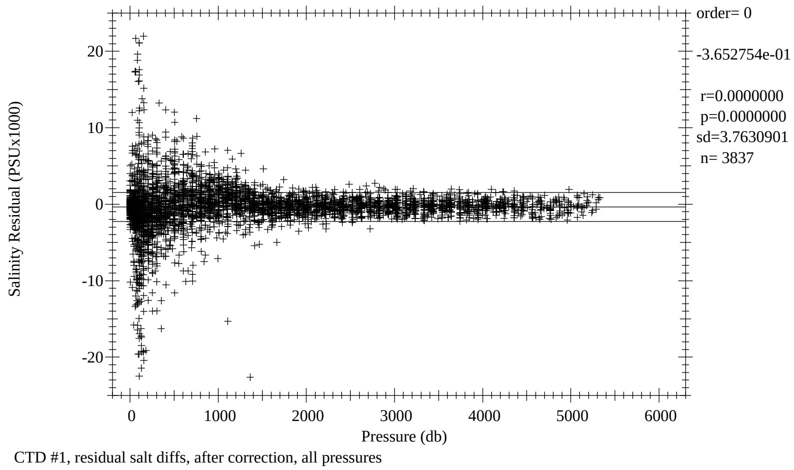


Figure 8.3.5 I4/I5W/I7C Salinity residual differences vs pressure (after correction).

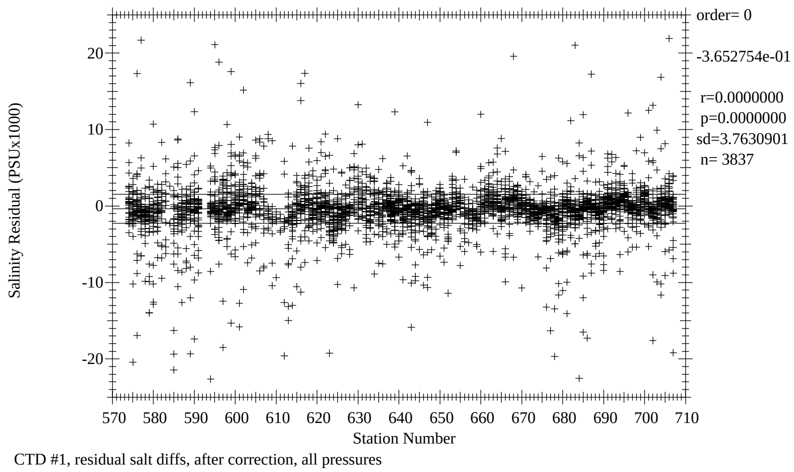


Figure 8.3.6 I4/I5W/I7C Salinity residual differences vs station # (after correction).

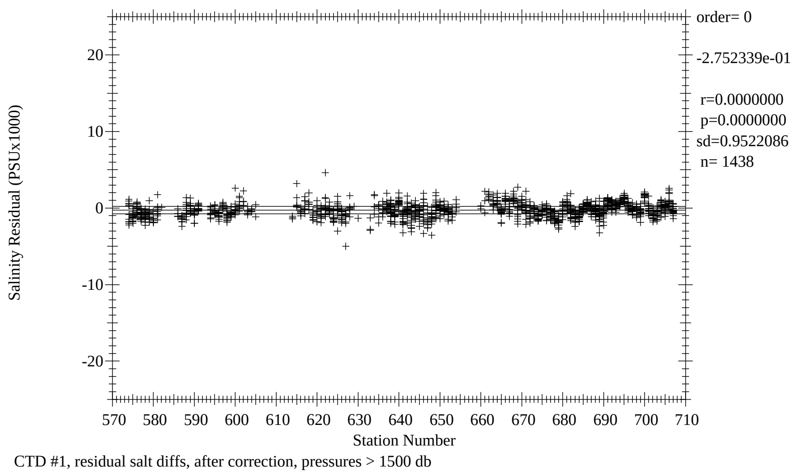


Figure 8.3.7 I4/I5W/I7C Deep salinity residual differences vs station # (after correction).

The CTD conductivity calibration represents a best estimate of the conductivity field throughout the water column. 3σ from the mean residual in Figures 8.3.6 and 8.3.7, or ±0.0056 PSU for all salinities and ±0.0014 PSU for deep salinities, represents the limit of repeatability of the bottle salinities (Autosal, rosette, operators and samplers). This limit agrees with station overlays of deep theta-salinity. Within most casts (a single salinometer run), the precision of bottle salinities appears to be better than 0.001 PSU. The precision of the CTD salinities appears to be better than 0.0005 PSU.

Final calibrated CTD data from WOCE95 I3 and I7N legs were compared with I4/I5W/I7C data. Deep theta-salinity comparisons for I4/I5W/I7C stations 574 and 705 (two casts done at the same position) and I3 station 548 (within 4 nautical miles (nm) of the two other casts) showed excellent agreement, less than 0.001 PSU difference. I7C stations 706-707 and I7N station 709, casts ~30 nm apart along the same track line, were compared for theta-salinity continuity; they also agreed well.

GEOSECS station 426 was compared with I7C station 707, casts taken 7 nm (and 17.5 years) apart. The GEOSECS data were +0.002 to +0.003 PSU compared to I7W data, the same difference seen on multiple casts comparing GEOSECS to data from 3 previous WOCE Indian Ocean legs. The average difference becomes close to 0 when corrections are applied for Standard Seawater batch differences for GEOSECS (P-63) [Mant87] and WOCE95 (P-126) [Culk98].

8.4. CTD Dissolved Oxygen

An oxygen sensor also used on I3, during either the first 11 casts or the last 117 casts, was used for most of I4/I5W/I7C. This first sensor (A) was switched out for a new sensor (B) for stations 670-697, during which there were extensive problems with CTD O_2 cut-outs, noise and offsets. Within one second after the sensor entered the water, the raw CTD O_2 values dropped dramatically, then rose slowly to "normal" values during the top ~100 db. After the first few casts, the raw values dropped to 0 and stayed there longer each cast before rising slowly to "normal" values. The raw CTD O_2 values rose sharply within a second or two after exiting the water at the end of each cast, often pegging-out at the maximum reading (4512) before dropping again to "normal" values. The cut-out problems, signal noise and apparent problems with sensor response in deeper water increased with each successive use of this replacement sensor. The sensor was finally put out of its misery after station 697: the original oxygen sensor (A) was re-installed prior to station 698, and was used for the remainder of the I3 leg.

There are a number of problems with the response characteristics of the SensorMedics O_2 sensor used in the NBIS Mark III CTD, the major ones being a secondary thermal response and a sensitivity to profiling velocity. Stopping the rosette for as little as half a minute, or slowing down for a bottom approach, can cause shifts in the CTD O_2 profile as oxygen becomes depleted in water near the sensor. Such shifts could usually be corrected by offsetting the raw oxygen data from the stop or slow-down area until some time after the sensor has been moving again, occasionally until the bottom of the cast. Unusually aggressive attempts were made to improve the drop-out areas for station 670-697, mentioned in the above paragraph, because various lags cause surface data to have a strong impact on the fit for the entire cast. All offset sections, winch stops or slow-downs that affected CTD oxygen data are documented in Appendix C.

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

Figures 8.4.0 and 8.4.1 show the residual differences between the corrected CTD O_2 and the bottle O_2 (ml/l) for each station. The standard deviations for stations 670-697 differences were nearly 30% larger for all bottles, and nearly 3 times larger for deep bottles, compared to the other I4/I5W/I7C casts. After quality codes have been applied to the worst CTD O_2 sections for stations 670-697, the differences are comparable to the rest of the cruise.

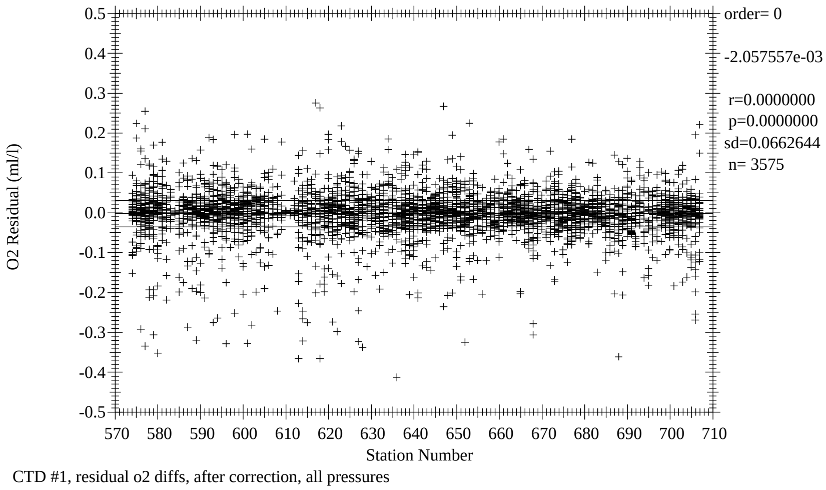


Figure 8.4.0 I4/I5W/I7C O_2 residual differences vs station # (after correction).

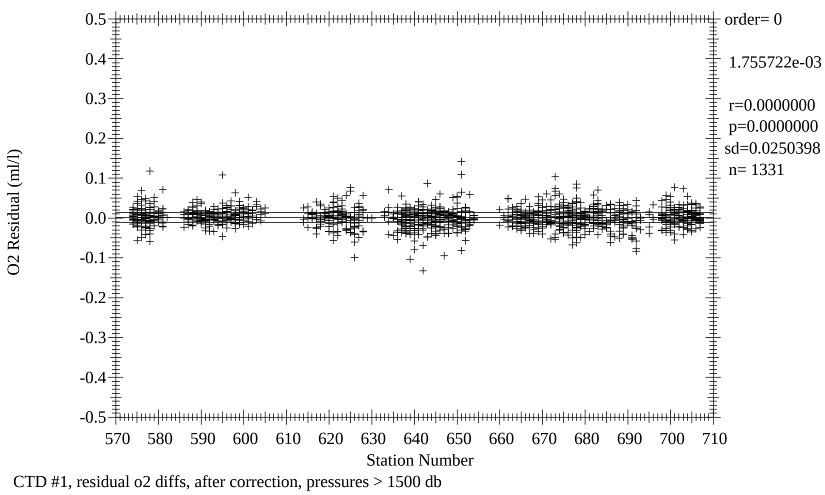


Figure 8.4.1 I4/I5W/I7C Deep O_2 residual differences vs station # (after correction).

The standard deviations of 0.066 ml/l for all oxygens and 0.025 ml/l for deep oxygens are only intended as indicators of how well the CTD and bottle O_2 values match up. ODF makes no claims regarding the precision or accuracy of CTD dissolved O_2 data.

The general form of the ODF O_2 conversion equation follows Brown and Morrison [Brow78] and Millard [Mill82], [Owen85]. ODF does not use a digitized O_2 sensor temperature to model the secondary thermal response but instead models membrane and sensor temperatures by low-pass filtering the PRT temperature. *In-situ* pressure and temperature are filtered to match the sensor response. Time-constants for the pressure response τ_p, and two temperature responses τ_{Ts} and τ_{Tf} are fitting parameters. The O_c gradient, dO_c/dt, is approximated by low-pass filtering 1st-order O_c differences. This gradient term attempts to correct for reduction of species other than O_2 at the cathode. The time-constant for this filter, τ_{og}, is a fitting parameter. Oxygen partial-pressure is then calculated:

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

where:

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

I4/I5W/I7C CTD O_2 correction coefficients (c_1 through c_6) are tabulated in Appendix B.

9. Bottle Sampling

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

- CFCs;
- ^3He;
- O_2;
- Total CO_2;
- Alkalinity;
- AMS ^{14}C;
- Tritium;
- Nutrients;
- Salinity;
- Barium;
- Chlorophyll.

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

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

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

Once individual samples had been drawn and properly prepared, they were distributed to their respective laboratories for analysis. Oxygen, nutrients and salinity analyses were performed on computer-assisted (PC) analytical equipment networked to Sun SPARCstations for centralized data analysis. The analysts for each specific property were responsible for insuring that their results were updated into the cruise database.

10. Bottle Data Processing

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

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

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

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

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

2	No problems noted.
3	Leaking. *An air leak large enough to produce an observable effect on a sample is identified by a code of 3 on the bottle and a code of 4 on the oxygen. (Small air leaks may have no observable effect, or may only affect gas samples.)*
4	Did not trip correctly. *Bottles tripped at other than the intended depth were assigned a code of 4. There may be no problems with the associated water sample data.*
5	Not reported. *No water sample data reported. This is a representative level derived from the CTD data for reporting purposes. The sample number should be in the range of 80-99.*
9	The samples were not drawn from this bottle.

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

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

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

2	Acceptable measurement.
3	Questionable measurement. *The data did not fit the bottle data, or there was a CTD conductivity calibration shift during the up-cast.*
4	Bad measurement. *The CTD up-cast data were determined to be unusable for calculating a salinity.*
7	Despiked. *The CTD data have been filtered to eliminate a spike or offset.*

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

1	Not calibrated. *Data are uncalibrated.*
2	Acceptable measurement.
3	Questionable measurement.
4	Bad measurement. *The CTD data were determined to be unusable for calculating a dissolved oxygen concentration.*
5	Not reported. *The CTD data could not be reported, typically when CTD salinity is coded 3 or 4.*
7	Despiked. *The CTD data have been filtered to eliminate a spike or offset.*
9	Not sampled. *No operational CTD O_2 sensor was present on this cast.*

Note that CTDOXY values were derived from the down-cast pressure-series CTD data except station 625, where the up-cast was processed because of conductivity problems on the down-cast. CTD data were matched to the up-cast bottle data along isopycnal surfaces. If the CTD salinity was footnoted as bad or questionable, the CTD O_2 was not reported.

Table 10.0 shows the number of samples drawn and the number of times each WHP sample quality flag was assigned for each basic hydrographic property:

Rosette Samples Stations 574-707								
	Reported Levels	WHP Quality Codes 1	2	3	4	5	7	9
Bottle	4017	0	4002	6	2	0	0	7
CTD Salt	4017	0	3974	5	2	0	36	0
CTD Oxy	4010	0	3638	303	69	7	0	0
Salinity	4000	0	3844	139	17	1	0	16
Oxygen	3997	0	3945	44	8	7	0	13
Silicate	3998	0	3910	22	66	0	0	19
Nitrate	3998	0	3984	8	6	0	0	19
Nitrite	3998	0	3988	4	6	0	0	19
Phosphate	3996	0	3937	53	6	2	0	19

Table 10.0 Frequency of WHP quality flag assignments for I4/I5W/I7C.

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

11. Pressure and Temperatures

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

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

12. Salinity Analysis

Equipment and Techniques

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

The salinity analyses were performed when samples had equilibrated to laboratory temperature, usually within 7-24 hours after collection. The salinometer was standardized for each group of analyses (typically one cast, usually 36 samples) using at least one fresh vial of standard seawater per cast. A computer (PC) prompted the analyst for control functions such as changing sample, flushing, or switching to "read" mode. At the correct time, the computer acquired conductivity ratio measurements, and logged results. The sample conductivity was redetermined until readings met software criteria for consistency. Measurements were then averaged for a final result.

There was one run of 180 samples (5 casts) over 6 hours with standards only at the beginning and end of the run. There were six other runs of 62-107 samples (2-3 casts) with 1.5-5 hours between standards. The drifts between the two standards of each long run was minimal, and there do not appear to be any data problems resulting from these longer runs.

Sampling and Data Processing

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

PSS-78 salinity [UNES81] was calculated for each sample from the measured conductivity ratios. The difference (if any) between the initial vial of standard water and one run at the end as an unknown was applied linearly to the data to account for any drift. The data were added to the cruise database. 4000 salinity measurements were made and 280 vials of standard water were used. The estimated accuracy of bottle salinities run at sea is usually better than 0.002 PSU relative to the particular standard seawater batch used.

Laboratory Temperature

The temperature stability in the salinometer laboratory was good, with the lab temperature generally 1-2°C lower than the Autosal bath temperature.

Standards

IAPSO Standard Seawater (SSW) Batch P-126 was used to standardize the salinometers.

13. Oxygen Analysis

Equipment and Techniques

Dissolved oxygen analyses were performed with an ODF-designed automated oxygen titrator using photometric end-point detection based on the absorption of 365nm wavelength ultra-violet light. The titration of the samples and the data logging were controlled by PC software. Thiosulfate was dispensed by a Dosimat 665 buret driver fitted with a 1.0 ml buret. ODF used a whole-bottle modified-Winkler titration following the technique of Carpenter [Carp65] with modifications by Culberson *et al.* [Culb91], but with higher concentrations of potassium iodate standard (approximately 0.012N) and thiosulfate solution (50 gm/l). Standard solutions prepared from pre-weighed potassium iodate crystals were run at the beginning of each session of analyses, which typically included from 1 to 3 stations. Several standards were made up during the cruise and compared to assure that the results were reproducible, and to preclude the possibility of a weighing or dilution error. Reagent/distilled water blanks were determined, to account for presence of oxidizing or reducing materials.

Sampling and Data Processing

Samples were collected for dissolved oxygen analyses soon after the rosette sampler was brought on board, and after samples for CFC and helium were drawn. Using a Tygon drawing tube, nominal 125ml volume-calibrated iodine flasks were rinsed twice with minimal agitation, then filled and allowed to overflow for at least 2 flask volumes. The sample draw temperature was measured with a small platinum resistance thermometer embedded in the drawing tube. Reagents were added to fix the oxygen before stoppering. The flasks were shaken twice to assure thorough dispersion of the precipitate, once immediately after drawing, and then again after about 20 minutes. The samples were analyzed within 2-18 hours of collection, usually within 10 hours, and then the data were merged into the cruise database.

Thiosulfate normalities were calculated from each standardization and corrected to 20°C. The 20°C normalities and the blanks were plotted versus time and were reviewed for possible problems. New thiosulfate normalities were recalculated after the blanks had been smoothed as a function of time, if warranted. These normalities were then smoothed, and the oxygen data were recalculated.

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

3997 oxygen measurements were made, with no major problems with the analyses. A problem with UV lamp output appeared to be temperature-related and resulted in reduced lamp life but did not otherwise affect the data. No other major problems were encountered with the analyses. The temperature stability of the laboratory used for the analyses was poor, varying from 22 to 28°C over short time scales. Portable fans were used to assist in maintaining some temperature stability. Titration temperatures were recorded and titer volumes adjusted to 20°C as noted earlier.

Volumetric Calibration

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

Standards

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

14. Nutrient Analysis

Equipment and Techniques

Nutrient analyses (phosphate, silicate, nitrate and nitrite) were performed on an ODF-modified 4-channel Technicon AutoAnalyzer II, generally within a few hours after sample collection. Occasionally samples were refrigerated up to 4 hours at 2-6°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 channels were digitized and logged automatically by computer (PC) at 2-second intervals.

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

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

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

Sampling and Data Processing

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

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

3998 nutrient samples were analyzed. No major problems were encountered with the measurements. The pump tubing was changed twice, and deep seawater was run as a substandard check. The temperature stability of the laboratory used for the analyses was poor, varying from 22 to 28°C over short time scales. Portable fans were used to assist in maintaining some temperature stability. Temperature effects on the data during the course of analysis were minimized as standards were run before and after the samples from each station.

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

Standards

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

Comparisons with reoccupied stations

Station 705 was a reoccupation of Station 574 as well as I3 Station 548. Overlays of these stations showed substantial variability in shallow to intermediate depths between stations. Overlays of the deep (0-2 deg theta) samples for all nutrients compared well, with the exception of Station 574 deep silicates. These silicate values have been coded questionable as they are higher for no apparent reason, and no other parameters show this increase. For stations 702-707, initial (shipboard) silicates were higher than adjacent stations by ˜3%. A problem with silicate standards was found to be the most likely cause. The silicate data for these stations (702-707) were increased by 3% to correct the data based upon deep calibration standards that were run with each station.

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Appendix A

WOCE95-I4/I5W/I7C: CTD Temperature and Conductivity Corrections Summary

Sta/ Cast	PRT Response Time(secs)	ITS-90 Temperature Coefficients $corT = t2*T^2 + t1*T + t0$ t2	t1	t0	Conductivity Coefficients $corC = c2*C^2 + c1*C + c0$ c2	c1	c0
574/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.81662e-03	0.01289
575/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.81634e-03	0.01289
576/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.81607e-03	0.01289
577/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.81579e-03	0.01289
578/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.81551e-03	0.01289
579/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.81523e-03	0.01289
580/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.81496e-03	0.01289
581/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.81468e-03	0.01289
582/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.81440e-03	0.01289
583/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.81413e-03	0.01289
584/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.81385e-03	0.01289
585/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.81357e-03	0.01289
586/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.81329e-03	0.01289
587/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.81302e-03	0.01289
588/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.81274e-03	0.01289
589/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.81246e-03	0.01289
590/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.81218e-03	0.01289
591/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.81191e-03	0.01189
592/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.81163e-03	0.01289
593/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.81135e-03	0.01289
594/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.81107e-03	0.01289
595/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.81080e-03	0.01289
596/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.81052e-03	0.01289
597/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.81024e-03	0.01819
598/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.80997e-03	0.01758
599/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.80969e-03	0.01596
600/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.80941e-03	0.01585
601/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.80913e-03	0.01573
602/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.80886e-03	0.01561
603/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.80858e-03	0.01550
604/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.80830e-03	0.01538
605/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.80802e-03	0.01527
606/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.80775e-03	0.01515
607/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.80747e-03	0.01504
608/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.80719e-03	0.01492
609/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.80691e-03	0.01481
610/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.80664e-03	0.01469
611/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.80636e-03	0.01458
612/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.80608e-03	0.01446
613/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.80581e-03	0.01435

Sta/ Cast	PRT Response Time(secs)	ITS-90 Temperature Coefficients corT = t2∗T² + t1∗T + t0 t2	t1	t0	Conductivity Coefficients corC = c2∗C² + c1∗C + c0 c2	c1	c0
614/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.80553e-03	0.01423
615/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.80525e-03	0.01411
616/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.80497e-03	0.01400
617/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.80470e-03	0.01388
618/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.80442e-03	0.01377
619/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.80414e-03	0.01465
619/02	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.80414e-03	0.01365
620/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.80386e-03	0.01354
621/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.80359e-03	0.01342
622/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.80331e-03	0.01331
623/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.80303e-03	0.01319
624/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.80275e-03	0.01308
625/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.80248e-03	0.01596
626/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.80220e-03	0.01384
627/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.80192e-03	0.01273
628/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.80164e-03	0.01261
629/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.80137e-03	0.01259
630/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.80109e-03	0.01260
631/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.80081e-03	0.01262
632/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.80054e-03	0.01263
633/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.80026e-03	0.01265
634/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.79998e-03	0.01266
635/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.79970e-03	0.01268
636/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.79943e-03	0.01269
637/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.79915e-03	0.01271
638/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.79887e-03	0.01272
638/02	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.79887e-03	0.01272
639/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.79859e-03	0.01274
640/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.79832e-03	0.01275
641/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.79804e-03	0.01277
642/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.79776e-03	0.01279
643/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.79748e-03	0.01280
644/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.79721e-03	0.01282
645/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.79693e-03	0.01283
646/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.79665e-03	0.01285
647/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.79638e-03	0.01286
648/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.79610e-03	0.01288
649/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.79582e-03	0.01289
650/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.79554e-03	0.01291
651/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.79527e-03	0.01292
652/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.79499e-03	0.01294
653/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.79471e-03	0.01295

Sta/ Cast	PRT Response Time(secs)	ITS-90 Temperature Coefficients corT = t2∗T^2 + t1∗T + t0 t2	t1	t0	Conductivity Coefficients corC = c2∗C^2 + c1∗C + c0 c2	c1	c0
654/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.79443e-03	0.01297
655/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.79416e-03	0.01298
656/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.79388e-03	0.01300
657/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.79360e-03	0.01301
658/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.79332e-03	0.01303
659/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.79305e-03	0.01304
660/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.79277e-03	0.01306
661/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.79249e-03	0.01308
662/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.79221e-03	0.01309
663/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.79194e-03	0.01311
664/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.79166e-03	0.01312
665/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.79138e-03	0.01314
666/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.79111e-03	0.01315
667/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.79083e-03	0.01317
668/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.79055e-03	0.01318
669/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.79027e-03	0.01320
670/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.79000e-03	0.01321
671/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.78972e-03	0.01323
672/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.78944e-03	0.01324
673/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.78916e-03	0.01326
674/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.78889e-03	0.01327
675/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.78861e-03	0.01329
676/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.78833e-03	0.01330
677/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.78805e-03	0.01332
678/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.78778e-03	0.01334
679/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.78750e-03	0.01334
680/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.78722e-03	0.01330
681/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.78695e-03	0.01327
682/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.78667e-03	0.01373
683/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.78639e-03	0.01369
684/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.78611e-03	0.01366
685/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.78584e-03	0.01362
686/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.78556e-03	0.01359
687/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.78528e-03	0.01355
688/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.78500e-03	0.01352
689/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.78473e-03	0.01348
690/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.78445e-03	0.01345
691/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.78417e-03	0.01341
692/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.78389e-03	0.01338
693/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.78362e-03	0.01334
694/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.78334e-03	0.01330
695/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.78306e-03	0.01327

Sta/ Cast	PRT Response Time(secs)	ITS-90 Temperature Coefficients corT = t2∗T^2 + t1∗T + t0			Conductivity Coefficients corC = c2∗C^2 + c1∗C + c0		
		t2	t1	t0	c2	c1	c0
696/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.78279e-03	0.01323
697/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.78251e-03	0.01320
698/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.78223e-03	0.01316
699/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.78195e-03	0.01313
700/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.78168e-03	0.01309
701/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.78140e-03	0.01306
702/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.78112e-03	0.01302
703/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.78084e-03	0.01299
704/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.78057e-03	0.01295
705/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.78029e-03	0.01291
706/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.78001e-03	0.01288
707/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.77973e-03	0.01284

Appendix B

Summary of WOCE95-I4/I5W/I7C CTD Oxygen Time Constants

Temperature		Pressure	O_2 Gradient
Fast(τ_{Tf})	Slow(τ_{Ts})	(τ_p)	(τ_{og})
1.0	400.0	24.0	16.0

WOCE95-I4/I5W/I7C: Conversion Equation Coefficients for CTD Oxygen

(refer to Equation 8.4.0)

>> additionally, see NOTE at the end of Appendix B <<

Sta/ Cast	O_c Slope (c_1)	Offset (c_2)	P_l coeff (c_3)	T_f coeff (c_4)	T_s coeff (c_5)	$\frac{dO_c}{dt}$ coeff (c_6)
574/01	1.07774e-03	-4.26607e-03	1.53945e-04	4.35581e-03	-3.40207e-02	-3.00433e-06
575/01	1.05960e-03	6.42435e-03	1.49501e-04	6.55602e-03	-3.44418e-02	8.58855e-06
576/01	1.19659e-03	-3.49196e-02	1.52621e-04	7.51564e-03	-3.97631e-02	6.98744e-06
577/01	1.03527e-03	1.44423e-02	1.49819e-04	1.16385e-02	-3.60497e-02	4.04932e-06
578/01	1.00115e-03	2.74098e-02	1.46129e-04	8.22697e-03	-3.13928e-02	2.56964e-06
579/01	1.08643e-03	-7.39503e-03	1.53790e-04	1.42057e-02	-3.87115e-02	8.31345e-06
580/01	1.06088e-03	3.85118e-03	1.51197e-04	1.09440e-02	-3.51551e-02	4.87343e-06
581/01	1.04553e-03	1.23988e-02	1.48626e-04	4.83574e-03	-3.05511e-02	1.28267e-05
582/01	9.85305e-04	4.13746e-02	1.34109e-04	8.84951e-03	-3.03086e-02	6.22680e-06
583/01	3.60987e-03	3.92258e-01	-9.01872e-04	-7.23814e-04	-7.45113e-02	2.17387e-06
584/01	1.87109e-04	3.92683e-01	-5.22798e-05	1.80963e-02	-6.36160e-03	1.06383e-05
585/01	1.79461e-03	4.06976e-02	-2.03951e-04	1.84145e-03	-5.27549e-02	-3.20290e-06
586/01	1.05497e-03	1.20560e-02	1.45011e-04	1.06532e-02	-3.56850e-02	3.38618e-06
587/01	1.01827e-03	1.44675e-02	1.57051e-04	6.36007e-03	-3.05885e-02	5.07146e-06
588/01	9.84172e-04	2.07739e-02	1.57705e-04	1.11378e-02	-3.24911e-02	5.56961e-06
589/01	9.88848e-04	2.63043e-02	1.54192e-04	6.36104e-03	-2.96757e-02	3.76685e-06
590/01	1.03670e-03	1.58448e-02	1.50761e-04	5.19070e-04	-2.94760e-02	9.97747e-07
591/01	1.01370e-03	3.66608e-02	1.42364e-04	3.65346e-03	-3.05671e-02	7.72076e-06
592/01	1.08055e-03	1.15845e-02	1.43850e-04	6.58926e-03	-3.49954e-02	1.60103e-06
593/01	1.02412e-03	3.66744e-02	1.38947e-04	6.34646e-03	-3.35545e-02	3.99250e-06
594/01	1.02036e-03	4.07592e-02	1.37368e-04	5.27338e-03	-3.36033e-02	1.53031e-07
595/01	9.82799e-04	5.00826e-02	1.40139e-04	7.56918e-03	-3.30963e-02	-1.64499e-06
596/01	1.02718e-03	2.97451e-02	1.42264e-04	9.74911e-03	-3.49878e-02	-4.38900e-06
597/01	1.02131e-03	1.82723e-02	1.52472e-04	2.49858e-03	-2.93907e-02	4.49472e-06
598/01	1.05621e-03	1.70162e-02	1.44376e-04	1.31389e-02	-3.87292e-02	1.71597e-06
599/01	1.04555e-03	1.65905e-02	1.47044e-04	3.54806e-03	-3.14464e-02	-3.25403e-06
600/01	1.09411e-03	1.28005e-03	1.44133e-04	1.20216e-02	-3.91469e-02	1.40303e-06
601/01	1.01951e-03	2.30132e-02	1.48803e-04	6.61417e-03	-3.16673e-02	5.72222e-06
602/01	9.81725e-04	2.05430e-02	1.64517e-04	7.13756e-03	-3.00803e-02	4.67921e-06
603/01	1.12341e-03	2.31673e-04	1.26784e-04	4.62365e-03	-3.36588e-02	5.80516e-06
604/01	1.01879e-03	1.87463e-02	1.51372e-04	7.22131e-04	-2.70946e-02	4.89508e-06

Sta/ Cast	O_c Slope (c_1)	Offset (c_2)	P_l coeff (c_3)	T_f coeff (c_4)	T_s coeff (c_5)	$\frac{dO_c}{dt}$ coeff (c_6)
605/01	1.13493e-03	-5.45403e-03	1.32529e-04	6.80830e-03	-3.60986e-02	3.41436e-06
606/01	1.92686e-03	2.47607e-01	-3.91726e-04	-1.57866e-02	-5.21424e-02	-2.61775e-06
607/01	1.83199e-03	1.10837e-01	-3.36274e-04	-4.29114e-03	-4.82396e-02	4.44219e-06
608/01	9.65969e-04	4.66189e-01	-3.52807e-04	1.11429e-03	-3.55884e-02	1.83852e-07
609/01	1.82969e-03	-3.90706e-01	-6.30626e-04	-3.11075e-02	-1.63224e-02	-4.14044e-06
610/01	-3.94182e-03	7.50751e+01	-1.51669e-04	9.28653e-02	-2.75470e-01	1.11688e-06
611/01	4.98760e-03	6.71512e+01	-4.30882e-04	6.66644e-02	-2.66837e-01	-1.00130e-06
612/01	1.03547e-03	4.61979e-01	-4.55060e-04	-2.66347e-03	-3.74158e-02	-4.34934e-06
613/01	4.75874e-04	6.83628e-02	4.37184e-04	-9.79597e-04	4.22970e-03	2.33917e-06
614/01	9.55374e-04	2.33067e-02	1.76915e-04	1.05863e-03	-2.52190e-02	6.03833e-06
615/01	1.30330e-03	-3.31601e-02	9.32117e-05	8.05820e-03	-4.34899e-02	4.03850e-06
616/01	9.99557e-04	3.31272e-02	1.44485e-04	2.20600e-03	-2.85377e-02	-1.52478e-06
617/01	1.03099e-03	5.31256e-02	1.20999e-04	1.41418e-02	-3.98974e-02	6.13754e-06
618/01	1.00019e-03	5.39593e-02	1.30566e-04	5.21505e-03	-3.23856e-02	8.89849e-06
619/01	1.11402e-03	-1.71772e-03	1.37028e-04	6.12956e-03	-3.65168e-02	2.46310e-06
619/02	1.09587e-03	7.36309e-03	1.35303e-04	3.49012e-03	-3.49397e-02	8.24358e-06
620/01	1.00275e-03	4.05560e-02	1.38224e-04	7.61480e-03	-3.39341e-02	5.22641e-06
621/01	1.07111e-03	2.02167e-02	1.34215e-04	9.37146e-03	-3.79142e-02	6.62090e-06
622/01	1.02040e-03	4.58274e-02	1.31532e-04	1.06371e-02	-3.66673e-02	9.78044e-06
623/01	1.06870e-03	1.21213e-02	1.44471e-04	6.41315e-03	-3.57194e-02	5.51898e-06
624/01	1.01301e-03	3.83584e-02	1.38643e-04	7.50002e-03	-3.56696e-02	4.26736e-06
625/01	1.33013e-03	-6.29816e-02	1.28509e-04	-3.18340e-02	-6.61196e-03	-1.24550e-06
626/01	1.04472e-03	2.50583e-02	1.38953e-04	1.13842e-02	-3.88418e-02	4.54493e-06
627/01	1.11122e-03	2.16783e-02	1.22416e-04	1.72699e-02	-4.52313e-02	7.03989e-06
628/01	1.74468e-03	-9.52163e-02	2.93808e-05	1.96709e-02	-6.83997e-02	8.36341e-06
629/01	2.15010e-03	1.72093e-01	-2.72036e-04	1.83046e-05	-6.35579e-02	1.21010e-06
630/01	1.69852e-03	7.65276e-02	-1.25423e-04	-1.41886e-03	-5.18894e-02	3.42050e-06
631/01	2.28373e-03	-2.28172e-01	-9.52207e-05	-3.34522e-03	-6.11240e-02	-1.83496e-06
632/01	9.54843e-04	1.94263e-01	-2.54797e-05	-8.21844e-03	-2.16331e-02	7.01874e-07
633/01	1.56139e-03	3.70748e-02	-4.14310e-05	7.98083e-03	-5.55980e-02	8.29218e-07
634/01	3.94580e-03	-5.93652e-01	-1.53339e-04	3.64662e-02	-1.21101e-01	-7.76925e-07
635/01	1.81392e-03	-1.13531e-01	2.39484e-05	2.23283e-02	-7.17671e-02	5.35853e-06
636/01	1.32668e-03	-1.36719e-02	8.18890e-05	1.59093e-02	-5.30646e-02	-5.44099e-06
637/01	9.59426e-04	6.38271e-02	1.33321e-04	1.24409e-02	-3.60033e-02	4.98530e-06
638/01	9.50919e-04	6.58713e-02	1.32403e-04	1.14409e-02	-3.50681e-02	-3.36601e-03
638/02	9.56530e-04	7.80338e-02	1.23748e-04	1.12315e-02	-3.56542e-02	1.09885e-05
639/01	1.04320e-03	2.52952e-02	1.40622e-04	6.21451e-03	-3.53283e-02	3.04204e-06
640/01	1.00148e-03	5.82274e-02	1.27117e-04	1.04033e-02	-3.66884e-02	2.11902e-06
641/01	1.05440e-03	1.83870e-02	1.42925e-04	1.08835e-02	-3.86705e-02	8.50993e-06
642/01	1.03749e-03	1.60932e-02	1.47873e-04	1.12946e-02	-3.81780e-02	-2.00813e-07
643/01	1.00048e-03	4.27507e-02	1.37637e-04	1.20439e-02	-3.76819e-02	1.59521e-06
644/01	1.00624e-03	4.85052e-02	1.33297e-04	9.00722e-03	-3.57159e-02	1.06581e-05
645/01	1.04801e-03	2.20436e-02	1.42023e-04	1.13548e-02	-3.83954e-02	4.02403e-06

Sta/ Cast	O_c Slope (c_1)	Offset (c_2)	P_l coeff (c_3)	T_f coeff (c_4)	T_s coeff (c_5)	$\frac{dO_c}{dt}$ coeff (c_6)
646/01	1.02330e-03	3.64706e-02	1.37836e-04	6.64961e-03	-3.49299e-02	-4.23685e-06
647/01	9.76003e-04	6.37736e-02	1.29432e-04	9.31256e-03	-3.47213e-02	7.96156e-07
648/01	9.94300e-04	6.43027e-02	1.25662e-04	1.56189e-02	-4.13242e-02	7.25048e-06
649/01	9.93448e-04	5.74798e-02	1.30624e-04	1.23833e-02	-3.82083e-02	5.69208e-06
650/01	9.79934e-04	6.68390e-02	1.27531e-04	1.33284e-02	-3.93932e-02	4.10778e-06
651/01	9.37710e-04	7.76155e-02	1.29066e-04	9.74912e-03	-3.41025e-02	5.73575e-06
652/01	1.09040e-03	1.75203e-02	1.37171e-04	4.20404e-03	-3.61652e-02	-1.93357e-06
653/01	7.14084e-04	1.32563e-01	1.47289e-04	4.05906e-03	-1.71706e-02	4.03981e-06
654/01	1.24744e-03	3.88045e-03	9.05094e-05	9.47467e-03	-4.69683e-02	-6.01766e-06
655/01	1.50026e-03	1.26529e-01	-1.13272e-04	-1.04022e-02	-4.02903e-02	-5.74014e-06
656/01	8.90372e-04	7.65913e-02	1.83732e-04	8.19779e-03	-3.28136e-02	-2.71402e-06
657/01	9.36008e-04	8.49884e-02	1.29315e-04	-1.21543e-03	-2.66726e-02	-8.10695e-07
658/01	1.87777e-03	-5.85195e-02	-1.14223e-04	-1.66134e-02	-4.52914e-02	3.97718e-07
659/01	9.56837e-04	1.12100e-02	1.78004e-04	-3.20518e-03	-2.39895e-02	-8.15257e-08
660/01	8.29284e-04	1.27265e-01	9.96201e-05	-9.02714e-03	-1.48927e-02	-1.09412e-06
661/01	9.27582e-04	5.84253e-02	1.44686e-04	-5.40439e-03	-2.25216e-02	-2.31779e-06
662/01	9.20453e-04	6.52191e-02	1.42561e-04	-2.30557e-03	-2.45354e-02	-8.89595e-06
663/01	9.80224e-04	5.27852e-02	1.36320e-04	-1.29483e-03	-2.78544e-02	-4.44421e-06
664/01	9.74345e-04	4.76618e-02	1.41459e-04	-1.71617e-03	-2.70522e-02	-3.05812e-06
665/01	1.02868e-03	3.54211e-02	1.35877e-04	-3.05621e-03	-2.92064e-02	-4.59003e-06
666/01	9.60976e-04	5.58690e-02	1.35600e-04	-2.92093e-03	-2.55131e-02	3.32596e-06
667/01	9.59295e-04	5.71419e-02	1.34537e-04	3.81305e-03	-2.97449e-02	6.89174e-06
668/01	8.46336e-04	1.02034e-01	1.25732e-04	7.34139e-03	-2.64827e-02	9.29377e-06
669/01	8.68790e-04	1.00594e-01	1.21951e-04	1.28199e-03	-2.41467e-02	3.03921e-05
670/01	8.33439e-04	4.63026e-02	1.37788e-04	-1.79140e-03	-2.51988e-02	-1.87750e-04
671/01	7.23775e-04	1.12982e-01	1.18656e-04	4.02840e-03	-2.38585e-02	-2.24179e-03
672/01	6.03974e-04	1.79742e-01	1.02825e-04	9.72739e-03	-2.11347e-02	-1.43153e-03
673/01	5.58200e-04	1.88926e-01	1.08705e-04	7.19718e-03	-1.48618e-02	-2.40977e-03
674/01	6.11174e-04	1.77537e-01	1.01233e-04	6.31921e-03	-1.93108e-02	-1.40206e-03
675/01	8.56054e-04	5.25890e-02	1.31288e-04	-8.91420e-04	-2.59137e-02	1.83662e-05
676/01	7.53912e-04	1.05790e-01	1.18948e-04	6.17905e-03	-2.64106e-02	-1.06495e-03
677/01	1.04392e-03	-4.67413e-02	1.79182e-04	1.99494e-02	-5.20233e-02	-9.97028e-04
678/01	7.03189e-04	9.00987e-02	1.52088e-04	2.43536e-03	-2.07706e-02	-4.12289e-03
679/01	8.76839e-04	4.15725e-02	1.50807e-04	1.11445e-02	-3.64605e-02	-5.58709e-07
680/01	8.44374e-04	5.33049e-02	1.30037e-04	8.03752e-03	-3.21694e-02	3.72503e-05
681/01	7.02807e-04	1.28167e-01	1.37612e-04	7.99378e-03	-2.32808e-02	6.01040e-05
682/01	5.98965e-04	1.38718e-01	1.44709e-04	3.79490e-03	-1.36950e-02	6.95610e-05
683/01	7.31619e-04	1.02092e-01	1.21470e-04	6.85026e-03	-2.51722e-02	-2.66348e-03
684/01	7.44615e-04	1.28278e-01	1.54842e-04	7.69465e-03	-2.76981e-02	-2.38704e-03
685/01	5.88665e-04	1.43812e-01	1.72007e-04	1.83691e-03	-1.10820e-02	-2.90625e-03
686/01	6.06726e-04	1.06140e-01	2.10265e-04	-2.02957e-03	-9.72328e-03	-2.66070e-03
687/01	5.51496e-04	1.68822e-01	1.71744e-04	-1.50664e-04	-9.49124e-03	-1.39397e-03
688/01	5.58019e-04	1.26686e-01	2.15490e-04	-1.33940e-03	-7.89712e-03	1.07387e-05

Sta/ Cast	O_c Slope (c_1)	Offset (c_2)	P_l coeff (c_3)	T_f coeff (c_4)	T_s coeff (c_5)	$\frac{dO_c}{dt}$ coeff (c_6)
689/01	4.94659e-04	1.82626e-01	1.83764e-04	6.49332e-03	-1.01690e-02	5.90994e-05
690/01	6.75493e-04	9.48426e-02	2.50054e-04	1.32429e-02	-2.58291e-02	-8.79153e-04
691/01	5.70899e-04	1.42745e-01	2.31125e-04	1.64078e-02	-2.07008e-02	-3.28404e-03
692/01	5.38114e-04	1.69848e-01	2.20143e-04	8.34531e-03	-1.34671e-02	-3.17084e-03
693/01	5.46580e-04	1.94253e-01	2.09946e-04	1.15516e-02	-1.78489e-02	-8.14990e-04
694/01	7.14287e-04	1.34462e-01	2.77503e-04	1.56618e-02	-3.10078e-02	-1.11644e-03
695/01	6.62942e-04	1.43333e-01	2.47668e-04	-1.37620e-03	-1.57640e-02	-9.93555e-04
696/01	9.12717e-04	9.56860e-02	2.35513e-04	8.47153e-03	-3.56654e-02	2.60426e-04
697/01	7.87334e-04	1.10898e-01	2.68097e-04	2.73503e-03	-2.55930e-02	-3.35986e-04
698/01	9.44029e-04	4.52845e-02	1.43197e-04	-3.70445e-05	-2.58645e-02	1.02184e-05
699/01	1.03446e-03	3.04596e-03	1.51794e-04	3.69996e-03	-3.10971e-02	-6.21044e-06
700/01	9.40915e-04	4.30285e-02	1.44523e-04	-2.28458e-04	-2.53433e-02	2.28777e-05
701/01	1.04124e-03	1.85112e-02	1.41270e-04	2.81364e-03	-3.11871e-02	9.57219e-06
702/01	1.04968e-03	1.04040e-03	1.53123e-04	6.04594e-03	-3.37982e-02	4.34827e-06
703/01	1.05228e-03	6.09741e-03	1.46263e-04	5.54159e-03	-3.26394e-02	4.22341e-06
704/01	1.06037e-03	2.17247e-03	1.49747e-04	-1.25231e-03	-2.88957e-02	2.67703e-06
705/01	1.09003e-03	-6.26028e-03	1.49503e-04	3.60156e-03	-3.32216e-02	5.31679e-06
706/01	1.05822e-03	-5.40587e-03	1.55374e-04	1.52428e-03	-2.97839e-02	-2.88859e-06
707/01	9.45809e-04	4.20144e-02	1.42315e-04	1.65140e-03	-2.63491e-02	-6.23200e-06

NOTE: after the CTD O_2 corrections were finalized, the bottle oxygen blanks and thiosulfate normalities were smoothed. Normally this step occurs before CTD O_2 corrections are calculated, since these corrections are based on a fit of CTD to bottle data. This smoothing shifted the bottle values up to 0.02 ml/l, and the CTD O_2 data were adjusted accordingly. (A first-order fit of the bottle data differences as a function of [old] bottle oxygen values, calculated station by station, was applied to "finalized" CTD O_2 data to effectively make an identical adjustment to the CTD O_2 values.)

Appendix C

WOCE95-I4/I5W/I7C: CTD Shipboard and Processing Comments

Key to Problem/Comment Abbreviations	
BQ	bottle oxygen value(s) questionable/missing, need to estimate for ctdoxy fit
CO	conductivity offset
DI	density inversion: data consistent/smooth in time-series ctd, possibly real
OB	bottom ctdoxy signal shift coincides with slowdown for bottom approach
OF	ctdoxy fit off more than 0.02 ml/l (deeper) or 0.10 ml/l (shallower) compared to bottle data and/or nearby ctd casts
OH	ctdoxy fit high near surface: high raw ctdoxy signal
OL	ctdoxy fit low near surface: low ctdoxy signal, often caused by slow transit through surface area
ON	ctdoxy signal unusually noisy
OP	ctdoxy signal zeroes going into water, then rises slowly in top ~100db in x steps; possible ctdoxy sensor/cabling/power problem
OS	raw ctdoxy signal shifts
SR	severe ship-roll problems: "yoyos" 5 db or larger detected during cast
SS	probable sea slime on conductivity sensor
UP	used up-cast data for final pressure-series data
WS	winch slowdown/stop, potential shift in ctdoxy signal (also, see "OB")

Key to Solution/Action Abbreviations	
DC	despiked conductivity (used instead of "OC" for short "SS" segments) - see .ctd file codes
DO	despiked raw ctdoxy, despiked data ok unless otherwise indicated
DS	despiked salinity, changed temperature and/or conductivity - see .ctd file codes
DU	down/up ctdoxy differ or similar features at different pressures in this area; but downcast ctd Salinity and Oxygen structures often correspond well with each other
EB	used nearby bottles and/or casts to estimate bottle oxygen value(s) for ctdoxy fit
GD/GS	downcast high-gradient areas Deeper/Shallower than upcast, ok if (upcast) btls do not match (downcast) ctdoxy in these areas
NA	no action taken, used default quality code 2
O3/O4	quality code 3/4 oxygen in .ctd file for pressures specified
OC	offset conductivity channel to account for shift/offset (units: mS/cm)
OK	ctdoxy data consistent with nearby and/or repeat cast(s) (±0.02 ml/l) after offset/despiking; may be coded 3 anyways because of extensive despiking or multiple offsets
RO	offset raw ctdoxy data to account for signal shift caused by slowdown/stop/yoyo; usually "DO" in transition area near offset
S3	quality code 3 salinity in .ctd file for pressures specified

Cast	Problem/Comment	Solution/Action
574/01	WS/1 min. at 3998-4002db, 1 min. at bottom 4db, ctdoxy signal shifts	O3/4000-4010db, DO/4636-4640db/btm
575-576	surface btl+ctdoxy +0.20 ml/l compared to subsequent casts	NA/very different top 300 db, other bottle parameters also differ - probably real

Cast	Problem/Comment	Solution/Action
575/01	DI/-0.018 top 6db OF/±0.15 ml/l compared to btls OF/max.+0.03 ml/l compared to btl at bottom; also odd drop at 3926-3982db: large up drop at same prs likely caused by btl stop	NA NA/0-180db, DU O3/4850-4994db/btm
576/01	ON/OF/±0.15 ml/l compared to btls	NA/40-120db, 250-350db; DU
577/01	ON/OF/max.-0.22 ml/l compared to 2 btls -0.02-3 ml/l drops in ctdoxy, no apparent slowdown SS/CO	NA/240-400db, down/up differ here O3/4282-4292db, O3/4470-4492db, both may be ok: similar drops on upcast may be caused by btl stop OC +0.19/S3 1382-1500db, large area, so coded 3
578/01	OS ON/OF/max.+0.20 ml/l compared to btls	DO/RO +40/2-36db NA/70-140db, GD/30db, DU; stas 578-581 downcasts similar here
579/01	DI/-0.015 top 6db OS ON/OF/max.±0.30 ml/l compared to btls OS	NA DO/RO +35 to +25/2-14db in 2 steps NA/0-210db, GD/15db, DU; stas 578-581 downcasts similar 50db+ RO +2/3860-3900db
580/01	OS ON/OF/max.+0.25 ml/l compared to btls	DO/RO +30/2-52db NA/60-150db, GD/15db, DU; stas 578-581 downcasts similar 50db+
581/01	OS/OL/max.-0.07 ml/l compared to btl/nearby casts OF/max.±0.10 ml/l compared to btls, ok compared to nearby casts	DO/RO +60/2-54db, O3/0-20db NA/22-110db, GD/20db, DU; stas 578-581 downcasts similar 50db+
582/01	DI/-0.014 top 6db OS/OL/sharp raw ctdoxy rise 12-18db OF/max.+0.10 ml/l compared to btls	NA DO/RO +40/0-12db, OK after despike NA/0-220db, GD/20db, DU
583/01	DI/-0.023 top 6db OB	NA RO +10/702-752db/btm
584/01	OL/-0.05 ml/l compared to btl/nearby cast DI/-0.024 top 10db SS/CO	O3/0-30db NA DS/+0.33 to +0.85PSU, 26-34db
585/01	BQ/OH/+0.10 ml/l or more compared to nearby cast, slow transit near surface	O3/0-4db

Cast	Problem/Comment	Solution/Action
587/01	OF/max.+0.10+ ml/l compared to btls OS/ON	NA/40-120db, up ctdoxy noisy but generally similar shape, ctdS/oxy features correlate RO +2/2986-3016db, DO/3022-3036db
588/01	DI/-0.019 top 10db OF/max.+0.15+ ml/l compared to btl	NA NA/40-70db, DU
589/01	OF/btl+ctdoxy -0.10 ml/l compared to nearby casts OF/max.-0.10 ml/l compared to btls	NA/0-120db, unusual S/oxy features, GS/10db, DU NA/165-225db, ctdoxy feature broader on down vs up, otherwise similar here
590/01	OF/max.±0.15 ml/l compared to btls OB	O3/40-98db, NA/100-225db, GD/20db, DU RO +3/3596-3626db/btm
591/01	OL/-0.20 ml/l compared to btls/nearby casts	O3/8-56db
592/01	OL/-0.20 to +0.10 ml/l compared to btls/nearby casts OB SS/CO	O3/8-70db RO +2/3700-3722db/btm OC -0.0005/3680-3716db
593/01	OF/max.±0.25 ml/l compared to btls	NA/0-150db, GD/20db, DU
594/01	OF/max.±0.15 ml/l compared to btls	NA/40-130db, GD/25db, DU
595/01	OF/max.±0.10 ml/l compared to btls OS	NA/35-130db, GD/25db, DU RO +2/3528-3554db
596/01	DI/-0.015 top 6db OL/-0.12 ml/l compared to btls/nearby casts OF/max.±0.15 ml/l compared to btls OB	NA O3/18-40db NA/40-140db, GD/10db, DU RO +1/3600-3610db/btm
597/01	OS/ON/OL/ctdoxy -0.15 ml/l before despike, now -0.05 ml/l compared to btls	RO +40 to +20/0-48db in 2 steps, DO/0-58db, O3/12-40db
598/01	DI/-0.024 top 6db	NA
600/01	OL/-0.10 to +0.15 ml/l compared to btls/nearby casts OF/max.±0.10 ml/l compared to btls OF/+0.03 ml/l compared to btl/upcast/nearby casts	O3/24-68db, upcast noisy, but seems to rise through this area also NA/70-340db, GS/15db, DU O3/2906-2936db
601/01	OF/max.+0.12 ml/l compared to btls OF/max.-0.12 ml/l compared to btls	O3/36-82db NA/84-160db, GD/5db

Cast	Problem/Comment	Solution/Action
602/01	DI/-0.014 top 6db	NA
	OF/max.+0.12 ml/l compared to btls	O3/30-84db
	OF/max.+0.10 ml/l compared to btls	NA/86-120db, GD/10db
603/01	OF/+0.12 ml/l compared to btl/nearby casts	O3/50-108db
	OF/ctdoxy does not match btls below 84db	OK/86-140db: GS/25db
604/01	OS/ON/OL/-0.05 ml/l compared to btls/nearby casts	DO/RO +70 to +20/2-70db in 4 steps; O3/4-28db, still low after offset/despike
	OL/ON/OF/less than ±0.10 ml/l compared to btls/nearby casts	0-350db, GD/10db, half of btl-ctd difference is hi ctd noise level; not coded except as noted above
	SR/2x5db yoyos at 318db, 350db	NA/any effect lost in the larger noise level, see above comment
605/01	Strong snap-roll going in water = bad kink in wire; only one good conductor on port wire	NA/no apparent effect on data
	OF/+0.15 ml/l compared to btls/nearby casts	O3/34-76db, deeper area OK: GD/10db
606/01	Reterminated (both) wires prior to cast	NA
	OS/ON/OH/surface rawoxy values 15% higher than normal, rapidly dropping signal	DO/RO -360 to -80/2-52db in 7 steps, O3/0-52db; surface ctdoxy looks ok after despike/offset, but huge change over large area - so coded 3
	OF/max.-0.10 ml/l compared to btls, ok compared to nearby casts	NA/292-414db, down/up differ, upcast seems to match btls ok
607/01	drop-section in downcast matches upcast structure, no btls	NA/0-90db
608/01	OF/+0.10 ml/l compared to btls/upcast/nearby casts	O3/14-50db
	OF/+0.20 ml/l compared to btl, not comparable to nearby casts	O3/370-450db, questionable btl? may be OK?
610/01	DI/-0.015 top 10db	NA
611/01	New ctd wire/termination on port winch during Durban portstop prior to cast	NA
612/01	DI/-0.013 at 130db, -0.03 at 140-150db: not visible upcast, btl stop at 149-153db may have obliterated; DI/-0.07 at 158db: feature also seen in salinity, same-magnitude feature present at 152-156db on upcast	NA/130-160db, inversions may be real, check LADCP for possible current shear/mixing?

Cast	Problem/Comment	Solution/Action
613/01	Undocumented problem at ~225m. on first cast attempt: brought cast back up and restarted	NA
	OF/max.+0.20 ml/l compared to btls, may be ok compared to nearby casts	NA/28-108db, upcast ctdoxy shows same rise here
	OF/max.±0.15 ml/l compared to btls	NA/110-180db, GD/5db, DU
614/01	ctd left powered-on after previous cast, not turned off till this cast over	NA/no apparent effect on data
	OS	DO/RO +30/0-22db
	OF/+0.10 to +0.30 ml/l compared to btls, incomparable to nearby casts	NA/40-130db, DU may account for some of btl-ctd difference, especially 75-130db
615/01	OF/+0.05 to +0.30+ ml/l compared to btls, ok compared to nearby casts	NA/60-140db, DU could account for most of btl-ctd difference
616/01	OS	DO/RO +30/2-18db
	OF/max.+0.15 ml/l compared to btl/nearby casts	O3/32-68db, up/nearby casts do not show similar rise at this point, no comparable structure in ctdS
617/01	OF/surface btloxy -0.05 ml/l compared to nearby casts	NA/0-60db, ctdoxy was fit using surface btl value from previous cast, still fit through this btl
	OF/max.-0.10 ml/l compared to btls below oxycline	NA/62-324db, DU
618/01	DI/-0.017 top 6db	NA
	OS	DO/RO +20/2-16db
	OF/±0.15 to 0.40+ ml/l compared to many btls	NA/0-420db, DU fits in with trend of nearby casts
	OS	RO +2/2930-2950db
619/01	ABORT at 2900m down: pylon failed	NA/reported cast anyways
	BQ/no btls tripped this cast due to pylon communications problem	EB/whole cast, as needed; cast 2 btl values used, matched to ctd by density
	OF/±0.20+ ml/l compared to many cast 2 btls	NA/76-220db, cast 2 gradients 10-15m deeper and ctdoxy different shape; large ctdoxy drop on cast 2 matches ~100db btl, but no such drop on cast 1 down or up - OK
	WS/19 mins., 14db yoyo at bottom while testing pylon, ctdoxy signal shifts	DO/2884-2888db/btm

Cast	Problem/Comment	Solution/Action
619/02	New rosette harness prior to cast; 4 attempts in 1 hour to start this cast: 2 attempts on port winch, 3rd attempt on stbd. revealed problem was harness, 4th/successful attempt with new harness on stbd. winch ok	NA
	OS	DO/RO +20/8-28db
	OF/max.+0.20 ml/l compared to btls	NA/60-240db, DU
	OB	RO -1/2988-2998db/btm
620/01	Back to port winch (not reterminated), new underwater connector to pylon	NA
	DI/-0.014 top 6db	NA
	OS	DO/RO +50/2-40db
	OF/-0.18 to +0.50 ml/l compared to btls	NA/50-240db, DU especially 120-140db: large drop on up in S/oxy (ctd and btl) not seen at all on down
621/01	DI/-0.020 top 10db	NA
	OS/ON/large drop this area	DO/RO +50/6-58db, O3/0-58db; improved after offset/despike, but ctdoxy still seems odd
	OF/max.+0.25 ml/l compared to btls	NA/100-200db, DU
622/01	ON	DO/whole cast, as needed
	ON/OF/mostly ±0.10 to 0.30 ml/l compared to btls, ±0.10 ml/l compared to nearby casts	DO/O3/0-148db, down/up ctdoxy generally resemble each other, and stas 620-623 similar near surface; but ctdoxy very noisy, hard to identify true signal here
	OF/high-gradient, highly variable area	NA/150-220db, DU
623/01	DI/-0.014 top 6db	NA
	OF/max.+0.20 ml/l compared to btl	NA/28-82db, up has same lower-oxy feature here, but more pronounced than on down
	OF/max.±0.15 ml/l compared to btls below oxycline	NA/84-228db, GS/15-20db
624-640	stas 626-629/634-637/640+ surface (0-50db) btloxy values agree with ea. other; surface btloxys for stas 624-625/630-633/638(c.1+2)-639 agree but approx. +0.10 ml/l compared to first group	NA/btloxy processors found no reason to question btl values, ctdoxys generally fit through btloxy values
624/01	Surface btloxy values jump approx. +0.20 ml/l between 623/624	NA/see note above for stas 624-640, larger jump between 623/624 probably real
	ON/OF/-0.05 to +0.25 ml/l compared to btls	DO/O3/0-218db
	SS/CO	OC +0.005/2416-2496db, OC +0.006/2498-3596db (+0.006 also applied to entire upcast for trip data)

Cast	Problem/Comment	Solution/Action
625/01	UP/18x8-46db segments of -0.005 to -0.024 mS/cm conductivity drops during downcast, upcast dropouts fewer and much shorter duration	DC/bottle stops, as needed, misc.short segments upcast
	ON/OF/±0.02 to 0.03 ml/l off at bottom 3 btls (upcast)	DO/O3/3100-3572db/btm
626/01	DI/-0.023 top 6db	NA
	OL/-0.06 to -0.30 ml/l compared to upcast/btls/nearby casts	DO/O3/0-76db, very noisy signal, difficult to decipher true shape
	OF/-0.10 to +0.30 ml/l compared to btls, not comparable to nearby casts	NA/78-250db, DU
	SR/4x5-6db yoyos at 1036db, 1044db, 1578db, 1586db; ctdoxy signal shifts	O3/1036-1048db, O3/1578-1602db
627/01	DI/-0.032 top 6db	NA
	ON/numerous small drops in rawoxy signal	DO/OK after despike whole cast, as needed
	OF/+0.04 to +0.30 ml/l compared to btls	NA/50-136db, NA/200-218db, DU; stas 627-629 similar ctdoxy top 130m
	ON/6db yoyo at 3090db, ctdoxy signal shifts near bottom	DO/3064-3092db/btm
628/01	SS/CO	OC +2.08/12-16db
	OL/max.-0.10 ml/l compared to nearby area	NA/6-90db, nearby casts similar ctdoxy structure, DU; upcast not comparable because of slowdown at surface
	OF/max.+0.20 ml/l compared to bottles	NA/92-186db: GS/10db, ctdoxy features also differ in magnitude on down/up casts; DU below 140db
	OF/ctdoxy/bottom btl look high compared to nearby casts, then upcast offset high compared to downcast	O3/2370-2372db
629/01	DI/-0.013 top 6db	NA
	ON	DO/whole cast, as needed, larger spikes/drops only
	OL/max.-0.20 ml/l compared to nearby area, nearby casts drop half as much	O3/8-52db
630/01	ON	DO/whole cast, as needed, larger spikes/drops only
	OB	RO +4/1520-1576db/btm
631/01	ON	DO/whole cast, as needed, larger spikes/drops only
	OB	RO +8/1278-1282db/btm

Cast	Problem/Comment	Solution/Action
632/01	DI/-0.015 top 6db	NA
	ON	DO/whole cast, as needed
	OF/max.±0.10 ml/l compared to btls/nearby casts	NA/0-210db, high noise level causes misc. drops and rises, similar noise level in rest of cast/upcast; DU
634/01	ON	DO/whole cast, as needed
	OF/-0.20 ml/l compared to btl, overlays nearby casts	NA/280-370db, down feature less pronounced than up and centered 20m deeper
635/01	ON/max.±0.20 ml/l compared to btls/nearby casts	DO/O3/0-120db, ctdoxy looks odd compared to nearby casts after despiking, too noisy to accurately determine true signal; up has similar noise/fluctuations
636/01	DI/-0.033 top 6db	NA
	OS/OF/within 0.05 ml/l except 104db btl; not many btls to compare with	RO +30/2-26db, NA/28-170db: GD/15db
	OS	RO +4/2568-2598db
637/01	No altimeter return during bottom approach: PDR scale mis-read by 750m	NA
	DI/-0.022 top 10db	NA
	ON/OL/-0.10 to -0.40 ml/l compared to btl/nearby casts	DO/O3/0-58db, much despiking top 6db and 50-58db, rest too noisy to accurately determine true signal; up very different, no such drops
638/01	Deepest pressure 750+m off bottom: PDR scale mis-read prior to sta 637	NA/cast reported anyways
	OS/OL/OF/-0.10 ml/l compared to cast 2 ctdoxy/ cast 1+2 btls - ctdoxy matches sta 637, but surface btloxys jump +0.10 ml/l between stas 637-638	DO/RO +120 to +40/2-94db in 3 steps; O3/0-66db, surface very low at start, still low after offset; low noise level this cast; see cmmts stas 624-640 re: surface btloxy values
	WS/1 min. + 5db yoyo at 4024-4030db, ctdoxy signal shifts	O3/4030-4038db
638/02	750m deeper than cast 1; error in PDR bottom scale reading before sta.637, detected half-hour into run toward sta 639	about-face/re-do station, cast 2 to correct bottom depth
	DI/-0.014 top 6db	NA
	OL/-0.10 to -0.30 ml/l compared to btls/nearby casts	O3/18-44db
	BQ/bottom btl	EB/4836db
	OF/ctdoxy +0.04 ml/l compared to nearby deeper casts	O3/4650-4836db/btm

Cast	Problem/Comment	Solution/Action
639/01	OL/max.-0.10 ml/l compared to btls/nearby casts	DO/O3/0-66db, much despiking this area, too noisy to accurately determine true signal; up even noisier, no help
	OF/max.+0.10 ml/l compared to btls	NA/260-520db, GS/10db, DU; dynamically changing area
640/01	OF/max.-0.15 ml/l compared to btls/nearby casts	NA/14-84db, DU: ctdoxy corresponds with ctdS/density feature seen only on this downcast, smaller/noisier drop seen on up ctdoxy
641/01	ON	DO/whole cast, as needed
	OF/ctdoxy does not match btls/nearby casts well	NA/0-115db, DU: smaller-scale features 5-10db deeper
	OS/OB	RO -2/5172-5182db, RO +2/5184-5186db/btm
642/01	OB	RO -1/5168-5178db/btm
643/01	OF/OL/ON/max.-0.13 ml/l compared to btls/nearby casts, especially top 36db	DO/O3/0-88db, much despiking this area, too noisy to accurately determine true signal; generally resembles upcast/nearby casts
	OF/max.-0.03 ml/l compared to btls/nearby casts	O3/3762-4618db
	OF/max.+0.04 ml/l compared to btls/nearby casts	O3/5158-5202db/btm
644/01	DI/-0.019 top 6db	NA
	OS/OF/OL/-0.06 to -0.10 ml/l compared to btls/nearby casts/upcast	DO/RO +40/2-38db, O3/0-42db, O3/66-80db
	OL/-0.05 to +0.30 ml/l compared to btls	NA/120-190db, GD/20db
645/01	DI/-0.019 top 10db	NA
	OF/max.-0.15 ml/l compared to btls, top 24m btl+ctdoxy -0.30 ml/l compared to nearby casts	NA/0-200db, DU: down has more pronounced rises/drops in ctdS/oxy
	OF/+0.03 ml/l compared to bottom btl	NA/5000-5074db/btm, overlays well with nearby ctd casts this range
646/01	DI/-0.019 top 6db	NA
	OF/+0.03 ml/l compared to bottom btl	NA/4980-5076db, overlays well with nearby ctd casts this range
647/01	OL/-0.10 or more ml/l compared to nearby casts, btl+ctdoxy match	NA/0-110db, down/up ctdoxy completely different structure than nearby casts, GD/10db
	BQ/bottom bottle looks ok compared to nearby casts	EB/3600-4800db
	OB	RO +2/4838-4842db/btm

Cast	Problem/Comment	Solution/Action
648/01	DI/-0.016 top 6db	NA
	OL/ctdoxy -0.15 ml/l compared to sta 649, no btl this area	O3/8-28db, drop also seen on up, although drop starts at bottle stop; down ctdoxy overlays previous cast here - may be OK?
	OF/ctdoxy +0.20 ml/l compared to btl/upcast	NA/270-340db, DU: up ctdS/oxy both drop here but down does not
649/01	OS/OL/-0.05 ml/l compared to btl/previous cast	DO/RO +25/0-44db, O3/0-20db, low ctdoxy at start, still low after despike, although matches next cast
	OF/-0.10 to +0.15 ml/l compared to btls, not comparable to nearby casts	NA/140-320db, GD/15db, DU
650/01	BQ/surface btl + bottom btl	EB/4db + 4334db
	OS/OL/-0.05 ml/l compared to nearby casts	DO/RO +15/2-36db, O3/0-16db, low ctdoxy at start and no btloxy here, still low after despike, although matches previous cast
651/01	DI/-0.017 top 6db	NA
	OL/max.-0.20 ml/l compared to btls/nearby casts	O3/24-48db, double ctdoxy drop also seen up, over half as many pressure intervals; deeper up-drop could be caused by btl stop, but no slowdown/stop on down here - may be OK?
	BQ/used these btloxys for fit despite quality code 3	NA/100-1800db, ctdoxy looks OK compared to nearby casts
	OF/max.+0.02-0.03 ml/l compared to bottom btl/ nearby casts	O3/4200-4340db/btm
652/01	ON	DO/whole cast, as needed, larger spikes/drops only
	OS/ON/OH/only 74 secs. between ctd power-on/in-water: not enough warm-up for ctdoxy sensor	DO/RO -185 to -30/2-98db in 6 steps, O3/0-64db; large offset/despike applied to top 100db, uncertain of true shape through this area with the biggest changes; may be OK now? same shape as upcast and overlays well with nearby casts
	OF/-0.05 to +0.20 ml/l compared to btls	NA/90-180db: GD/20db, compares well with nearby casts, although noisy
653/01	OS/OL/ON/low and noisy rawoxy near surface	DO/RO +60 to +50/2-50db in 2 steps, OK after offset/despike
	OL/max.-0.20 ml/l compared to btl/nearby casts	NA/24-30db, OK? drop also seen sta 651 and on upcast; up-drop could be caused by btl stop, but no slowdown/stop on down here
	OF/max.+0.15 ml/l compared to btls	NA/52-120db, compares well with nearby casts, GD/10db

Cast	Problem/Comment	Solution/Action
654/01	ON	DO/whole cast, as needed, larger spikes/drops only
	OS/OH/raw ctdoxy high at surface	DO/RO -30 to -10/0-14db in 2 steps, OK after offset/despike
	OL/max.-0.20 ml/l compared to nearby casts (no btl)	O3/34-56db, no such feature visible on up either
655/01	OS/ON/OH/raw ctdoxy somewhat high at surface	RO -30/0-10db, DO/0-18db, OK after offset/despike
656/01	OF/high compared to btls, not comparable to nearby casts	NA/140-200db, GD/15+db, DU
660/01	OS/OH/raw ctdoxy high at surface	DO/RO -30/0-28db, OK after despike
661/01	OS/OH/raw ctdoxy slightly high at surface	DO/RO -10/0-32db, OK after despike
	OF/max.-0.30 ml/l compared to btls, nearby casts	NA/76-120db: GS/20db, DU
	OF/max.±0.10 ml/l compared to btls	NA/122-330db, DU; btloxys lower than nearby casts also, but match sta 660 btl/ctdoxys from 230-320db, then matches next few casts at deeper pressures
662/01	OS	RO -10/2-16db
664/01	ON	DO/0-1300db
665/01	OF/max.+0.20 ml/l compared to btls	NA/100-180db, GD/10db, DU: ctdoxy compares well to nearby casts
666/01	OL/max.-0.10 ml/l compared to btls: ctdoxy matches 667 btls/ctd, btloxy matches 665 btls/ctd	NA/30-70db, may be OK: downward-shift in ctdoxy top 60db, stas 665 to 667: sta 666 right down the middle; DU 15db from 60-110db
667/01	OF/max.±0.20 ml/l compared to btls	NA/70-250db, GD/20+db, DU; ctdoxy similar only to sta 668
668/01	Wind at 40+ knots, wave in inner wet lab	NA/see noise/yoyo problems stas 668-672
	OS/OL/max.-0.10 ml/l compared to btls/nearby casts after offset/despike	DO/RO +70/2-34db, O3/0-44db
	OF/max.+0.10 ml/l compared to btls	NA/85-150db, GD/10db, similar only to sta 667 in an area of change
	OF/max.+0.30 ml/l compared to btls	NA/220-400db, GD/50db, DU
	SR/5x5db yoyos at 324db, 536db, 802db, 1228db, 1414db	DO/O3/800-804db, ctdoxy signal shifts
	BQ	EB/4224db
669/01	OL/max.-0.30 ml/l compared to btls/nearby casts	RO +20/6-28db, O3/0-104db
	SR/4x5-9db yoyos at 180db, 186db, 232db, 550db	DO/O3/182-188db, O3/230-232db; ctdoxy signal shifts
	OB	RO -1/4202-4206db/btm

Cast	Problem/Comment	Solution/Action
670-697	New/replacement ctdoxy sensor used for these casts. Whenever ctdoxy sensor entered the water, big drop in rawoxy values within ~1 second, then rose slowly during top ~100+db. After the first few casts, rawoxy value dropped to 0 and stayed there longer each cast, eventually rising again to "normal" values during the top ~100db. When exiting water, rawoxy values rose sharply within a second or two, often pegging out at maximum rawoxy value (4512) before dropping again to "normal" values. Over time, surface rawoxy values dropped by ~150, not counting the drops to 0 on first entering the water. The rawoxy values at 1000db and the bottom dropped by ~300 between stas 670-697. The 1000-db rawoxy drop may be normal - that much change is seen between 669-698 (old sensor). Bottom calibrated ctdoxys for 698-707 overlay well, but continually dropping for 670-697, except when it's apparent that someone attempted to fix the problem near the end of that sensor's use	Conservatively coded many levels O3/or O4, much higher overall noise level and nearly triple standard deviation (btloxy vs ctdoxy, before O3/O4/coded levels removed) compared to other casts this leg
670/01	OL/ON/OF/ctdoxy -0.60 ml/l compared to surface btl: very low rawoxy at start of cast	DO/O4/0-100db, still fits low after extensive despiking
	ON/OF/very noisy, especially top 700db; SR/over 25x5-10db yoyos/stops/ctdoxy signal shifts in top 1180db; -0.30 ml/l ctdoxy drop at 1012-1036db not seen upcast/nearby casts	DO/O3/102-1180db
	SR/2x7db yoyos at 1374-1378db, 2x6-8db yoyos at 2168-2180db; ctdoxy signal shifts	DO/OK after despike
671/01	ON/very noisy, especially top 750db	DO/whole cast, as needed
	OP; OL/ON/OF/max.-0.25 ml/l compared to btls	DO/RO +240 to +50/2-100db in 4 steps; O4/0-102db
	SR/4x5-7db yoyos at 496db, 504db	O3/504-510db, ctdoxy signal shifts
	OB/SR/2x5-7db yoyos at 4286db, 4290db/btm; ctdoxy signal shifts	RO -3/4286-4290db/btm
672/01	ON/especially top 1000db	DO/whole cast, as needed
	OP; OL/ON/OF/max.-0.30 ml/l compared to btls	DO/RO +220 to +20/2-70db in 3 steps; O4/0-90db
	SR/9x5-8db yoyos at 228db, 518db, 698db, 772db, 802db, 890db, 1010db, 1016db, 1030db	DO as needed/OK except as noted below
	OF/max.+0.25 ml/l compared to btl, 30-second/8-db yoyo 518-510db causes higher spike at 520-522db	O3/498-538db

Cast	Problem/Comment	Solution/Action
673/01	ON/especially top 900db	DO/whole cast, as needed
	OP; OL/ON/OF/max.-0.20 ml/l compared to btls	DO/RO +310 to +50/2-104db in 3 steps; O4/0-118db
	OB	RO -2/4224-4236db/btm
674/01	ON/deeper sections OK compared to nearby casts	DO/0-700db
	OP; OL/ON/OF/max.-0.25 ml/l compared to btls	DO/RO +250 to +20/2-82db in 4 steps; O4/0-76db
	SR/2x5-7db yoyos at 400db, 404db; ctdoxy signal shifts	DO/398-410db, OK after despike
675/01	ON/especially top 1100db, increases again deep	DO/whole cast, as needed
	OP; OL/ON/OF/max.-0.15 ml/l compared to btls	DO/RO +210 to +20/2-62db in 4 steps; O4/0-62db
	OB	RO +3/4890-4902db/btm
	Hard landing on deck at end of cast	NA/no apparent effect on data
676/01	DI/-0.021 top 6db	NA
	ON/especially top 400db; entire cast somewhat noisy, better than nearby casts	DO/whole cast, as needed
	OP; OL/ON/OF/max.-0.10 ml/l compared to btls	DO/RO +270 to +30/0-24db in 5 steps; O4/0-42db
677/01	ON/entire cast very noisy	DO/whole cast, as needed
	OP; OL/ON/OF/max.±0.10 ml/l compared to btls	DO/RO +110 to +80/2-56db in 2 steps; O4/0-54db
	OB	RO -1/5136-5140db/btm
678/01	ON/especially top 1400db, increases again below 4100db	DO/whole cast, as needed
	OP; OL/ON/OF/max.-0.30 ml/l compared to btls, slow top 154db	
679/01	ON/especially top 700db	DO/whole cast, as needed
	OP; OL/ON/OF/OK compared to btls, but odd shape in between	DO/RO +80 to +20/2-12db in 2 steps; O4/0-56db
680/01	DI/-0.018 top 6db	NA
	ON/especially top 1250db, deeper sections better than nearby casts	DO/0-2500db
	OP; OL/ON/OF/max.-0.35 ml/l compared to btls	DO/RO +205 to +40/2-92db in 6 steps; O4/0-102db
	OL/ON/OF/max.-0.10 ml/l compared to btls	DO/O3/104-170db

Cast	Problem/Comment	Solution/Action
681/01	DI/-0.019 top 6db	NA
	ON/especially top 1000db, then 1450db to bottom progressively noisier	DO/whole cast, as needed
	OP; OL/ON/OF/max.-0.15 ml/l compared to btls	DO/RO +200 to +30/2-68db in 4 steps; O4/0-70db
	OL/ON/OF/max.-0.25 ml/l compared to btls, drop not seen on upcast	DO/O3/110-132db
	OF/max.±0.05 ml/l compared to btls	DO/O3/1700-2500db, O3/2950-4070db
682/01	DI/-0.022 top 6db	NA
	ON/especially top 1100db, then 3800db to bottom progressively noisier	DO/whole cast, as needed
	OP; OL/ON/OF/max.-0.40 ml/l compared to btls	DO/RO +230 to +40/2-18db in 3 steps; O4/0-118db
	OF/max.+0.10 ml/l compared to btls	DO/O3/2600-3500db
683/01	DI/-0.020 top 6db	NA
	ON/especially top 1100db; deeper sections better than nearby casts	DO/0-2500db
	OP; OL/ON/OF/ok compared to btls	DO/RO +270 to +40/2-50db in 5 steps; O4/0-50db
	OF/max.+0.05 ml/l compared to btls	O3/2649-3150db
	OF/drifts to +0.06 ml/l compared to bottom btl	DO/O3/5110-5242db/btm
684/01	DI/-0.028 top 6db	NA
	ON/especially top 800db, then 2700db to bottom progressively noisier	DO/whole cast, as needed
	OP; OL/ON/OF/max.-0.25 ml/l compared to btls	DO/RO +300 to +20/0-40db in 6 steps; O4/0-90db
	OF/max.±0.10+ ml/l compared to btls	DO/O3/1600-3850db
	Large, 2-second drop in raw ctdoxy, did not hit bottom, no explanation	DO/5246-5248db/btm
685/01	OP; OL/ON/OF/max.-0.15+ ml/l compared to btls	DO/RO +235 to +30/0-34db in 4 steps; O4/0-84db
	OF/max.-0.14 ml/l compared to btls	DO/O3/1250-2550db
	ON/progressively noisier as approach bottom	DO/2000-5186db/btm
686/01	ON/especially top 600db, then 1400db to bottom progressively noisier	DO/whole cast, as needed
	OP; OL/ON/OF/max.-0.30 ml/l compared to btls	DO/RO +230 to +25/2-42db in 5 steps; O4/0-82db
	OF/max.-0.25 ml/l compared to btls	DO/O3/1350-2678db
	OB	RO +1/5308-5314db/btm

Cast	Problem/Comment	Solution/Action
687/01	ON/especially top 700db, then 1400db to bottom progressively noisier	DO/whole cast, as needed
	OP; OL/ON/OF/max.-0.06 ml/l compared to btls	DO/RO +430 to +60/2-38db in 6 steps; O4/0-58db
	OL/ON/OF/max.±0.15 ml/l compared to btls	DO/O3/1700-4100db
688/01	ON/especially top 700db, then 2600db to bottom progressively noisier	DO/whole cast, as needed
	OP; OL/ON/OF/max.-0.10 ml/l compared to btls	DO/RO +260 to +60/0-58db in 5 steps; O4/0-58db
	OF/max.-0.20 ml/l compared to btls	DO/O3/1400-2600db
	OF/max.+0.05 ml/l compared to btls	DO/O3/3100-3950db
689/01	Styrofoam cups [on package] this cast	NA/no apparent effect on data
	ON/top 150db somewhat noisy, then 2000db to bottom progressively noisier	DO/whole cast, as needed
	OP; OL/ON/OF/max.-0.15 ml/l compared to btls	DO/RO +260 to +30/0-66db in 5 steps; O4/0-60db
	OF/max.-0.12 ml/l compared to btls	DO/O3/1600-2650db
	OB/ON/OF/max.+0.05 ml/l compared to bottom btl after despike	DO/RO -2/5282-5290db/btm, O3/5236-5290db/btm
690/01	DI/-0.023 top 6db	NA
	ON/especially top 800db, then 1350db to bottom progressively noisier	DO/whole cast, as needed
	OP; OL/ON/OF/max.-0.08 ml/l compared to btls	DO/RO +400 to +15/2-48db in 5 steps; O4/0-54db
	OF/max.-0.18 ml/l compared to btls	DO/O3/1500-2500db
	OF/max.+0.08 ml/l compared to btls	DO/O3/2800-4000db
	ON/especially top 500db, then 1300db to bottom progressively noisier	DO/whole cast, as needed
691/01	OP; OL/ON/OF/max.-0.06 ml/l compared to btls	DO/RO +280 to +25/2-38db in 5 steps; O4/0-38db
	OL/ON/OF/max.+0.25 ml/l compared to btls	DO/O3/40-176db
	OF/max.-0.25 ml/l compared to btls	DO/O3/1350-2750db
	OF/max.-0.05 ml/l compared to btls	DO/O3/4236-4820db
692/01	OP; OL/ON/OF/max.-0.23 ml/l compared to btls	DO/RO +620 to +30/2-90db in 9 steps; O4/0-90db
	OF/max.+0.10 ml/l compared to btls	DO/O3/114-240db
	ON/progressively noisier as approach bottom	DO/1150-5094db/btm
	OF/max.-0.25 ml/l compared to btls	DO/O3/1182-2500db
	OF/max.-0.14 ml/l compared to btls, despike does not help	DO/O4/4886-5094db/btm

Cast	Problem/Comment	Solution/Action
693/01	"Kink in cable about sheave" when rosette at surface: no strands out of place	NA/no apparent effect on data
	DI/-0.023 top 6db	NA
	ON/especially top 1000db, then 1200db to bottom progressively noisier	DO/whole cast, as needed
	OP; OL/ON/OF/max.-0.12 ml/l compared to btls	DO/RO +820 to +60/2-46db in 10 steps; O4/0-46db
	ON/OF/max.±0.20 ml/l compared to btls	DO/O3/48-280db
	OF/max.±0.20 ml/l compared to btls	DO/O3/1450-4000db
	OF/max.-0.05 ml/l compared to btls	DO/O3/4250-4650db
694/01	Kink in cable unchanged	NA/no apparent effect on data
	DI/-0.017 top 10db	NA
	ON/especially top 750db, then 1000db to bottom progressively noisier, very noisy at bottom	DO/whole cast, as needed
	OP; OL/ON/OF/max.-0.20 ml/l compared to btls	DO/RO +960 to +40/2-44db in 8 steps; O4/0-70db
	ON/OF/very noisy, fits to ±0.20 ml/l compared to btls	DO/O3/1500-4206db/btm
695/01	OP/WS/1 min. at 10-14db, ctdoxy signal shifts; OL/ON/OF/max.-0.20 ml/l compared to btls	DO/RO +740 to +100/2-52db in 8 steps; O4/0-90db
	ON/OF/fits to ±0.15 ml/l compared to btls	DO/O3/1400-4222db
	ON/progressively noisier as approach bottom	DO/1250-4866db/btm
696/01	ON/especially top 700db, then 1250db to bottom progressively noisier	DO/whole cast, as needed
	OP; OL/ON/OF/max.-0.22 ml/l compared to btls	DO/RO +580 to +30/0-48db in 7 steps; O4/0-50db
	ON/OF/fits to ±0.13 ml/l compared to btls	DO/O3/1450-3500db
	OB	RO +2/3878-4000db/btm
697/01	ON/especially top 850db, then 1200db to bottom progressively noisier	DO/whole cast, as needed
	OP; OL/ON/OF/max.-0.40+ ml/l compared to btls	DO/RO +600 to +60/2-52db in 8 steps; O4/0-96db
	ON/OF/fits to ±0.15 ml/l compared to btls	DO/O3/1386-4208db/btm
	OS	RO +4/4200-4206db
698/01	Back to old ctdoxy sensor beginning this cast	NA/signal much improved
	ON/OS; OL/max.-0.05 ml/l compared to btl/nearby cast, even after offset/despike	DO/0-700db; DO/RO +50 to +80/0-50db in 3 steps, O3/0-50db
	OB	RO -2/4292-4300db/btm

Cast	Problem/Comment	Solution/Action
699/01	OS	DO/RO +20 to +90/0-32db in 4 steps, still noisy after offsets
700/01	DI/-0.016 top 6db	NA
	ON/OS; OL/max.-0.15 ml/l compared to btls/nearby casts, even after offset/despike	DO/0-700db; DO/RO +20 to +160/2-66db in 5 steps, O3/0-70db
	OF/max.+0.10 ml/l compared to btls	NA/120-410db, GD/10-15db, DU
	OB	RO -1/4354-4362db/btm
701/01	ON/OS; OL/ON/raw ctdoxy low near surface	DO/0-700db; DO/RO +20 to +60/0-44db in 3 steps, OK after despike
702/01	DI/-0.018 top 6db	NA
	ON	DO/0-700db
	OF/max.-0.10 ml/l from 4104db btl to near-bottom, compared to nearby ctd casts	NA/4106-4246db, may be OK, ctdoxy fit looks the same even if bottom btl not used for fit
	Bottom 2 levels rise 0.06 ml/l to meet up with btl, looks suspicious	O3/4248-4250db, probably caused by bottom stop, not seen on upcast
703/01	DI/-0.017 top 6db	NA
704/01	ON/OL/jagged and noisy signal throughout surface area, upcast does not show any such ctdoxy structure	O3/0-122db
	odd ctdoxy structure near bottom	DO/4400-4468db/btm, OK - shape unaltered by despiking, within 0.02 ml/l of btl value
705/01	OF/max.±0.15 ml/l compared to btls	NA/100-400db, GD/10-20db, DU
	OF/-0.05 ml/l compared to trend of nearby levels within same cast; not comparable to nearby casts	O3/4540-4558db, no such feature on upcast
706/01	OF/max.±0.10 ml/l compared to nearest btls	NA/0-80db, upcast ctdoxy has similar features between btls
	OF/max.±0.20 ml/l compared to btls	NA/80-380+db, GD/10-20db, DU
	OB	RO -1/4818-4832db/btm
	OF/+0.03 ml/l compared to bottom btl, not comparable to nearby casts	O3/4814-4832db, probably caused by bottom slowdown, not seen on upcast
707/01	DI/-0.013 top 6db	NA
	OF/OL/max.-0.20 ml/l compared to nearest btls	O3/0-34db, no such feature on upcast; NA/36-56db, upcast ctdoxy has similar feature
	OF/max.+0.10 ml/l compared to btls	NA/50-410db, GS/10-20db, DU

Appendix D

WOCE95-I4/I5W/I7C: Bottle Quality Comments

Remarks for deleted samples, missing samples, PI data comments, and WOCE codes other than 2 from WOCE I4/I5W/I7C KN-145.9. Investigation of data may include comparison of bottle salinity and oxygen data with CTD data, review of data plots of the station profile and adjoining stations, and rereading of charts (i.e., nutrients). Comments from the Sample Logs and the results of ODF's investigations are included in this report. Units stated in these comments are degrees Celsius for temperature, Practical Salinity Units for salinity, and unless otherwise noted, milliliters per liter for oxygen and micromoles per liter for Silicate, Nitrate, Nitrite, and Phosphate. The first number before the comment is the cast number (CASTNO) times 100 plus the bottle number (BTLNBR).

Station 574

122	Sample log: "Leaking from bottom end cap" (before air vent opened; O-ring out of groove). No samples drawn.
116	Delta-S at 1614db is -0.0046. Autosal run ok. No notes. Footnote salinity questionable.
115	Delta-S at 1715db is -0.0037. Autosal run ok. No notes. Footnote salinity questionable.
108-109	Delta-S is approx. -0.0025. Autosal run ok. No notes. Footnote salinity questionable.
103	Delta-S at 4151db is -0.0036. Autosal run ok. No notes. Footnote salinity questionable.
101-109	Silicates higher by ˜3uM than adjacent (703-706) stations; No corresponding feature in other parameters. Peaks and calcs OK; footnote SIO3 questionable.

Station 575

130	Sample log: "Leaking from bottom after venting - no O2 drawn." Salt and nutrient samples look ok. Oxygen mistakenly not drawn.
122	Sample log: "Leak at bottom o-ring - no CO2 or O2." Drew nutrient but no water for salt or oxygen. O-ring out. Replaced end cap and o-ring before next station. PO4, NO3, SiO3 appear low but inversion on CTD S & O2 this level. Next station has similar feature this level. Footnote bottle leaking, salinity and oxygen not drawn and nutrients questionable.
105	Delta-S at 4151db is -0.0034. Salinity value low compared to CTD and adjacent values. Footnote salinity questionable.
102	Sample log: "Small air bubble from MnCl2" O2 agrees well with CTDOXY and adjacent stations at 4767db.
101	CTD Processor: "ctdoxy max. +0.03 ml/l compared to bottle at bottom." Footnote 4850-4994 db CTDOXY questionable.

Station 576

101	Delta-S at 4792db is 0.0063. Four Autosal runs to get agreement. Footnote salinity bad.

Station 577

110	Sample log: "Leak in upper air vent o-ring." Water samples look ok.
101	No samples per Nutrient data sheet. Drawn ok per Sample log. Apparent drawing error.

Station 578

126	Sample log: Bottom o-ring leak. Water samples look ok.
124	Sample log: "Top lid knocked on recovery." Water samples look ok.
120	CTD Processor: "Bottle O2 +.10 (or more) high compared to dnCTD; feature is 70m shallower than bottle on up, so bottle doesn't match upcast CTD either." No notes of any analytical problems; assume questionable. Footnote O2 questionable.

Station 579

126	Sample log: "Bottom o-ring not seated." Data are acceptable.
122	Sample log: "Top o-ring not seated." Data are acceptable.
116	Delta-S at 1210db is -0.0035. Salt sample analysis ok, sample from minor gradient area.

Station 580

Cast 1	Nutrient data sheet:"Bad sil moly." Deep values about 2 uM/L low. Corrected prior Station 582. Footnote SiO3 bad on this station and station 581.
105-130	See Cast 1 SiO3 comment, footnote SiO3 bad.
104	Sample log: "Bottle did not close." No samples drawn. Trip level also not confirmed by CTD acquisition.
101	Delta-S at 3501db is -0.0026. Bottom five bottles a little low compared to CTD salinity. This bottle is the only one that exceeds standards. No notes and analysis appears OK. On overlays with station 579, values agree. Footnote salinity questionable.
101-103	See Cast 1 SiO3 comment, footnote SiO3 bad.

Station 581

Cast 1	Nutrient data sheet:"Bad sil moly." Deep values about 2uM/L low. Corrected prior to next station.
131	CTD Processor: "ctdoxy max. -0.07 ml/l compared to bottle/nearby casts." Footnote 0-20 db CTDOXY questionable.
131-101	See Cast 1 SiO3 comment, footnote SiO3 bad.
123	Sample log: "Dripping from bottom." Water samples look ok.
122	Sample log: "Water flow from spigot before venting (air leak)." Water samples look ok. Salt Log: Chipped neck on salt bottle.
120	Sample log: "Top end cap cocked during recovery ˜ 10s (or less){dripping at spigot before venting}." (Top end cap knocked open briefly by tag line.) Salt, nutrients, and oxygen look good. CO2 also sampled.
111	Sample log: "Dripping from bottom." Water samples look ok.

Station 582

121	Sample log: "BTLs 16, 18, 19, & 21 tripped for Alistair only(chlorophyll) - no other sampling.
118-119	Sample log: "BTLs 16, 18, 19, & 21 tripped for Alistair only (chlorophyll) - no other sampling.
116	Sample log: "BTLs 16, 18, 19, & 21 tripped for Alistair only (chlorophyll) - no other sampling.
105	Sample log: "Dripping @ bottom after venting. Reseated." Water samples look ok.

Station 583

106	Salt Log: Wrong suppression. Samples ok.
105	Salt Log: Wrong suppression. Samples ok.

Station 584

104	CTD Processor: "ctdoxy max. -0.05 ml/l compared to bottle/nearby cast." Footnote 0-30 db CTDOXY questionable.
101	Delta-S at 97db is -0.026. High delta-S, but in area of steep salinity gradient. Salinity value OK.

Station 585

119	CTD Processor: "Bottle O2 (and CTD fit) +.10 compared to any nearby cast. No analytical problems noted; flag O2 questionable. CTD Processor: "ctdoxy max. +0.10+ ml/l compared to nearby cast." Footnote 0-4 db CTDOXY questionable.

Station 586

108	Sample log: "Bottle leaked." Water samples look ok.

Station 587

129	Delta-S at 54db is -0.0348. In area of steep salinity gradient, salinity value OK.
126	Sample log: "Leak bottom end cap after venting." Water samples look ok.
122	Sample log: "Leak bottom end cap after venting." Water samples look ok.
109	Sample log: "Upper end cap not set, leaked w/vent opening." Water samples look ok.

Station 588

126	Sample log: "Bottom end cap not sealed, leaked w/vent opening". Water samples look ok.

Station 589

126	Delta-S at 85db is -0.0273. Salt analysis ok. Sample from gradient area.
125	Sample log: "Dripping @ bottom" (after air vent opened?). Delta-S 0.016 high at 104db. Nutrient, o2 & salinity features correspond to CTD O & S inversion. Looks ok.
122	Sample log: "Spigot open before venting" (air leak?) Water samples look ok.

Station 590

131	Sample log: "Leaking from bottom after venting, reseated, ok." Water samples look ok. Oxygen: "air bubble." Looks OK vs other parameters & adjacent stations.
129-127	CTD Processor: "ctdoxy max. +0.15 ml/l compared to bottles." Footnote 40-98 db CTDOXY questionable.
104	Delta-S at 3030db is 0.0098. Six Autosal runs to get agreement. Other water samples ok. Probable salt crystal contamination. Footnote salinity bad.

Station 591

133	Sample log:"Dripping out @ base" Water samples look ok.
133-132	CTD Processor: "ctdoxy max. -0.20 ml/l compared to bottles/nearby casts." Footnote 8-56 db CTDOXY questionable.

Station 592

135-133	CTD Processor: "ctdoxy -0.20 to +0.10 ml/l compared to bottles/nearby casts." Footnote 8-70 db CTDOXY questionable.
126	Sample log: "Bottom leaking after seal opened." Water samples look ok.
101-136	Deep theta-S plot of down/up shows upcast CTD data ok. Footnote CTD salinity acceptable. Bottle salinity values are >0.0025 lower than CTD salinity values on most of this cast. Bottle values lower in value to adjacent stations also, especially in deeper bottles. No analyst's notes, Autosal log looks OK. There may have been some unknown, systematic error in Autosal readings. Footnote all salinities questionable.

Station 593

130-101	CTD Processor: "bottle salts avg 0.0015 low compared to CTD cast & nearby stas." Flag all salts questionable - no analytical problems noted.
122	Sample log: "Top o-ring not seated/valve leaked when opened." Nutrients and oxygen samples look ok. See 130-101 salinity comment.

Station 594

133 Sample log: "Dripping from bottom." Water samples look ok, near surface.

132 Sample log: "Vent not closed tightly". Water samples look ok, in mixed layer.

119 Sample log: "O2 bottle 643 has bubbles." Bottle o2 agrees well with CTDOXY at 658db.

113 Delta-S at 1362db is -0.0226. Autosal run ok. High gradient, CTD T inversion. Salinity is acceptable.

Station 595

133 Sample log: "Leaking from bottom end cap after venting, (profusely!)." Water samples look ok for surface sample.

122 Sample log: "Flowed from spigot prior to venting." Water samples look ok. Average gradient for this level.

Station 596

134 CTD Processor: "ctdoxy max. -0.12 ml/l compared to bottles/nearby casts." Footnote 18-40 db CTDOXY questionable.

133 Sample log: "Drip after venting at base plug." Water samples look ok for surface.

130 Delta-S at 105db is -0.0281. High delta-S, but in a high salinity gradient. Salinity value OK.

126 Sample log: "Has a drip from bottom plug." Water samples look ok.

103 Delta-S is -0.0022 at 3236db. Salinity a little low compared to CTD value and adjacent stations. Footnote salinity questionable.

Station 597

Cast 1 Multiple CTD conductivity dropouts during upcast. Bottle salinity was compared to CTD salinity at trip time and appropriate code was assigned to questionable values.

132 CTD processor notes CTD signal dropout at trip time. Footnote CTD salinity questionable. No CTDOXY reported because CTD salinity coded questionable.

131 CTD Processor: "ctdoxy max. -0.05 ml/l compared to bottles." Footnote 12-40 db CTDOXY questionable.

128 CTD processor notes CTD signal dropout at trip time. Footnote CTD salinity questionable. No CTDOXY reported because CTD salinity coded questionable.

126 Sample log: "Bottom o-ring" High Delta-S at 129db. Autosal run ok. Other water samples ok. High gradient and inversion on CTD S.

122 Sample log: "Leaks @ vent valve" Water samples look ok.

120 CTD processor notes CTD signal dropout at trip time. Footnote CTD salinity questionable. No CTDOXY reported because CTD salinity coded questionable.

118 Sample log: "Leaks @ vent valve". Delta-S 0.0039 high at 707db. Bottle oxygen has normal gradient agreeing with CTDOXY but nutrients have same value as 19, at level above. Possibly water sample ok but dupe draw on nutrients. Adjacent stations have normal gradient for nutrients also. Footnote nutrients questionable.

112 Sample log: "Leaks thru spigot." Water samples look ok.

108 Delta-S at 2118db is 0.0029. Autosal run OK. CTD processor notes CTD signal dropout at trip time. Footnote CTD salinity questionable. No CTDOXY reported because CTD salinity is coded questionable.

106 Delta-S at 2523db is 0.0056. Four Autosal runs to get agreement. Careful examination shows CTD signal OK at trip time. Footnote bottle salinity questionable.

Station 598

134	Sample log: "Top o-ring not set." Water samples look ok.
133	Sample log: "Leaks {through} bottom cap." Water samples look ok.
107	CTD processor notes CTD signal dropout at trip time. Footnote CTD salinity questionable. CTDO not reported because CTD salinity coded questionable.

Station 599

131	Delta-S at 30db is -0.0268. Salt analysis ok. Surface salt gradient.
122	Sample log: "Flow before venting." Delta-S 0.005 high at 508db. Other samples also ok.
116	Delta-S at 1109db is -0.0153. Same value as 17, above, but CTD has high gradient & inversion this level with 116 salinity very similar to 117 level value. Autosal run ok. Other water samples ok. Salinity is acceptable.
115	Delta-S at 1209db is 0.0041. Salt analysis ok. CTS indicates slight gradients at this depth.
106	Sample log: "Flow before venting". Delta-S at 2210db is 0.0219. Five Autosal runs to get agreement. Other samples ok at 2210db. Probably salt crystal contamination. Footnote salinity bad, other parameters OK.

Station 600

131	Sample log: "Tripped before surface." Used bottle 32 for surface. No samples from bottle 31.
130-128	CTD Processor: "ctdoxy -0.10 to +0.15 ml/l compared to bottles/nearby casts; upcast noisy, but seems to rise through this area also." Footnote 24-68 db CTDOXY questionable.
114	Oxygen appears low vs CTDOXY and adjacent stations; no notes. See 114-108 PO4 comment. Footnote O2 and PO4 questionable.
114-108	PO4 appears up to 0.08 uM/L high compared to adjacent stations and p:n plots. Spikes on 109 & 116 chart peaks, otherwise peaks look ok. Analyst says spikes were air bubbles that were pinched out in the normal way. No reagent changes previous cast. PO4 values appear a little high from 108 to near bottom but bottom sample back to normal compared to adjacent station and p:n values. Footnote PO4 questionable.
110	Delta-S 0.0026 high at 1507db. Autosal run ok. High CTD S gradient & inversion this level.
103	CTD Processor: "ctdoxy max. +0.03 ml/l compared to bottle/upcast/nearby casts." Footnote 2906-2936 db CTDOXY questionable.

Station 601

128-127	CTD Processor: "ctdoxy max. +0.12 ml/l compared to bottles." Footnote 36-82 db CTDOXY questionable.
122	Salt sample mistakenly not drawn.
112	Delta-S at 1160db is 0.0059. Salt sample ok. Sample from area of minor gradients. Similar structure in surrounding nearshore stations.

Station 602

126	Sample log: Bottle leaks. Surface water samples look ok.
124-123	CTD Processor: "ctdoxy max. +0.12 ml/l compared to bottles." Footnote 30-84 db CTDOXY questionable.

Station 603

124-122	CTD Processor: "ctdoxy max. +0.12 ml/l compared to bottle/nearby casts." Footnote 50-108 db CTDOXY questionable.
117	Oxygen data sheet shows 2 titrations for this sample. Adding both together gives good value, matching CTDOXY and adjacent stations. Oxygen is acceptable after adjustment.

116-118	Nutrient data sheet: "No sample", but Ok per Sample log. Assume sampling error.
108	Sample log: Top end cap problem. Water samples look ok.
Station 604	
125-124	CTD Processor: "ctdoxy max. -0.05 ml/l compared to bottles/nearby casts." Footnote 4-28 db CTDOXY questionable.
Station 605	
122-121	CTD Processor: "ctdoxy max. +0.15 ml/l compared to bottles/nearby casts." Footnote 34-76 db CTDOXY questionable.
Station 606	
118-117	CTD Processor: "surface ctdoxy looks ok after despike/offset (surface rawoxy values 15% higher than normal, rapidly dropping signal), but huge change over large area - so coded 3." Footnote 0-52 db CTDOXY questionable.
114	Delta-S at 103db is -0.0315. In steep salinity gradient, salinity value OK.
Station 608	
112-111	CTD Processor: "ctdoxy max. +0.10 ml/l compared to bottles/upcast/nearby casts." Footnote 14-50 db CTDOXY questionable.
103	Oxygen max here corresponds to nutrient minimum, but still higher than CTDOXY trace; no adjacent comparable stations, so code questionable. No analytical problems. CTD Processor: "ctdoxy max. +0.20 ml/l compared to bottle, not comparable to nearby casts. Footnote 370-450 db CTDOXY and bottle O2 questionable.
Station 609	
111	Sample log: "Leaked from bottom after venting, reseated." Water samples look good at surface.
Station 610	
105	Sample log: "Drip from bottom o-ring." Water samples look good at surface.
Station 612	
104	Sample log: Tag line hooked on no apparent opening. High gradient, water samples look ok.
Station 615	
104	Oxygen data sheet: "Dosimat continued titrating passed end point. Had to power off to stop." O2 sample lost.
Station 616	
127-126	CTD Processor: "ctdoxy max. +0.15 ml/l compared to bottle/nearby casts." Footnote 32-68 db CTDOXY questionable.
116	Oxygen looks low vs adjacent stations and nutrients and CTDO; no notes. Footnote O2 questionable.
Station 617	
124	CTD Processor: "Bottle O2 -0.04 to -0.10 compared to nearest 4 casts' surface bottles; dnCTD matches because it was fit to this bottle." 124 Oxy only -.01 different from 123 which should be similar; no analytical notes - assume OK for now.
Station 618	
127	Oxygen: "jagged ep." Looks OK vs other parameters & adjacent stations. Footnote bottle oxygen ok.
118	Sample log: "Top o-ring not sealed." Water samples look ok.

118-129 CTD Processor: "bottle-dnCTD diffcs (O2 and S) OK; down/up quite different/no code."

107 Delta-S at 1711db is 0.0045. Salt data sheet: "salt cryst." Six Autosal runs to get agreement. Other water samples ok. Footnote salinity bad.

103 Delta-S at 2511db is 0.0069. Three Autosal runs to get agreement. No notes. Other water samples ok. Same value as bottle 2 at level below. Possible dupe draw. Footnote salinity questionable.

Station 619

228 Sample log: "Dripping @ bottom o-ring after venting." Water samples look ok, in mixed layer.

217 Oxygen: "zig-zag ep." Looks high vs station 618 & CTD trace. Footnote O2 questionable.

Station 620

133 Sample log: "O-ring drip @ base." Water samples look OK at surface.

127 Sample log: "O2 bubble during pickling." Bottle oxygen 0.4 ml/l low compared to down CTDOXY trace but up CTDOXY shows a 0.4 ml/l low, 10db deep spike at this level. Also CTD S up only feature this level. O2 is acceptable. CTDO looks high, see CTD Processor comments.

127-130 CTD Processor: "bottle-dnCTD diffcs (O2 and S) OK: down/up quite different/no code. Bottle 127/132db looks especially low, but large O2/S feature on upCTD and bottle - so OK."

120 Sample log: "Dripping @ base, after opening." Water samples look ok.

101-113 PO4 appears 0.03 uM/L to 0.05 uM/L high compared to adjacent stations & n:p plot. Bubble spike between samples 113 and 112 on AA chart. Footnote PO4 questionable.

Station 621

133 Sample log: "Leak @ bottom o-ring." Water samples ok at surface.

133-131 CTD Processor: "large ctdoxy signal drop this area; improved after offset/despike, but ctdoxy still seems odd; noisy signal." Footnote 0-58 db CTDOXY questionable.

125 Sample log: "May have tripped early based on temp." Delta-S at 210db is -0.7901. All water samples appear to be from around 3000db. Footnote bottle did not trip correctly, all samples bad.

Station 622

135-129 CTD Processor: "ctdoxy (+-0.10 to 0.30 ml/l compared to bottles, (+-0.10 ml/l compared to nearby casts; down-up ctdoxy generally resemble each other, and stas 620-623 similar near surface; but ctdoxy very noisy, hard to identify true signal here." Footnote 0-148 db CTDOXY questionable.

133 Sample log: "Leaks from the Bottom". Water samples look ok, in mixed layer.

Station 623

115 Sample log: "Lower end cap leak after venting, sealed with a twist." Delta-S at 1259db is 0.0067. High gradient. Autosal run ok. Other water samples ok, oxygen minimum matches CTDO. Salt consistent with u/c TS.

101 Delta-S at 3600db is 0.0026. Autosal run ok. TS not consistent. Footnote salinity questionable.

Station 624

Cast 1 CTD cond offset on d/c, filtered and calibrated. Offset continues u/c, CTD cond trip values uncalibrated.

133 Sample log: "Leak @ bottom after venting." Water samples look ok, in mixed layer.

133-124 CTD Processor: "ctdoxy max. -0.05 to +0.25 ml/l compared to bottles." Footnote 0-218 db CTDOXY questionable.

133-131 Bottle oxygen similar to stations 630-633 but higher by 0.10-0.20ml/L than stations 626-629 and 634-637; no analytical problems found but differences seem to be related to analyst and time of day samples were collected. Could be a coincidence since from an analytical standpoint looks OK, but may need further comparison with other gases.

130 Sample log: "Drip from bottom o-ring after venting." Water samples look ok, in mixed layer.

101 Sample log: "Spigot pushed in." Delta-S 0.002 high at 3592db. Autosal run ok. Somewhat of a gradient at bottom. All water samples look ok.

Station 625

Cast 1 CTD processor notes multiple spikes in conductivity during upcast. Conductivity signal despiked at appropriate levels.

133 Sample log: "Leaking from bottom o-ring after venting - ran out after tritium." No nutrients, salinity or barium. Oxygen looks good at surface. Footnote bottle leaking.

131-133 Bottle oxygen similar to station 624 but higher by 0.10-0.20ml/L than stations 626-629; no analytical problems found, but seems to be related to analyst and time of day samples were collected. From an analytical standpoint looks OK, but may need further comparison with other gases.

128 CTD salinity value OK after despiking, footnote CTS despiked.

127 CTD salinity value OK after despiking, footnote CTS despiked.

111 Sample log: "Tripped in motion ˜1600." Sampled O2, nutrients, salinity and barium. Delta-S 0.003 low at 1609db. High gradient. O2 agrees well with CTDOXY at oxygen minimum.

103-101 CTD Processor: "ctdoxy max. (+-0.03 ml/l off at bottom 3 bottles (upcast)." Footnote 3100-3572 db CTDOXY questionable.

101 Delta-S 0.009 high at 3571db. Autosal run OK. CTD S hook at bottom. Bottle salt agrees well with other bottle salts on T-S curve. Numerous d/c & u/c cond offsets, d/c was filtered. Footnote CTD salinity bad. CTD salinity value OK after despiking, footnote CTS despiked.

Station 626

136 Delta-S 0.03365 at 3db. CTS spikes near surface. Autosal run ok. Bottle salt matches other mixed layer salts and adjacent stations better than CTDS. Footnote CTD salinity bad. No CTDOXY reported because CTD salinity coded bad.

136-133 Bottle oxygen similar to stations 627-629 but lower by 0.10-0.20ml/L than stations 624-625 and 630-633; no analytical problems found but seems to be related to analyst and time of day samples were collected. From an analytical standpoint looks OK, but may need further comparison with other gases.

135-132 CTD Processor: "ctdoxy -0.06 to -0.30 ml/l compared to upcast/bottles/nearby casts; very noisy signal, difficult to decipher true shape." Footnote 0-76 db CTDOXY questionable.

134 Sample log: "Bottle 34 a replicate in case bottle 33 leaked."

120 Sample log: Leak from bottom. Water samples look ok.

114 Sample log: Leak from bottom. High gradient & inversion. Water samples look ok.

Station 627

128-130 Sample log: Top valve open, leak from bottom. Water samples look ok, in mixed layer.

126-130 Bottle oxygen similar to adjacent stations but lower by 0.10-0.20ml/L than stations 624-625 and 630-633; no analytical problems found but seems to be related to analyst and time of day samples were collected. From an analytical standpoint looks OK, but may need further comparison with other gases.

122 Sample log: "Bottom end cap not seated- leaked on venting." Water samples look ok.

109 Delta-S at 1665db is -0.005. Autosal run ok. High gradient and inversion.

Station 628

125	Sample log: "Vent open?" All samples look ok for surface.
123-125	Bottle oxygen similar to adjacent stations but lower by 0.10-0.20ml/L than stations 624-625 and 630-633; no analytical problems found but seems to be related to analyst and time of day samples were collected. From an analytical standpoint looks OK, but may need further comparison with other gases.
101	CTD Processor: "ctdoxy/bottom bottle look high compared to nearby casts." Footnote 2370-2372 db CTDOXY questionable.

Station 629

114-116	Bottle oxygen similar to stations 626-628 but lower by 0.10-0.20ml/L than stations 624-625 and 630-633; no analytical problems found but seems to be related to analyst and time of day samples were collected. From an analytical standpoint looks OK, but may need further comparison with other gases.

Station 630

121-123	Bottle oxygen similar to stations 631-633 but higher by 0.10-0.20ml/L than stations 626-629 and 634-637; no analytical problems found but differences seem to be related to analyst and time of day samples were collected. Could be a coincidence since from an analytical standpoint looks OK, but may need further comparison with other gases.

Station 631

121-123	Bottle oxygen similar to stations 630, 632-633 but higher by 0.10-0.20ml/L than stations 626-629 and 634-637; no analytical problems found but differences seem to be related to analyst and time of day samples were collected. Could be a coincidence since from an analytical standpoint looks OK, but may need further comparison with other gases.

Station 632

122	Sample log: "Air leak, reseated top cap, ok." Water samples look ok at surface.
119-122	Bottle oxygen similar to adjacent stations but higher by 0.10-0.20ml/L than stations 626-629 and 634-637; no analytical problems found but differences seem to be related to analyst and time of day samples were collected. Could be a coincidence since from an analytical standpoint looks OK, but may need further comparison with other gases.
114	Sample log: "Dripping from bottom after venting." Water samples look ok.

Station 633

123-126	Bottle oxygen similar to stations 630-632 but higher by 0.10-0.20ml/L than stations 626-629 and 634-637; no analytical problems found but differences seem to be related to analyst and time of day samples were collected. Could be a coincidence since from an analytical standpoint looks OK, but may need further comparison with other gases.
122	Sample log: Air leak, reseated top end cap, OK. Water samples look ok.
110	Sample log: Drips after O2 drawn. Autosal run ok. Water samples look ok.

Station 634

Cast 1	F1s high compared to adjacent stations. Max no3 0.8uM/L lower than adjacent stations. Max po4 0.06uM/L lower than adjacent stations. Max sil 4.0uM/L higher than subsequent stations. Assume standard preparation error. Used F1s from stations before and after which were very consistent. New no3 values match adjacent stations. New po4 values match adjacent stations. Previous stations did not reach max, still in high gradient so no comparison. In area of high silicate and oxygen change so higher values probably good. New sil values 5.0uM/L higher than subsequent stations. Nutrients are acceptable after corrections.

122-123 Oxygen similar to stations 635-637 but lower by 0.10-0.20ml/L than stations 630-633 and 638-639; no analytical problems found but differences seem to be related to analyst and time of day samples were collected. Could be a coincidence since from an analytical standpoint looks OK, but may need further comparison with other gases.

108 CTD Processor: "Bottle O2 +0.05 compared to dnCTD; dnCTD matches nearby casts. but bottle OK: matches upCTD feature." Oxygen 0.10 higher than adjacent stas 633 & 635; 0.05 higher than adjacent sta 636; assume O2 value questionable.

Station 635

128-123 CTD Processor: "ctdoxy max. +-0.20 ml/l compared to bottles/nearby casts, too noisy to accurately determine true signal." Footnote 0-120 db CTDOXY questionable. Bottle oxygens similar to adjacent stations but lower by 0.10-0.20ml/L than stations 630-633 and 638-639; no analytical problems found but differences seem to be related to analyst and time of day samples were collected. Could be a coincidence since from an analytical standpoint looks OK, but may need further comparison with other gases.

127 Sample log: "Leak from bottom end cap - fixed." Water samples look ok.

124 Sample log: "Leak from top end cap - fixed." Water samples look ok.

122 Sample log: "Leak from top end cap - fixed." Water samples look ok. Oxygen max agrees with CTDO.

109 Salinity sample mistakenly not drawn.

104 Sample log: "Leak from bottom end cap - fixed." Water samples look ok.

Station 636

121-122 Bottle oxygens similar to adjacent stations but lower by 0.10-0.20ml/L than stations 630-633 and 638-639; no analytical problems found but differences seem to be related to analyst and time of day samples were collected. Could be a coincidence since from an analytical standpoint looks OK, but may need further comparison with other gases.

106 CTD Processor: "Bottle O2 +.10 compared to dnCTD: probably flask typo (use Automated checking did not work on this level. Sample log sheet indicated this was flask 868. However, 868 was not used at any time during this expedition. Correct oxygen raw data file.

104 Delta-S at 2115db is 0.0223. Autosal run ok. Other water samples ok. Same value as 103 at level below. Probable dupe draw. Footnote salinity bad.

Station 637

130-128 CTD Processor: "ctdoxy max. -0.10 to -0.40 ml/l compared to bottle/nearby casts; too noisy to accurately determine true signal; up very different, no such drops." Footnote 0-58 db CTDOXY questionable. Bottle oxygens similar to stations 634-636 but lower by 0.10-0.20ml/L than stations 630-633 and 638-639; no analytical problems found but differences seem to be related to analyst and time of day samples were collected. Could be a coincidence since from an analytical standpoint looks OK, but may need further comparison with other gases.

107 Delta-S at 3009db is 0.0059. Six Autosal runs to get agreement. Second accepted 2CR 0.00003 higher than first. Probable salt crystal contamination. Inversion at this level in both down & up CTDS trace. Bottle salt fits gradient well if no inversion. Feature on CTD T trace this level. Footnote salinity questionable.

Station 638

130-129 CTD Processor: "ctdoxy max. -0.10 ml/l compared to bottles/cast 2 - matches sta 637, but surface bottle oxygen jumps +0.10 ml/l between stas 637-638." Footnote 0-66 db CTDOXY questionable. Bottle oxygens similar to stations 630-633 but higher by 0.10-0.20ml/L than stations 634-637 and 640-641; no analytical problems found but differences seem to be related to analyst and time of day samples were collected. Could be a coincidence since from an analytical standpoint looks OK, but may need further comparison with other gases.

123 Sample log: "Tripped in motion." Water samples look ok. Down CTD T differs from up CTD T.

120 Sample log: "Leak from bottom after venting, reseated, ok." Water samples look ok.

102-115 PO4 appear 0.005 uM/L to 0.010 uM/L high compared to adjacent stations and n:p values. Air bubble spikes on peak 6 and between 3 & 2. Peaks 15 and 2 both have imperfect shapes but no spikes. Looks like same problem as Stations 600 & 620. Footnote PO4 questionable.

203 Bottle salinity a little low compared to CTD salinity and may be low compared to adjacent stations. Footnote salinity questionable.

201 O2 Over titrated, 1 ml KIO3 not enough, added 3 additional mls after overtitrate option and retitrated. Result appears 0.05 ml/L low at 4836db compared to CTDOXY and adjacent stations. Footnote O2 bad. CTD Processor: "ctdoxy max. +0.04 ml/l at bottom compared to nearby deeper casts." Footnote 4650-4836 db CTDOXY questionable.

Station 639

136-134 CTD Processor: "ctdoxy max. -0.10 ml/l compared to bottles/nearby casts; too noisy to accurately determine true signal; up even noisier, no help." Footnote 0-66 db CTDOXY questionable.

130-136 Bottle oxygen similar to stations 630-633 but higher by 0.10-0.20ml/L than stations 634-637 and 640-641; no analytical problems found but differences seem to be related to analyst and time of day samples were collected. Could be a coincidence since from an analytical standpoint looks OK, but may need further comparison with other gases.

125 Salinity data sheet: "Salt bottle 25 empty." OK per sample log, assume sampling error.

122 Sample log: Slight air leak, fixed. Water samples look ok.

121 Sample log: Slight air leak. Water samples look ok. Down CTD T&S differ from up.

105 Delta-S at 4107db is 0.0036. Four Autosal runs to get agreement. Second accepted 2CR 0.00001 lower than first so possibly not salt crystal. Smooth CTD traces. CTD TS is consistent, no major gradient, no analytical problems noted. Footnote salinity questionable.

103 Salinity a little low compared to CTD salinity and may be low compared to adjacent stations. Footnote salinity questionable.

Station 640

136 Delta-S at 3db is 0.0838. Autosal run ok. Heavy rain during station. High surface gradient on CTD S.

127 Sample log: "Very slow drip." Water samples look ok.

124 Sample log: "Bottom o-ring leak." Water samples look ok.

115 Sample log: "Leaking steady." Water samples look ok.

110 Sample log: "Top o-ring not sealed." Nutrient and salt samples ok. Bottle oxygen appears 0.02 ml/L high compared to adjacent stations and CTDO. Titration ok, no other notes. Bottle and oxygen seem acceptable.

104 O2 Appears 0.02 high at 4667db. Titration ok. No notes. Smooth CTDOXY gradient. Same value as 103 below. Possible dupe draw. Footnote O2 questionable.

Station 641

129	CTD Processor: "Bottle O2 -0.15 to -0.20 compared to dn/upCTD, nearby casts. rawO2-drop at up bottle stop isn't even enough to pull CTD trace near this bottle." Agreed; Flag O2 questionable.
118	Sample log: "Top o-ring not sealed" Air leak? Water samples look ok.
116	Delta-S at 2223db is -0.0032. Salt analysis ok. Sample from gradient area. Overlays well with Sta. 632/633.
108	Bottle salinity a little low compared to CTD salinity and to bottle values at adjacent stations. Footnote salinity questionable.
103	O2 appears 0.015 high at 4760db. Reversing 101 and 103 oxygen would give good smooth trace based on CTDOXY and adjacent stations. No notes or titration problems. Other water samples have normal gradient. Footnote O2 questionable.
101	O2 appears 0.02 ml/L low at 5186db. Reversing 101 and 103 oxygen would give good smooth trace based on CTDOXY and adjacent stations. No notes or titration problems. Bottle Salinity a little low compared to CTD salinity and to bottle values at adjacent stations. Other deep bottle values look similarly low but within WOCE standards. Footnote salinity and O2 questionable.

Station 642

133	Oxygen: "jagged ep, OK." Slightly high vs CTD trace & adjacent stations. Footnote O2 questionable.
128	Sample log: "Vent already open." Water samples look ok.
125	Sample log: "Dripping." Water samples look ok.
124	Sample log: "Air leak." Water samples look ok.
122	Sample log: "Air leak." Water samples look ok.
118	Sample log: "Air leak, reseated, ok." Water samples look ok.
116	Sample log: "Dripping from bottom." Water samples look ok.
115	Sample log: "Dripping from bottom." Water samples look ok.
110	Sample log: "Dripping from bottom." Water samples look ok.

Station 643

136-133	CTD Processor: "ctdoxy max. -0.13 ml/l compared to bottles/nearby casts, espec. top 36db; too noisy to accurately determine true signal; generally resembles upcast/nearby casts." Footnote 0-88 db CTDOXY questionable.
136-135	Sample log: "O2 PRT started malfunctioning" Draw temps within 0.5 deg of expected temps based on adjacent stations. PRT repaired prior next station. Oxygen is acceptable.
129	Sample log: Air leak, reseated top end cap, OK. Water samples look ok.
123	Delta-S at 711db is -0.0101. Autosal run ok. Other water samples ok. CTD down trace has normal gradient. CTD salinity is acceptable.
120	Delta-S at 1063db is 0.0045. Salt analysis ok. Sample from gradient area. Overlays well with Sta. 641/642.
118	Sample log: "Flow before venting, air leak?" Water samples look ok.
115	Delta-S at 2024db is -0.0031. Salt analysis ok. Sample from gradient area. Overlays well with Sta. 641/642.
114	Delta-S at 2226db is -0.0026. Salt analysis ok. Sample from gradient area. Overlays well with Sta. 641/642. Oxygen: "stir bubble ?." Looks OK vs other parameters & adjacent stations.

109 Sample log: "Did not close @ base, ’hung up’." Bottom end cap lanyard apparently hung up on bottle 8 lower hose clamp. Closed on deck before attempting to sample. No samples.

108 Delta-S at 3430db is -0.0026. Bottle salinity looks a little low compared to CTD and adjacent stations. Footnote Salinity questionable.

106 CTD Processor: "ctdoxy max. -0.03 ml/l compared to bottles/nearby casts." Footnote 3762-4618 db CTDOXY questionable.

105 Sample log: "Did not trip." No confirm. No samples. See 106 CTD oxygen comment.

104 See 106 CTD oxygen comment. Bottle O2 looks fine vs adjacent station 642; OK. Bottle salinity looks a little low compared to CTD and adjacent stations. Footnote CTD oxygen and bottle salinity questionable.

101 CTD Processor: "ctdoxy max. +0.04 ml/l at bottom compared to bottles/nearby casts." Footnote 5158-5202 db CTDOXY questionable.

Station 644

136 CTD Processor: "Bottle O2 matches well with nearby casts, dnCTD-O2 drops -0.07 at surface (but not upcast). Drop on dnCTD density at surface, not seen on up. Sta 645 has even larger surface drop at surface on dnCTD. 644 surface OK?" Bottle O2 looks OK; acceptable. CTD Processor: "ctdoxy shifts/-0.06 to -0.10 ml/l compared to bottles/nearby casts." Footnote 0-42 db CTDOXY questionable.

133 CTD Processor: "bottle-dnCTD diffcs (O2 and S) OK: down/up quite different/no code." Bottle O2 looks OK; acceptable.

110 Sample log: "Top end cap o-ring leaked" Air leak? Water samples look ok.

108 O2 appears 0.03 ml/L high at 3750db. CTDOXY trace and other water samples have smooth gradient. Titration ok, no notes. Footnote O2 questionable.

Station 645

136 CTD Processor: "Bottle O2 -.28 to -.30 compared to nearest 4 casts: OK, S/density also have weird drop ˜top 22db, dn only and not up. Up density higher at surface vs dn, but S/O2 on dn/up match at surface (just not next 22db)." No analytical problems noted; however looks way low so flag questionable. After further investigation by CTD processors, it was decided to leave as OK.

130-132 CTD Processor: "bottle-dnCTD diffcs (O2 and S) OK: down/up quite different/no code." Bottle O2s look reasonable vs theta & adjacent stations.

126 Sample log: "vent may have been open." Water samples look ok.

119 Salt not from this cast (salt log). Footnote salinity bad.

103 Salt not from this cast (salt log). Footnote salinity bad.

Station 646

132 Sample log: "Dripping slowly from bottom." Water samples look ok.

126 Sample log: "Vent not closed." Water samples look ok.

118 Sample log: "Air leak @ top, not reseated." Water samples look ok.

113-116 Delta-S is greater than -0.0025. Bottle salinity a little low compared to CTD values and adjacent stations. Autosal run looks OK. Footnote salinity questionable.

107-110 Delta-S is greater than -0.0025. Bottle salinity a little low compared to CTD value but compared to adjacent stations looks OK. Autosal run looks OK. Footnote salinity questionable.

105 Sample log: "Leak @ bottom end cap." Water samples look ok.

Station 647

132	Sample log: "Dripping from bottom" after air vent opened. Water samples look ok.
125	Sample log: "Dripping from bottom" after air vent opened. Water samples look ok.
122	Sample log: "Air leak in top - mostly reseated." Water samples look ok.
111-105	Salinity looks about 0.0022 low compared to CTD salinity. Station 648 looks similar. Deep bottles on stations 647 and 648 look low when compared to adjacent stations. Footnote salinity questionable.
107	Sample log: Kimwipe w/silicon dropped in bottle before cast. First freon from this bottle on Station 652.
107-102	CTD Processor: "Bottle O2 +0.02 compared to dnCTD/nearby casts CTDs and bottles. Most salts were deleted in this area already. This problem is independent of an apparent + drift in deeper CTD signal." These bottle O2s higher vs other parameters as well; No analytical problems noted; flag O2 questionable.
103-102	Salinity looks about 0.0025 low compared to CTD salinity. Station 648 looks similar. Deep bottles on stations 647 and 648 may be low when compared to adjacent stations. Footnote salinity questionable.

Station 648

136	Sample log: Drip at base. Water samples look ok.
134	Sample log: Drip at base. Water samples look ok.
129	Sample log: Air leak @ top cap. Water samples look ok.
124	Sample log: Air leak @ top, fixed. Water samples look ok.
118	Sample log: Air leak @ top cap. Water samples look ok.
108	Salinity looks 0.0036 low compared to CTD salinity. Station 647 looks similar. Deep bottles on stations 647 and 648 may be low when compared to adjacent stations. Footnote salinity questionable.
107	Sample log: Kimwipe w/silicon grease dropped in this bottle between casts 646 & 647.
105	Delta-S at 4154db is -0.0032. Compared to adjacent stations may be a little low. Footnote salinity questionable.
104	Properties indicate leak. No notes from sample log. Delta-S at 4359db is -0.0419. Samples from about 2000db. Footnote bottle leaking and samples bad. Delta-S is -0.042 and compared to adjacent stations is clearly off.
102	Salinity looks about 0.0022 low compared to CTD salinity. Station 647 looks similar. Deep bottles on stations 647 and 648 may be low when compared to other stations in this area. Footnote salinity questionable.

Station 649

136	CTD Processor: "ctdoxy max. -0.05 ml/l compared to bottle/previous cast; despiked low ctdoxy at start." Footnote 0-20 db CTDOXY questionable.
133	O2 appears 0.2 ml/L high at 67db. Titration ok. All other samples and CTDOXY down & up indicate water well mixed at this level. Footnote O2 questionable.
129	Sample log: Top end cap not sealed. High gradient. Water samples look ok.
111	CTD Processor: "Bottle O2 +0.05 compared to dnCTD, but looks OK vs up and on theta-O2 plot with dnCTD." Also looks OK vs Stn 648.

Station 650

136	Strange color after acid added & stirred. End point no good. Apparently not enough acid added, possibly 2 ml NaI-NaOH added in error. Similar problem on Station 651, samples 114 thru 131. Footnote oxygen lost. CTD Processor: "ctdoxy max. -0.05 ml/l compared to nearby casts, no bottle oxygen here; despiked low ctdoxy at start." Footnote 0-16 db CTDOXY questionable.
126	"No sample" per Nutrient data sheet. No note on sample log. Assume sampling error.
119	CTD oxy vs bottle oxy difference is about 0.10 ml/l. Value close to bottle 20 value; could be double draw on 20. Footnote O2 questionable.
109	Sample log: "Sample temp too warm, late closure?" All nuts very low. Possible post-trip? Delta-S, O2 and nuts are consistent with sample from 800-900db. O2 ok. Analyst noted sample looked shallower. O2 looks good at intended depth 2723db as well as 900db where other water samples appear to be from. Assume all water samples came from wrong depth. Footnote bottle did not trip correctly, all samples bad.
103	CTD Processor: "Bottle O2 +0.02-3 compared to dnCTD/nearby casts - currently not coded." Compares with Stn 652 however; acceptable.
102	Delta-S 0.0023 high at 4140db. Autosal run ok. CTD Processor: "Bottle O2 compares well w/dnCTD and nearby casts." O2 looks OK - code it ’2’. Footnote salinity questionable.
101	O2 appears 0.03 ml/L low compared to CTDOXY but matches adjacent stations. Titration ok. Nutrients look ok. If 102 oxy ok then 101 oxy appears 0.03 ml/L high. Titration ok. CTDOXY smooth at bottom. CTD Temp water changing between stations at bottom. Footnote O2 questionable. CTD Processor: "Bottle O2 +.04 compared to dnCTD/nearby casts.

Station 651

135-134	CTD Processor: "ctdoxy max. -0.20 ml/l compared to bottles/nearby casts. Footnote 24-48 db CTDOXY questionable.
115-131	Required 2 ml H2SO4 to dissolve precipitate. May have been pickled with 2 ml NaI-NaOH. O2 sampler recalls some problem with pickling this station but not sure what happened. Samples requiring 2ml H2SO4 had precipitate level about twice as high at other samples after same settling time. On station 666 drew duplicate samples on bottle 16. Pickled one with 2ml NaI-NaOH. Same symptoms as 114-131 this station. Footnote O2 questionable. CTD Processor: "Bottle O2 all coded 3, used for fit anyways: worked better than using nearby casts’ values for these pressures. dnCTD seems to overlay well w/nearby casts at these pressures." Looks OK vs CTDO; change to code ’2’.
103-109	Other deep silicates appear 1.5 to 2.0 uM/L high compared adjacent stations. F1(end) obtained from one good peak and one usable but poor peak is higher than F1(beg) and F1s from adjacent stations so using adjacent F1s would give even higher silicates. Sil temp went up fro 24.4 to 26.5 deg C during run. Footnote SiO3 questionable.
101	PO4 appears 0.04 high at 4340db(bottom sample) compared to adjacent stations and n:p plot. Peak ok. Footnote PO4 questionable. CTD Processor: "ctdoxy max. +0.03 ml/l compared to bottom bottle/nearby casts." Footnote 4200-4340 db CTDOXY questionable.
101-102	Nutrient data sheet:"Sil peaks from Sample 1 - SWs look bad - air was being sucked in through SnCl2 line. The level in the reservoir was low enough that the draw tube drew air during big ship rolls." Footnote SiO3 questionable.

Station 652

136-134	CTD Processor: "high raw ctdoxy at surface, extensive despiking; noisy signal, uncertain of true shape through this area; may be ok now? same shape as upcast and overlays well with nearby casts." Footnote 0-64 db CTDOXY questionable.

127 Sample log: "Dripping from bottom." Water samples look ok.

126 Sample log: "Leaking from bottom end cap after venting, reseated, ok." Water samples look ok.

124 Sample log: "Dripping from bottom." Water samples look ok.

Station 653

124 Sample log: "Air leak" reseated top cap, ok. Water samples look ok.

Station 654

123 CTD Processor: "ctdoxy max. -0.20 ml/l compared to nearby casts (no bottle); not seen on upcast." Footnote 34-56 db CTDOXY questionable.

122 Sample log: "Dripping from bottom after venting, reseated, ok." Water samples look ok.

118 Sample log: "Air leak, reseated top cap, OK." Water samples look ok.

114 Sample log: "Dripping from bottom after venting." Water samples look ok.

110 Sample log: "Dripping from bottom after venting." Water samples look ok.

108 Delta-S 0.0034 high at 1011db. Autosal run ok. Other water samples ok. Normal CTD S gradient.

107 Delta-S at 1110db is 0.007. Autosal run ok. Other water samples ok. Normal CTD S gradient, CTD T bump.

Station 655

122 CTD Processor: "Bottle O2 -0.02 compared to surface bottles on 4 nearby stas (2 before/2 after). dnCTD matches because it was fit to this bottle." Bottle Oxygens on these stas (653,654,655,656,657) correlate with nutrients, assume OK.

121 Sample log: Bottom leak (after vented), reseated, ok. Water samples look ok, in mixed layer.

Station 658

117 Nutrient data sheet:"No sample" Nutrient draw ok per Sample log. Assume drawing error.

101 Sample log:"Bottle No 1 was not closed"?? O2, CO2, nutrients & salt were sampled, but no freon. Assume leak. Delta-S 0.0025 high at 960db. Other water samples look ok. High gradient then hook at bottom on CTD T&S. Autosal run ok.

Station 660

124 Sample log: "Dripping at bottom after venting." Water samples look ok, in mixed layer.

121 Sample log: "Dripping at bottom after venting." Water samples look ok, in mixed layer.

112 Delta-S at 506db is 0.012. Salt analysis ok. Sample from gradient area.

106 Oxygen: "BAD STIR Bubbles." High vs other parameters and CTD trace. Footnote O2 questionable.

Station 662

110 Sample log: "Air leak, vent closed tightly." Water samples look ok.

105 Oxygen data sheet:"accidentally abort when hit keyboard." Oxygen value lost.

Station 663

122 Sample log: "Leak @ top cap." Water samples look ok.

Station 664

129 Delta-S 0.008 high at 66db. Four Autosal runs to get agreement. CTD and other water samples indicate surface well mixed to 100db. Possible salt crystal contamination. Footnote salinity questionable.

124 Sample log: "Slow leak from bottom cap before venting & top after venting." Water samples look ok.

122 Sample log: "Bottom leak after venting." Water samples look ok.

108 CTD Processor: "Bottle O2 +0.08 compared to dnCTD, nothing to compare to with nearby casts: this area changing too rapidly. Bottle O2 +0.02-3 compared to upCTD on prs-O2 plot, but looks fine on theta-O2 plot vs up, so likely OK." No corresponding features in other parameters on this station vs theta; assume O2 questionable.

Station 665

102-103 Delta-S is -0.002. Salinity values appear a little low compared to CTD values and adjacent stations. Footnote salinity questionable.

Station 666

134 Delta-S 0.005 high at 48db. CTD T & S and other samples show surface well mixed to 60db. Six Autosal runs to get agreement. Possible salt crystal problem. Footnote salinity questionable.

128 Sample log: "Dripping from bottom." Water samples look ok.

125 Sample log: "Dripping slightly from bottom." Water samples look ok.

119 Delta-S at 1012db is 0.0081. Four Autosal runs to get agreement. Down T & S differ from up T & S but gradient and other salt sample in area match well. Possible salt crystal contamination. Footnote salinity questionable.

116 Oxygen: "2XNaOH 2X acid." Slightly high vs adjacent stations. Adding 2x NaOH will result in erroneous blank being applied to data (blank too small). Footnote O2 questionable.

115 Sample log: "Did not trip." No confirm. No samples.

112 Sample log: "Dripping slightly from bottom." Water samples look ok.

105 Sample log:"Dripping from bottom, reseated, ok." Water samples look ok.

104 PO4 appears 0.03 uM/L high at 3540db. NO3, SIL and other water samples ok. Peak good but definitely high. Footnote PO4 questionable.

Station 667

136 Sample log: "Dripping @ base." All water samples look good at surface.

122 Sample log: Drip, reseated. Delta-S at 697db is 0.0242. Autosal run ok. Other water samples have slight bump this level not shown on CTD T, S or O2, Up trace slightly different from down, but adjacent T&S level follow up trace well. Footnote bottle leaking, all bottle samples bad.

119 Sample log: "NaOH/NaI dispenser drawing air, cleaned and redrew oxygen from bottle." Oxygen value looks 0.1 ml/l high compared to CTD value and adjacent stations. Footnote oxygen questionable.

111 Sample log: Slight air leak, fixed via top cap adjustment. Water samples look ok.

Station 668

136 Sample log: Reversing therm lanyard in bottle 36. Delta-S 0.006 high at 7db. Four Autosal runs to get agreement. Other water samples look ok at surface of mixed layer. Possible salt crystal contamination. Footnote salinity questionable.

136-135 CTD Processor: "ctdoxy shifts/max. -0.10 ml/l compared to bottles/nearby casts." Footnote 0-44 db CTDOXY questionable.

130 Sample log: Opened slightly at surface, hooked lanyard during recovery. Water samples look ok.

129 Sample log: "Top cap loose", air leak? Water samples look ok.

126-131 CTD Processor: "Bottle O2 vs dnCTD diffcs OK: down/up quite different/no code."

123-128 CTD Processor: "Bottle salt vs dnCTD diffcs OK: down/up quite different/no code."

122 Sample log: Leaks. Delta-S 0.0187 high at 657db. Autosal run ok. Smooth CTD gradient. Slight bump in other samples similar to bottle 22 on previous station. Footnote bottle leaking, all

	samples bad.
118-121	CTD Processor: "Bottle salt vs dnCTD diffcs OK: down/up quite different/no code."
116	Delta-S at 1399db is 0.0061. Six Autosal runs to get agreement. Other water samples look ok, o2 matches CTDO. High gradient on all samples. Possible salt crystal contamination. Footnote salinity questionable.
114	Delta-S at 1732db is 0.0107. Four Autosal runs to get agreement. Other water samples OK. O2 minimum matches CTDO. High but smooth CTD gradient, footnote salinity questionable.
113	Delta-S at 1907db is 0.0047. Four Autosal runs to get agreement. Other water samples ok. CTD S down differs from up. Footnote salinity questionable.
104	Sample log: Slight leak. Water samples look ok.
101	Delta-S is 0.0024 psu. Salinity value a little high compared to CTD value and station 667. Footnote salinity questionable. CTD Processor: "Bottle O2 -0.04 compared to dnCTD/nearby casts; bottle salt is coded 3. No corresponding feature in other parameters (nutrients). No analytical problems noted. Assume O2 questionable.

Station 669

131-130	CTD Processor: "ctdoxy max. -0.30 ml/l compared to bottles/nearby casts." Footnote 0-104 db CTDOXY questionable.
122	Sample log: "Bottom leak." Water samples look ok.
108	Delta-S at 2780db is 0.0027. Autosal run ok. CTD S max. Other samples look ok. CTDOXY max also.
104	CTD Processor: "Bottle O2 +0.05 compared to dnCTD/nearby casts; does not match upCTD either." No analytical problems noted - assume suspicious. Footnote O2 questionable.
103	CTD Processor: "Bottle salt -0.002 compared to CTD/nearby casts." No problems noted; looks OK vs Stns 667 & 669.
101	Delta-S 0.0019 high at 4203db. Three Autosal runs to get agreement. 2nd 2CR 0.00001 higher than 1st. Possible small salt crystal. Footnote salinity questionable.

Station 670

127	Sample log: "Dripping slightly". Water samples look ok. CTD Processor: "ctdoxy max. -0.60 ml/l compared to bottle after offset/despike; new ctdoxy sensor, signal cut-out at surface." Footnote 0-100 db CTDOXY bad.
126-118	CTD Processor: "noisy ctdoxy signal, over 25 ea. 5-10db yoyos/stops in top 1180db; -0.30 ml/l ctdoxy drop at 1012-1036db not seen on upcast/nearby casts." Footnote 102-1180 db CTDOXY questionable.
124	Sample log: "Dripping from bottom end cap before venting, reseated. Air leak also". Water samples look ok.
123	Sample log: "Dripping slightly." Water samples look ok.
122	Sample log: "Air leak in bottom end cap." Water samples look ok.
111	Sample log: "Air leak in top cap, reseated." Water samples look ok.
104	Delta-S is 0.0023. Salinity value is a little high compared to CTD and adjacent stations. Took 3 tries to get value on Autosal. Footnote salinity questionable.
103	NO3 appears 0.3 uM/L low at 3840db. Peak ok but definitely low. No corresponding feature in other bottle values or in NO3 values in adjacent stations. Footnote NO3 questionable.

Station 671

129-128 CTD Processor: "ctdoxy max. -0.25 ml/l compared to bottles after offset/despike; signal cut-out at surface." Footnote 0-102 db CTDOXY bad.

126 Sample log: "Dripping from bottom after venting, reseated ok." Water samples look ok.

105 Oxygen: "duplicate." Value OK; this sample was a duplicate.

102 NO3 appears 0.3 uM/L low at 4211db. Poor peak but looks low. Footnote NO3 questionable.

Station 672

131 Delta-S at 2db is 0.0252. Autosal run ok. Bottle salt matches other mixed layer values. High surface gradient on CTD T & S.

131-130 CTD Processor: "ctdoxy max. -0.30 ml/l compared to bottles after offset/despike; signal cut-out at surface." Footnote 0-90 db CTDOXY bad.

127-128 All nutrients from 153db & 204db show inversion not indicated on other properties this station or on adjacent station nutrients. Possibly samples drawn out of order. No notes. Footnote nutrients questionable.

117 O2 appears 0.1 to 0.05 ml/l high at 1187db compared to CTDO and adjacent stations. Titration ok. No notes. Footnote O2 questionable.

104 Sample log: "Bottom end cap leaked." Water samples look ok.

101 O2 appears 0.04 low at 4170db compared to adjacent stations but CTDO shows curve to lower oxygen at bottom. Titration ok. No notes. CTD Processor: "Bottle O2 -0.03-4 compared to dnCTD/nearby bottle/CTD casts; small drop near bottom of dnCTD, but not as low as bottle." No corresponding feature in other parameters. Assume O2 bad.

Station 673

134-129 CTD Processor: "ctdoxy max. -0.20 ml/l compared to bottles after offset/despike; signal cut-out at surface." Footnote 0-118 db CTDOXY bad.

126 Sample log: "Bottom leak." Water samples also ok.

122 Sample log: "Bottom leak." Water samples look ok.

107 O2 appears 0.04 high at 3036db per CTDO Scatter not apparent in other properties this station. Footnote O2 questionable.

105 O2 not analyzed. Sample was drawn per Sample Log, and there are no notes from the analyst. Footnote O2 lost.

103 O2 appears 0.05 ml/l high compared to CTDO. Scatter not apparent in other properties this station. Footnote O2 questionable. CTD Processor: "Bottle O2 coded 3, but looks OK vs dnCTD, considering noise level - looks better than code-2 bottles 109/110 (2626/2421db) O2s." Change code to ’2’.

Station 674

132-131 CTD Processor: "ctdoxy max. -0.25 ml/l compared to bottles after offset/despike; signal cut-out at surface." Footnote 0-76 db CTDOXY bad.

127 Sample log: "Slow leak on bottom after venting." Water samples look ok.

Station 675

Cast 1 Rosette free fell onto cart with about 5 extra meters of wire paid out. No apparent damage but may be responsible for high number of bottle leaks on outboard side (bottles 22-29)

132-131 CTD Processor: "ctdoxy max. -0.15 ml/l compared to bottles after offset/despike; signal cut-out at surface." Footnote 0-62 db CTDOXY bad.

129	Sample log: "Slight air leak in top cap." Water samples look ok.
128	Bottom drip, reseated ok. Water samples look ok.
126	Sample log: "Bottom drip after venting." Water samples look ok.
125	Bottom drip. Water samples look ok.
123	Sample log: "Bottom drip, reseated, ok." Water samples look ok.
122	Sample log: "Air leak in top cap, reseated, ok." Water samples look ok.
114	Sample log: "Bottom drip after venting." Water samples look ok.
110	Sample log: "Air leak BIGTIME." Water samples look ok.

Station 676

136-135	CTD Processor: "ctdoxy max. -0.10 ml/l compared to bottles after offset/despike; signal cut-out at surface." Footnote 0-42 db CTDOXY bad.
129	Sample log: "Leak @ bottom end cap, not fixed." Water samples look ok.
127	Sample log: "Leak @ bottom end cap, fixed." Water samples look ok.
105	Sample log: "Leak @ bottom end cap." Water samples look ok.
104	PO4 appears 0.02 uM/L low at 4363db. Poor peak may have also contributed to slightly low value on 103 and low value on 104. Footnote PO4 questionable.
103	PO4 appears 0.02 uM/L low at 4618db. Peak fair but problem on 104 peak. Footnote PO4 questionable.
102	PO4 appears 0.04 uM/L low at 4874db. Peak fair but problem on 104 peak. Footnote PO4 questionable.
101	O2 appears 0.1 ml/L low at 5080db. Titration ok. Nutrients look ok, delta-S is 0.000. Possibly thio not rinsed off buret tip after flush. Footnote O2 questionable.

Station 677

136-135	CTD Processor: "ctdoxy max. (+-0.10 ml/l compared to bottles after offset/despike; signal cut-out at surface." Footnote 0-54 db CTDOXY bad.
131	Nutrient data sheet: "No sample." Ok per Sample log. Assume drawing error.
114	Delta-S at 2422db is -0.1345. Autosal run ok. Other water samples ok. Same value as 114 from Station 671, the last time this salt box was used. Probably bottle turned upright but not sampled this station. Footnote salinity bad.
112	PO4 appears 0.03 uM/L high at 2832db. Peak good but definitely high. Footnote PO4 questionable NO3 appears 0.1 uM/L low. Peak irregular but definitely low. Footnote NO3 questionable.
106	O2 appears 0.02 ml/L high at 4052db. Smooth CTDOXY trace. Titration ok. Other water samples ok with sil slightly low (1.0 uM/L) indicating high o2 may be ok.

Station 678

136-135	CTD Processor: "ctdoxy max. -0.30 ml/l compared to bottles after offset/despike; signal cut-out at surface." Footnote 0-88 db CTDOXY bad.
134	Sample log: "Major bottom drip after venting, reseated, ok." Delta-S 0.0196 low at 96db. High gradient, down CTD T&S differ from up. Other water samples ok in start of thermocline. All bottle values OK.
125	Sample log: "Drip at bottom after venting." Water samples look ok.
124	Sample log: "Bottom knocked after o2 draw." Delta-S 0.004 high at 863db. Nutrients also ok. CO2s sampled.

122	Sample log: "Slight air leak in top cap, reseated, ok." Water samples look ok.
110	Sample log: "Slight drip at bottom after venting." Delta-S -0.0021 at 3346db. Other water samples also ok.
109	Sample log: "Slight drip at bottom after venting." Delta-S -0.0023 at 3550db. Other water samples also ok.
107-110	Delta-S is a little greater than -0.002 psu. Overlays of salinity with adjacent stations also look low. Footnote salinity questionable.
105	Delta-S is -.0021. Overlays of salinity with adjacent stations also look low. Several deep bottle salinity values a little low; salinity run on Autosal looks OK. Footnote salinity questionable.

Station 679

133	CTD Processor: "ctdoxy ok compared to bottles after offset/despike, but odd shape in between; coded 4 because of huge change; signal cut-out at surface." Footnote 0-56 db CTDOXY bad.
124	Delta-S at 508db is -0.0116. Salt analysis ok. Sample from strong gradient area. Overlays well with adjacent stations.
123	Delta-S at 634db is -0.0101. Salt analysis ok. Sample from strong gradient area. Overlays well with adjacent stations.
122	Sample log: "Drip from bottom after venting." Water samples look ok.
114	Delta-S at 2020db is -0.0026. Salt analysis ok. Sample from strong gradient area. Overlays well with adjacent stations.
111	No confirm, not tripped. No samples.
103	Sample log: "Leak from bottom after venting, reseated ok." Water samples except po4 look ok. See 102 PO4 comment, footnote PO4 lost.
102	Nutrient data sheet: "Hydra draw tube popped out of its reservoir - caused PO4 to drop to baseline through samples 1-3. Reran all 3 samples, but only achieved a peak for sample 1. Samples 2 & 3 will have to be thrown away." 101 PO4 looks ok. Footnote PO4 lost. Delta-S is -0.0022 psu. Salinity value a little low compared to CTD value. Footnote salinity questionable.

Station 680

136-132	CTD Processor: "ctdoxy max. -0.35 ml/l compared to bottles after offset/despike; signal cut-out at surface." Footnote 0-102 db CTDOXY bad.
131-129	CTD Processor: "ctdoxy max. -0.10 ml/l compared to bottles after offset/despike; signal cut-out at surface." Footnote 104-170 db CTDOXY questionable.
130	Sample log: "Top o-ring air leak, reseated again." Water samples look ok.
127	Sample log: "Leak @ base, reseated, ok." Water samples look ok.
122	Sample log: "Leak @ base, reseated, ok." Water samples look ok.
111	Sample log: "Dripping @ base." Water samples look ok.

Station 681

136-135	CTD Processor: "ctdoxy max. -0.15 ml/l compared to bottles after offset/despike; signal cut-out at surface." Footnote 0-70 db CTDOXY bad.
133	CTD Processor: "ctdoxy max. -0.25 ml/l compared to bottles after despike, drop not seen on upcast." Footnote 110-132 db CTDOXY questionable.
122	Sample log: "Bottom leak on recovery(?)." Delta-S at 995db is 0.0264. Overlays with adjacent stations indicate oxygen and nutrient values are OK. Salinity high compared to CTD and adjacent stations; footnote salinity questionable.

119	Delta-S at 1335db is 0.0755. Autosal run ok. Other water samples ok. Same value as 118 at level below. Probably dupe draw. Footnote salinity bad.
116-113	CTD Processor: "ctdoxy max. (+-0.05 ml/l compared to bottles after despike." Footnote 1700-2500 db CTDOXY questionable.
110-105	CTD Processor: "ctdoxy max. (+-0.05 ml/l compared to bottles after despike." Footnote 2950-4070 db CTDOXY questionable.
108	Delta-S at 3393db is -0.0053. Autosal run ok. Other water samples ok. Same value as 107 at level below. Possible dupe draw. Footnote salinity questionable.
Station 682	
136-134	CTD Processor: "ctdoxy max. -0.40 ml/l compared to bottles after offset/despike; signal cut-out at surface." Footnote 0-118 db CTDOXY bad.
127	Delta-S at 757db is 0.0112. Autosal run ok. Other water samples look ok in high gradient area, salinity acceptable.
126	No confirm first trip try. Tripped ok second try.
121	Delta-S 0.002 high at 1664db. Four Autosal runs to get agreement. Other water samples look ok. High gradient area, salinity acceptable.
114-111	CTD Processor: "ctdoxy max. +0.10 ml/l compared to bottles after despike." Footnote 2600-3500 db CTDOXY questionable.
108-109	CTD Processor: "Bottle O2 -0.03 (bottle 108) or +0.03 (bottle 109) compared to dnCTD, exact amount of diffc buried in CTD noise level: but one does not match up with pattern of other nearby bottles vs CTD (dn or up) on this cast. Not comparable to nearby casts at this level. Bottles 108/109 O2 values within 0.01 of each other - dupe draw?" O2 seems to match nutrients; lots of O2/nutrient structure stns 682 & 683; don't think dupe draw. Leave as qflg=2.
106	Delta-S 0.0021 high at 4359db. Other water samples look ok. Autosal run ok. Same value as 107 salinity at level above. Possible dupe draw. Footnote salinity questionable.
102	O2 titration problem. First try stopped just after start. Restarted and looked ok but unsure how much if any thio added at beginning. Sample 1 had a similar problem, but lost screen on this sample and thio not recorded on computer file. Have 3 digit Dosimat value only. Oxygen lost.
Station 683	
136	CTD Processor: "ctdoxy ok compared to bottles after offset/despike, coded 4 because of huge change; signal cut-out at surface." Footnote 0-50 db CTDOXY bad.
128	Sample log: "Air leak in top." Water samples look ok.
127	Sample log: "Air leak in top." Water samples look ok.
122	Sample log: "Bottom leak after venting." Water samples look ok.
121	Sample log: "Major airleak in top." Water samples also ok.
114-113	CTD Processor: "ctdoxy max. +0.05 ml/l compared to bottles after despike." Footnote 2640-3150 db CTDOXY questionable.
105	Sample log: "Bottom leak after venting." Water samples look ok other than PO4 0.02 high. PO4 peak poor, air spike. Footnote PO4 questionable.
102-101	CTD Processor: "ctdoxy max. drifts to +0.06 ml/l compared to bottom bottle after despike." Footnote 5110-5242 db CTDOXY questionable.
Station 684	
136-134	CTD Processor: "ctdoxy max. -0.25 ml/l compared to bottles after offset/despike; signal cut-out at surface." Footnote 0-90 db CTDOXY bad.

129	Sample log: "Air leak in top - not reseated." Water samples look ok.
125	Sample log: "Dripping after venting, reseated, ok." Water samples look ok.
122	Sample log: "Dripping from bottom after venting." Water samples look ok.
119-109	CTD Processor: "ctdoxy max. (+-0.10+ ml/l compared to bottles after despike." Footnote 1600-3850 db CTDOXY questionable.
111	NO3 appears 0.2 low at 3334db. Poor peak. Other samples ok. Footnote NO3 questionable.
105	Sample log: "Leaking from bottom after venting." Water samples look ok.
102	O2 appears 0.02 high at 5077db. Titration ok. Other samples ok. CTDO shows complex oxygen structure at this depth. Bottle oxygen value OK.

Station 685

136-133	CTD Processor: "ctdoxy max. -0.15+ ml/l compared to bottles after offset/despike; signal cut-out at surface." Footnote 0-84 db CTDOXY bad.
128	Sample log: "Leaks @ base, not fixed." Water samples look ok.
123-120	CTD Processor: "Bottle O2s look off one level (too deep) vs upCTD, bottle 124/509db has same O2 value as bottle 123/609db; test-fit of down with values shifted pulls in max ˜400db much closer to bottles." No analytical problems noted; however does look like Bottles 123 & 124 could be duplicates (no corresponding similarities in other parameters); flag O2 questionable.
118-112	CTD Processor: "Bottle O2s look off one level (too shallow) vs dnCTD shape, bottle 112/2517db O2 value within 0.01 of bottle 111/2717db O2 value; test-fit of up says maybe, maybe not - up features over this pressure range seem shallower by ˜100db than down, but still not consistent with these bottles." CTD Processor: "ctdoxy max. -0.14 ml/l compared to bottles after despike." Footnote 1250-2550 db CTDOXY questionable.
112-111	No analytical problems noted; however does look like Bottles 111 & 112 could be duplicates (no corresponding similarities in other parameters). flag 112-111 O2 questionable.
111	PO4 looks high vs other parameters; No corresponding feature in other parameters, especially no3; Peak shape OK but high; no analytical problems noted;
108	CTD Processor: "Bottle O2 -0.07 compared to dnCTD, also low compared to upCTD; overlays with 686, but none of other nearby bottles do - cast (including most bottles) seems to be mid-way transition between 683/4 and 686/7, doesn’t match either." No corresponding feature in other parameters; no analytical problems noted; flag O2 questionable.
106	Sample log: "Leaking @ base, reseated." Water samples look ok.

Station 686

136-135	CTD Processor: "ctdoxy max. -0.30 ml/l compared to bottles after offset/despike; signal cut-out at surface." Footnote 0-82 db CTDOXY bad.
128	Sample log: "Bottom leak after venting." Water samples look ok.
127	Sample log: "Bottom leak after venting." Water samples look ok.
120-114	CTD Processor: "ctdoxy max. -0.25 ml/l compared to bottles after despike." Footnote 1350-2678 db CTDOXY questionable.

Station 687

136	CTD Processor: "ctdoxy max. -0.06 ml/l compared to bottles after offset/despike; signal cut-out at surface." Footnote 0-58 db CTDOXY bad.
130	Not run on Autosal, drawn ok per Sample log, no notes. Other samples ok. Footnote salinity lost.
122	Sample log: "Leaking from bottom." Water samples look ok.

121-109	CTD Processor: "ctdoxy max. (+-0.15 ml/l compared to bottles after despike." Footnote 1700-4100 db CTDOXY questionable.
114	CTD Processor: "Bottle 14 O2 +.10 compared to dnCTD/upCTD, nearby bottles; lies on 688 bottle trace, but rest of Bottle O2s match up with sta 686 in this vicinity. CTD fit is high, but smooth and shaped like bottles this area, dn or up - this one Bottle O2 does not line up."
113-114	Oxygen 113 & 114 switched? Switching these values looks better. However, no hard evidence to switch samples; leave as is and code O2 questionable.
103	O2 appears 0.09 high at 5035db compared to adjacent station and CTDO. Titration OK, no notes. Delta-S 0.001 high but bottle salt same as levels above and below. Nutrients also OK. Footnote O2 questionable.

Station 688

136-135	CTD Processor: "ctdoxy max. -0.10 ml/l compared to bottles after offset/despike; signal cut-out at surface." Footnote 0-58 db CTDOXY bad.
128	Sample log: "Dripping from bottom after venting, reseated, ok." Water samples look ok.
125	Sample log: "Dripping after venting." Water samples look ok.
123	No confirm first trip try. Tripped ok second try.
122	Sample log: "Leaking from bottom after venting." Water samples look ok.
121-116	CTD Processor: "ctdoxy max. -0.20 ml/l compared to bottles after despike." Footnote 1400-2600 db CTDOXY questionable.
112-109	CTD Processor: "ctdoxy max. +0.05 ml/l compared to bottles after despike." Footnote 3100-3950 db CTDOXY questionable.
110	Sample log: "Air leak, reseated top cap, ok." Water samples look ok.

Station 689

136-135	CTD Processor: "ctdoxy max. -0.15 ml/l compared to bottles after offset/despike; signal cut-out at surface." Footnote 0-60 db CTDOXY bad.
135	Delta-S at 58db is 0.0375. In high salinity gradient. Value OK.
130	Sample log: "Bottom drip, reseated, partially successful." Water samples look ok.
127	Sample log: "Bottom drip, reseated, ok." Water samples look ok.
119-115	CTD Processor: "ctdoxy max. -0.12 ml/l compared to bottles after despike." Footnote 1600-2650 db CTDOXY questionable.
113	Oxygen: "ragged ep." Possibly low by .05 vs CTD but no worse than 111 which is also slightly low. Qflg=2.
112	Sample log: "Bottom drip, reseated, ok." Water samples look ok.
109	Sample log: "Bottom drip, reseated, ok." Water samples look ok.
101	CTD Processor: "ctdoxy max. +0.05 ml/l compared to bottom bottle after despike." Footnote 5236-5290 db CTDOXY questionable.

Station 690

Cast 1	All nutrients appear low compared to adjacent stations and deep check sample 9999. Possible working standard measurement error. PO4 & SIL temperatures for 690 were closer to 691 temperatures than 689 temperatures. Used F1s from 691 for 690. NO3 & PO4 agree much better with both 689 & 691. SIL agrees with 691. Definite SIL change between 689 and 691. Nutrient values acceptable.
136-134	CTD Processor: "ctdoxy max. -0.08 ml/l compared to bottles after offset/despike; signal cut-out at surface." Footnote 0-54 db CTDOXY bad.

117-113 CTD Processor: "ctdoxy max. -0.18 ml/l compared to bottles after despike." Footnote 1500-2500 db CTDOXY questionable.

111-107 CTD Processor: "ctdoxy max. +0.08 ml/l compared to bottles after despike." Footnote 2800-4000 db CTDOXY questionable.

Station 691

117-114 CTD Processor: "ctdoxy max. -0.06 ml/l compared to bottles after offset/despike; signal cut-out at surface." Footnote 0-38 db CTDOXY bad.

106 Delta-S at 859db is 0.0152. Autosal run ok. CTD S spike on up trace. Bottle salt & other water samples ok. Footnote CTD salinity bad. CTDO not reported because CTD salinity coded bad.

102-101 CTD Processor: "ctdoxy max. -0.25 ml/l compared to bottles after despike." Footnote 1350-2750 db CTDOXY questionable.

136-131 CTD Processor: "ctdoxy max. -0.25 ml/l compared to bottles after despike." Footnote 1350-2750 db CTDOXY questionable.

134 Sample log: "leaks from the bottom". Water samples look ok.

122-120 CTD Processor: "ctdoxy max. -0.05 ml/l compared to bottles after despike." Footnote 4236-4820 db CTDOXY questionable.

Station 692

129-128 CTD Processor: "ctdoxy max. -0.23 ml/l compared to bottles after offset/despike; signal cut-out at surface." Footnote 0-90 db CTDOXY bad.

127 Sample log: "Slight bottom leak." High gradient, inversion, down T&S differ from up trace. Water samples look ok.

126-125 CTD Processor: "ctdoxy max. +0.10 ml/l compared to bottles after despike." Footnote 114-240 db CTDOXY questionable.

125 Sample log: "Leaking from bottom." Water samples look ok.

116-108 CTD Processor: "ctdoxy max. -0.25 ml/l compared to bottles after despike." Footnote 1182-2500 db CTDOXY questionable.

131-128 CTD Processor: "ctdoxy max. -0.14 ml/l compared to bottles after despike." Footnote 4886-5094 db CTDOXY bad.

Station 693

128 Sample log: "slight leak after venting, reseated to drip." Water samples look ok.

127-123 CTD Processor: "ctdoxy max. (+-0.20 ml/l compared to bottles after despike." Footnote 48-280 db CTDOXY questionable.

125 Sample log: "Dripping after venting, reseated, ok." Water samples look ok.

112-101 CTD Processor: "ctdoxy max. (+-0.20 ml/l compared to bottles after despike." Footnote 1450-4000 db CTDOXY questionable.

105 High vs other parameters and adjacent stations. O2 is questionable.

105-106 CTD Processor: "On closer inspection, overlays with nearby casts show problem may be bottles 105/106 O2s are +0.05 vs bottle O2s on stas 692/694. CTD not real helpful here - signal only getting worse, going by bottle overlays and CTD shape."

104 CTD Processor: "Bottle O2 -0.05 compared to nearby bottles, no such drop/shape on dn or up CTD." Looks like problem with 105 vs other parameters. See below. 104 OK.

136 CTD Processor: "ctdoxy max. (+-0.20 ml/l compared to bottles after despike." Footnote 1450-4000 db CTDOXY questionable.

134 Sample log: "Dripping after venting." Water samples look ok.

133-132 CTD Processor: "ctdoxy max. -0.05 ml/l compared to bottles after despike." Footnote 4250-4650 db CTDOXY questionable.

Station 694

134-131 CTD Processor: "ctdoxy max. -0.20 ml/l compared to bottles after offset/despike; Footnote 0-70 db CTDOXY bad.

129 Sample log: "Vent not closed." Water samples look good at start of thermocline. Near salinity max.

127 Sample log: "Dripping @ bottom." Water samples look ok.

114-101 CTD Processor: "ctdoxy max. (+-0.20 ml/l compared to bottles after despike." Footnote 1500-4206 db CTDOXY questionable.

111 Delta-S at 2215db is 0.0038. Bottle salinity value high compared to CTD and adjacent stations. Four tries on Autosal to get value. Footnote salinity questionable.

Station 695

136-134 CTD Processor: "ctdoxy max. -0.20 ml/l compared to bottles after offset/despike; signal cut-out at surface." Footnote 0-90 db CTDOXY bad.

118-105 CTD Processor: "ctdoxy max. (+-0.15 ml/l compared to bottles after despike." Footnote 1400-4222 db CTDOXY questionable.

112 Delta-S at 2629db is 0.0025. Bottle salinity a little higher than CTD value and adjacent stations. Footnote salinity questionable.

110 Sample log: "Top not sealed, fixed it." Water samples look ok.

Station 696

131 CTD Processor: "ctdoxy max. -0.22 ml/l compared to bottles after offset/despike; signal cut-out at surface." Footnote 0-50 db CTDOXY bad.

115-104 CTD Processor: "ctdoxy max. (+-0.13 ml/l compared to bottles after despike." Footnote 1450-3500 db CTDOXY questionable.

107 Delta-S at 2764db is 0.0026. Bottle salinity higher than CTD value and station 697 but lower than station 695. Autosal run OK. Footnote salinity questionable.

Station 697

135-133 CTD Processor: "ctdoxy max. -0.40+ ml/l compared to bottles after offset/despike; signal cut-out at surface." Footnote 0-96 db CTDOXY bad.

116-101 CTD Processor: "ctdoxy max. (+-0.15 ml/l compared to bottles after despike." Footnote 1386-4208 db CTDOXY questionable.

Station 698

131 Sample log: "Leak @ bottom after venting." Water samples look ok, at surface. CTD Processor: "ctdoxy max. -0.05 ml/l compared to bottle/nearby cast." Footnote 0-50 db CTDOXY questionable.

129 Flask broken during second shake. No titration. Oxygen lost.

125 Sample log: "Slight drip after venting." Water samples look ok.

121 Sample log: "Leak @ bottom after venting, slowed to drip after reseating." Water samples look ok.

109 Sample log: "Lanyard from 8 caught in top - air leak." Delta-S at 2828db is 0.0545. Autosal run ok. O2 0.06 ml/L NO3 2.7 uM/L low. PO4 0.18 uM/L low. SiO3 16 uM/L low. Footnote bottle leaking and samples bad.

Station 699

131	Sample log: "Drip @ base." Water samples look ok, at surface.
118	Sample log: "Air leak in top cap, reseated ok." Delta-S at 1057db is 0.0075. 3 Autosal runs to get agreement. Other water samples look ok. At salinity minimum. Footnote salinity questionable.
110	Sample log: "Air leak in top cap, reseated, ok." Delta-S 0.002 high at 2523db. 3 Autosal runs to get agreement. Other water samples ok. At deep salinity maximum. Footnote salinity questionable.
102	Delta-S is -0.0021 psu. Salinity value is a little low compared to CTD and adjacent stations. Footnote salinity questionable.

Station 700

135-134	CTD Processor: "ctdoxy max. -0.15 ml/l compared to bottles/nearby casts." Footnote 0-70 db CTDOXY questionable.
127	Sample log: "Slight air leak, fixed." Water samples look ok.
118	Sample log: "Slight leak, fixed." Water samples look ok.
113	Delta-S 0.0025 high. Autosal run ok. Value a little higher than CTD salinity and adjacent stations. Footnote salinity questionable.
110	Sample log: "Slight air leak, fixed." Delta-S at 2525db is 0.0029. Water samples look ok at salinity max. Bottle salinity questionable.
108	Delta-S at 2927db is 0.003. Autosal run ok. Other water samples look ok just below CTD Salinity max. Same value as both levels above at salinity max. Possible dupe draw. Footnote salinity questionable.
105	Delta-S 0.0021 high. Autosal run ok. Value a little higher than CTD salinity and adjacent stations. Footnote salinity questionable.

Station 701

121	Sample log: Leak @ bottom. Water samples look ok.
120	Delta-S at 761db is -0.1738. Other water samples ok. Autosal run ok. Same value as bottle 19 at level below. Assume dupe draw from bottle 19. Footnote salinity bad.
118	Sample log: "Top end cap not set." Water samples look ok.
104	Delta-S is -0.0021. Salinity a little low compared to CTD and adjacent stations. Footnote salinity questionable. CTD Processor: "Bottle O2 +0.05 compared to dnCTD, not much different compared to upCTD. Bottle O2 overlays sta 700 CTD/bottles, but bottles/CTD for sta 701 match 702 below 3700db/1.3 theta - both much lower than 700." Slight depression in nutrients at this level, corresponds to higher O2; leave as acceptable.
101-132	Deep PO4 0.10 uM/L lower than previous stations and 0.05 uM/L lower than subsequent stations after discontinued surfactant in hydrazine prior this station. No change in NO3 between 700 & 701. Possibly Sta 700 PO4s have the worst problem because 700 Redfield ratio lower than any adjacent stations. Adjusting Base(E) for Stns 695-700, looks better; code po4 ’2’

Station 702

134	Sample log: "Leaked after venting, reseated, ok." Water samples look ok, at surface.
127	Sample log: "Leak from bottom on deck." Water samples look ok, in high gradient.
126	Sample log: "Leaked after venting, reseated, ok." Water samples look ok, in high gradient.
118	Sample log: "Air leak from top cap, reseated." Water samples look ok, at oxygen min, PO4,NO3 max.

115 Sample log: "Dripping after venting." Water samples look ok. Oxygen: "ragged ep." Looks OK vs other parameters & adjacent stations.

101 CTD Processor: "Bottle O2 looks high, although dnCTD matches: looks more like dnCTD drifted up at bottom 2db during stop and happens to match. Bottle O2 looks OK vs upCTD, which has no sharp rise at bottom. Bottle O2 also overlays sta 701 bottle O2 and dnCTD." Oxygen Log: "ragged ep." Oxygen analyst: Looks high by ˜.07 ml/L vs adjacent stations. No corresponding feature in other parameters. No notes of any analytical problems. Footnote bottle O2 questionable.

Station 703

129 Sample log: "Slight top end cap air leak." Water samples ok.

127 Sample log: "Dripping from bottom after drawing started." Water samples ok. High gradient.

123 Sample log: "Leaking from bottom end cap." Water samples ok.

Station 704

136-133 CTD Processor: "ctdoxy jagged and noisy throughout surface area, not seen on upcast." Footnote 0-122 db CTDOXY questionable.

127 Sample log: "Drip at bottom cap." Water samples look ok.

122 Sample log: "Very slow air leak before venting." Water samples look ok.

105 Sample log: "Drip @ bottom cap." Water samples look ok.

Station 705

110-116 PO4 appears 0.05 low compared to adjacent stations with high Redfield ratios. Other water samples compare well this area. Peaks look ok, 116 definitely lower that 117 and 110 definitely lower than 109. Footnote PO4 questionable.

Station 706

134 Delta-S at 107db is 0.0315. Salt analysis ok. Sample from strong gradient area.

112-113 Delta-S is about 0.0025, but salinity profile shows many complex salinity structures at this depth. Salinity OK.

110 Sample log: "Top end cap not seated." Nutrient and oxygen samples look ok. At po4 max and near salinity max. Salinity same as 111. Delta-S at 3078db is 0.003. Footnote salinity questionable.

101 CTD Processor: "ctdoxy max. +0.03 ml/l compared to bottom bottle, not comparable to nearby casts, not seen on upcast, probably caused by bottom slowdown." Footnote 4814-4832 db CTDOXY questionable.

Station 707

136 CTD Processor: "ctdoxy max. -0.20 ml/l compared to nearest bottles, not seen on upcast." Footnote 0-34 db CTDOXY questionable.

128 Oxygen value about 0.2 ml/l high compared to CTD oxygen and adjacent stations. Footnote oxygen questionable.

122 Delta-S at 1008db is 0.004. Salt analysis ok. Sample from gradient/feature area.

120 Sample log: "Air leak in top cap, reseated, ok." Water samples look ok.

119 Sample log: "Slight drip after venting." Water samples look ok.

114 Oxygen Lost during titration.

108 Delta-S 0.004 at 3637db. Other water samples ok. Three Autosal runs to get agreement. Normal CTD gradient. Same value as level above, so possible dupe draw or bad run or both. Footnote salinity bad.

4. Acoustic Doppler Current Profiler Observations

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All data are to be considered preliminary at this time.

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Ocean velocity observations were taken on the WHP Indian Ocean Expedition lines I4, I5W, and I7C using two acoustic Doppler current profiler (ADCP) systems and accurate navigation data. The two systems are the hull-mounted ADCP and a lowered ADCP mounted on the rosette with the CTD. The data were taken aboard the R/V KNORR from June 11, 1995 through July 11, 1995. Both end ports of call were Port Louis, Mauritius, with an intermediate port call in Durban, South Africa. The purpose of the observations was to document the upper ocean horizontal velocity structure along the cruise track, and to measure vertical profiles of the horizontal velocity components at the individual hydrographic stations. The observations provide absolute velocity estimates including the ageostrophic component of the flow. Figure 4.1 shows the cruise track and upper ocean currents measured by the hull-mounted ADCP.

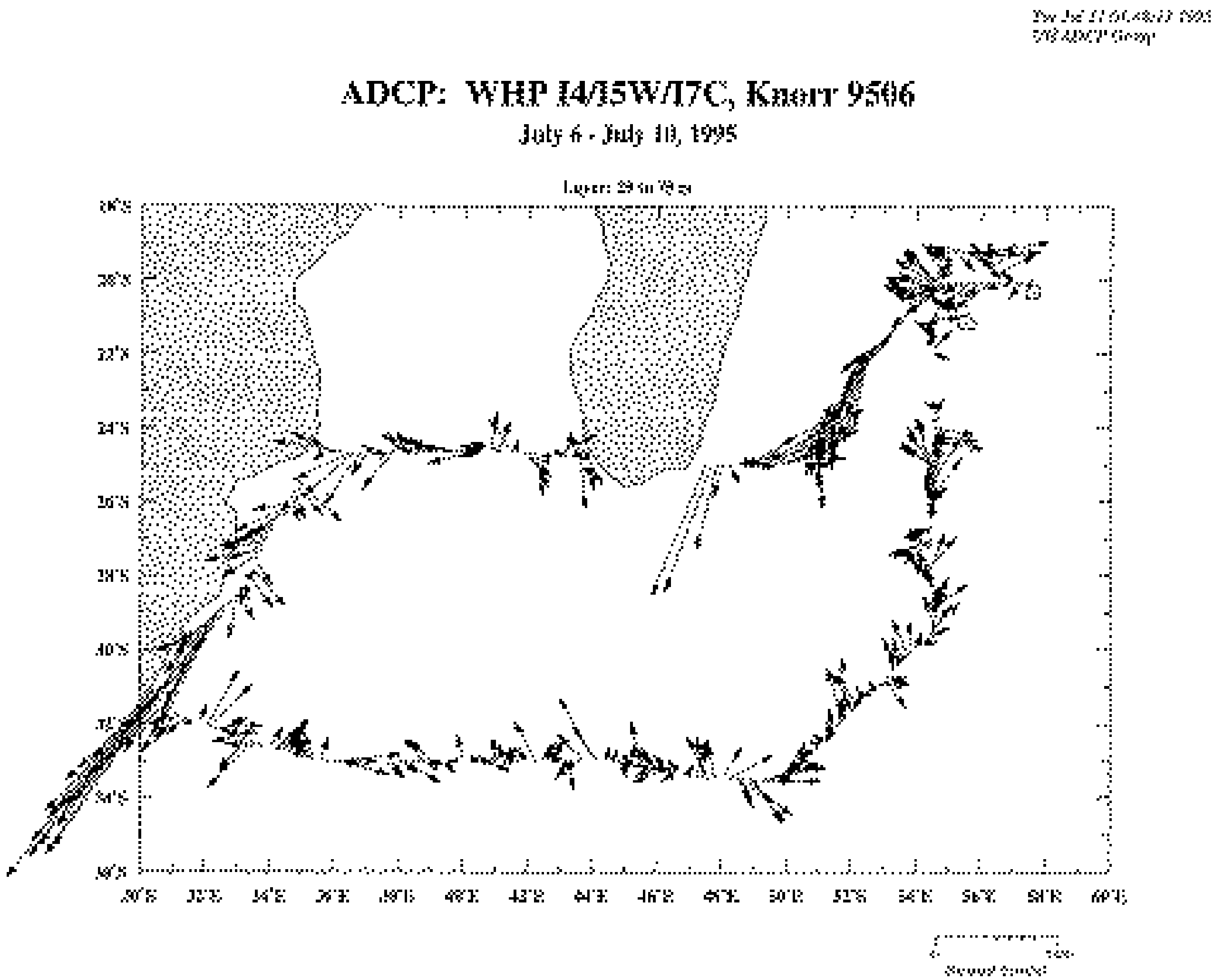

Figure 4.1 Upper ocean currents along the ship track measured with the hull-mounted ADCP.

Preliminary results show flows of almost 2m/s in the Agulhas, and 1.4m/s southward at the southeast coast of Madagascar.

Hull-mounted ADCP

The hull-mounted ADCP is part of the ship's equipment aboard the KNORR. The ADCP is a 150 kHz unit manufactured by RD Instruments. The instrument pings about once per second, and for most of the cruise the data were stored as 5-minute averages or ensembles. The user-exit program, ue4, receives and stores the ADCP data along with both the P-code navigation data from the ship's Trimble receiver and the Ashtech GPS receiver positions. The P-code (military precision) data are used as navigation for the ADCP processing. Civilian quality GPS navigation was used for most of the cruise (see "Naviagtion", below). The ship gyro provides heading information for vector averaging the ADCP data over the 5-minute ensembles. The user-exit program ue4 calculates and stores the heading offset based on the difference between the heading determination from the Ashtech receiver and from the ship gyro.

The thermistor in the ADCP was replaced at the beginning of the cruise and now reads approximately .1C high. The nominal "forward" beam of the shipboard ADCP was mounted facing due aft, as it has been since Columbo. The ADCP transducer is mounted at a depth of about 5 meters below the sea surface. A preliminary comparison of ADCP thermistor temperature to CTD temperature at 3m shows the ADCP is about .1C higher than the flowthrough system and .03C higher than the CTD.

As setup parameters, we used a blanking interval of 4 meters, a vertical pulse length of 16 meters, and a vertical bin size of 8 meters. We used a 5 minute sampling interval for the entire cruise. Bottom tracking was activated during the transit around the southern tip of Madagascar.

Final editing and calibration of the ADCP data has not yet been done. For example, some spikes due to pinging off the CTD wire or rosette on station are still present in the data. A complete set of preliminary plots was generated during the cruise. The plots consist of: vector plots with velocity averaged over several depth intervals, and over one hour in time; and contour plots of u (positive east) and v (positive north) typically averaged over 0.1 degree of longitude or latitude, depending on the track. The velocity was measured from a depth of 21 meters to a depth of about 300 to 400 meters. The depth to which "good" data existed was 300-400m throughout the entire cruise.

Lowered ADCP

The second ADCP system is the lowered ADCP (LADCP), which was mounted to the rosette system with the CTD. The LADCP yields vertical profiles of horizontal velocity components from near the ocean surface to near the bottom. The unit is a broadband, self-contained 150 kHz system manufactured by RD Instruments, model BBCS 150, serial no. 1246. We used single ping ensembles. Vertical shear of horizontal velocity was obtained from each ping. These shear estimates were vertically binned and averaged for each cast. By combining the measured velocity of the ocean with respect to the instrument, the measured vertical shear, and accurate shipboard navigation at the start and end of the station, absolute velocity profiles are obtained (Fisher and Visbeck, 1993). Depth is obtained by integrating the vertical velocity component; a better estimate of the depth coordinate will be available after final processing of the data together with the CTD profile data. The shipboard processing results in vertical profiles of u and v velocity components, from a depth of 60 meters to near the ocean bottom in 20 meter intervals. These data have been computer contoured to produce preliminary plots for analysis and diagnosis.

CTD casts were made at stations 574-707. LADCP casts were made at all stations except 584, 610 and 611, which were too shallow. On cast 623, the LADCP turned off prematurely during the upcast due to a previously noted instrument firmware problem.

The deep casts often have noise problems below 3000 meters or so due to poor instrument range and interference from the return of the previous ping.

Navigation

The ship used a Trimble P-code receiver for navigation, with data coming in at once per second. We have stored this once per second data for the entire cruise, We also decimated this once per second data by a factor of 10 to 10-second intervals and stored these processed files as daily matlab files of latitude, longitude and time.

The Ashtech receiver uses a four antennae array to measure position and attitude. The heading estimate was used with the gyro to provide a heading correction for the ADCP ensembles. The Ashtech data was stored by the ADCP user-exit program along with the ADCP data.

Due to problems obtaining P-code navigation, only dithered Trimble GPS was only available until Durban. A different Trimble receiver was shipped to Durban and installed there, giving us P-code navigation between 6/22 when we left Durban, and 6/26 0000Z, when the "key" obtaining the P-code ceased to function. At approximately 1200Z the newly installed Trimble stopped receiving navigation altogether and the previous one was installed. In summary, civilian quality GPS was used for navigation during the entire cruise except for the first 3 days out of Durban, covering one complete Agulhas crossing, during which time P-code was used.

References

Fisher, J. and M. Visbeck, 1993; Deep velocity profiling with self-contained ADCPs; J. Atmos. Oceanic Technol., 10, 764-773.

5. Lagrangian instrument deployments

Ray Peterson, SIO
Russ Davis, SIO
Wolfgang Krauss, IfM Kiel

Two types of Argos-tracked Lagrangian platforms were deployed during the length of the cruise: 20 neutrally-buoyant ALACE (Autonomous Lagrangian Circulation Explorer) floats, provided by R. Davis (SIO), and 40 surface drifters drogued at 100-m depth with 10-m-long holey socks, provided by W. Krauss (Institut fuer Meereskunde, Kiel). The ALACEs were ballasted to float at a nominal depth of 1000 m. Of these, 12 were preset to rise to the surface every 26 days (dubbed "slow", providing positional data only) and 8 were set to cycle every 15 days (dubbed "fast", providing positional and temperature profile data). The "fast" ALACEs were deployed mainly within the Agulhas Current along line I5W. Of

the surface drifters, 7 were released east of Madagascar, 6 within the southern Mozambique Channel along line I4, 7 within the Agulhas Current directly offshore Durban, 8 more within the Agulhas Current along line I5W, and the remaining 12 along the eastern half of line I5W (7) and along line I7C (5). Positions of deployments are listed below.
ALACE floats

ALACE s/n	**Type**	**Date**	**Time (Z)**	**Lat (S)**	**Lon (E)**
500	slow	06/14/95	0137	24 59.91	48 30.26
501	slow	06/16/95	1822	24 40.02	41 59.89
502	slow	06/17/95	1331	24 39.82	39 59.46
447	fast	06/18/95	1022	24 40.06	37 45.12
456	fast	06/18/95	2208	24 41.07	36 44.36
370	fast	06/19/95	0635	24 39.93	35 59.66
369	fast	06/22/95	2105	31 09.70	30 25.50
518	fast	06/23/95	0235	31 14.57	30 32.68
519	fast	06/23/95	0905	31 27.81	30 49.53
516	fast	06/23/95	2321	31 50.65	31 23.52
503	slow	06/24/95	1625	32 22.53	32 59.28
517	fast	06/25/95	1118	32 53.98	34 59.86
282	slow	06/25/95	2353	33 00.59	36 13.80
239	slow	06/26/95	2337	31 01.46	37 29.82
507	slow	06/28/95	1000	33 00.32	40 59.72
506	slow	06/29/95	1610	33 00.41	43 02.71
505	slow	06/30/95	1307	33 12.94	45 59.19
504	slow	07/01/95	0731	33 29.90	47 59.63
508	slow	07/06/95	0608	27 00.17	54 29.18
498	slow	07/08/95	0635	23 38.59	54 31.67

100-m drogued drifting buoys

Drifter s/n	Date	Time (Z)	Lat (S)	Lon (E)
15189	06/13/95	0801	24 59.98	50 06.30
11345	06/13/95	2055	24 59.85	49 00.76
21495	06/14/95	0650	25 00.05	48 00.04
21523	06/14/95	1030	25 01.00	47 49.59
21512	06/14/95	1350	25 01.72	47 38.44
21503	06/14/95	1605	25 01.16	47 29.28
21501	06/14/95	1735	25 00.36	47 27.58
21494	06/17/95	1328	24 39.93	39 59.83
21489	06/18/95	0400	24 10.53	38 30.06
00598	06/18/95	1858	24 40.18	36 59.98
21517	06/19/95	0401	24 39.59	36 14.32
00593	06/19/95	1425	24 39.85	35 43.21
21519	06/19/95	1658	24 40.02	35 29.24
21522	06/22/95	0705	29 57.18	31 13.04
21514	06/22/95	0756	30 04.18	31 20.73
21505	06/22/95	0833	30 10.41	31 24.80
21465	06/22/95	0901	30 14.49	31 27.74
21521	06/22/95	0916	30 16.42	31 29.03
21500	06/22/95	0932	30 18.42	31 30.33
21508	06/22/95	0952	30 21.37	31 32.44
21458	06/22/95	1830	31 07.41	30 22.37
21504	06/22/95	2108	31 09.63	30 25.64
21507	06/22/95	2354	31 11.94	30 29.41
11322	06/23/95	0238	31 14.57	30 32.70
21502	06/23/05	0542	31 17.80	30 35.90
00625	06/23/95	0906	31 27.81	30 49.55
21510	06/23/95	1604	31 34.99	30 59.43
21520	06/23/95	2320	31 50.16	31 23.20
21498	06/24/95	0724	32 03.78	32 03.81
11342	06/24/95	1625	32 22.47	32 59.38
21518	06/25/95	0125	32 36.80	33 47.43
21496	06/25/95	1123	32 54.08	34 59.78
04015	06/25/95	2355	33 00.50	36 13.80
21469	06/26/95	2335	33 01.47	37 29.93
21472	06/28/95	1003	33 00.30	40 49.66
11323	07/05/95	1005	28 18.80	54 29.99
21513	07/06/95	0610	27 00.54	54 28.97
21511	07/07/95	0208	25 39.46	54 30.33
04016	07/08/95	0155	23 58.96	54 31.39
00661	07/08/95	2055	22 29.10	54 29.71

6. CFC Observations

Kevin Maillet (U.Miami / RSMAS)
Steve Covey (U. Washington)

CFC samples were drawn on 105 of 134 stations. The total number of CFC samples drawn was 1512 of which 33 were replicate samples and 3 were not analyzed due to sample loss. Marine air measurements were made at 19 locations during the cruise. The average marine air CFC concentrations measured was 266.60 ppt F-11 and 507.49 ppt F-12.

Along the I4 line, 5 stations were sampled east of Madagascar and another 18 were sampled west of Madagascar. Measurable CFC-11 concentrations were seen to penetrate to around 1500 m. A subsurface CFC maximum, indicative of Sub Antarctic Mode Water (SAMW), was observed in the range of 200 - 400 m.

A total of 56 stations were sampled on the I5W line. Maximum CFC-11 penetration was 1500 m on the western end of the I5W line, increasing to over 2000 m eastward into the western Madagascar Basin. Again, SAMW was evident as a subsurface CFC maximum. Elevated concentrations of up to 0.1 pmol/kg CFC-11 were observed in the bottom water of the western slope of the Mozambique Basin, gradually decreasing eastward across the basin. Bottom waters in the Madagascar Basin were generally less than 0.01 pmol/kg. On the I7C line, 25 stations were sampled. CFC-11 penetration shoaled from 1500 m on the southern end of the line to around 1000 m to the north. Slightly elevated concentrations (CFC-11 of 0.02 pmol/kg) were observed in the bottom waters between 27d S and 29d S along the I7C line.

7. Shallow Helium / Tritium & Deep Helium

Scot Birdwhistell WHOI
Ralf Weppernig LDEO

On this group of legs I4w, I5w & I7c the shallow helium / tritium and the deep heliums were sampled as a joint operation by WHOI and LDEO. S. Birdwhistell from WHOI and R. Weppernig from LDEO were the people responsible for the sampling and onboard processing of the helium and the tritium samples. They sampled 18 stations for shallow (surface to 1500-1800m) helium/tritium and a total of 24 for deep helium (1500-1800 to bottom). Station spacing was approximately 1.5 - 2 degrees of longitude on I4, 3 to 4 degrees of longitude on I5w and approximately every 3 degrees of latitude on the I7c line except at continental boundaries where the station spacing was reduced so as to sample any boundary currents . On each station, approximately 16 helium /tritium pairs were collected and processed, along with 16 deep heliums. Deep heliums were also taken on the I4 and I5w lines at stations which split the distance between the shallow stations . A total of approximately 670 heliums and 300 tritiums were taken and processed on 24 of the stations.

8. C14 Sample Collection

Tonalee Key
Ocean Tracers Lab
Princeton University

All C14 sample collection proposed for this leg of WOCE was completed. In all, 15 stations were sampled producing 366 samples.

TABLE 1 C14 Samples Collected

Station	**Number of Samples**	**Type of Sample**
578	16	upper column
593	30	full column
599	32	full column
622	32	full column
628	16	upper column
638	32	full column
644	16	upper column
650	32	full column
660	16	upper column
666	32	full column
672	16	upper column
676	32	full column
684	16	upper column
694	32	full column
702	16	upper column

9. Underway pCO2 System

Tonalee Key
Ocean Tracers Lab
Princeton University

Approximately 530 hours of air and surface water pCO2 values were collected with the underway pCO2 system. The system performed to specifications except for one mechanical failure which resulted in the loss of approximately 15 hours of data, however most of that was time spent on station. In addition, there was a loss of approximately 15 hours of data due to rough weather which caused the bow pump to air lock. Once again, most of this time was spent on station.

10. Total Carbon dioxide

R. Wilke
Brookhaven National Laboratory

Samples for TCO2 were taken at all 134 stations occupied during cruise legs I4, I5W and I7C. Full profiles were taken at 66 stations while mixed layer (0-100meters) samples were taken at the rest. A total of approximately 2050 discrete samples were analyzed.

No significant problems were encountered with the instrumentation during the cruise. Certified Reference Materials (Batch 26) supplied by Dr.Andrew Dickson of SIO were analyzed daily on each SOMMA instrument. The combined CRM results from both SOMMA's are:

Mean = 1976.46 uM/Kg Std. Dev. = 0.93 uM/Kg N = 79

This compares to a given CRM TCO2 value of:

Mean = 1978.34 uM/Kg Std. Dev. = 0.67 uM/Kg N = 9

Note that at the time the CRM's were shipped (March, 1995), SIO had not yet conducted sufficient analyses to "Certify" the batch. The sample data are considered to be of high quality based upon the CRM data and the analyses of duplicate pairs of samples. The difference ,in TCO2, between the duplicates was:

Mean = 0.38 uM/Kg Std. Dev. = 1.03 uM/Kg N = 200

In general, all samples from a given station were analyzed on the same instrument. On occasion, samples from one station were analyzed on both instruments to facilitate sample throughput. In these cases, duplicate samples were analyzed on both Somma's. The difference in TCO2 of these duplicates was:

Mean = 0.17 uM/Kg
Std. Dev. = 1.04 uM/Kg
N = 12

Upon cursory examination of the data, the TCO2 concentrations follow the usual pattern of low values at the surface while increasing with depth in the water column. The lowest surface concentrations (~1950 uM/Kg) were found in the vicinity of Station 584, off the eastern shore of Madagascar. Low surface concentrations were also observed at stations on the northern end of the I7C transect. The highest surface TCO2 concentrations (~2050uM/Kg) were found near and to the east of the Madagascar Ridge around Stations 656-662. The highest TCO2 concentrations (~2300 uM/Kg) at depth were found in the Madagascar Basin near Stations 680-700 at around 3000-3600 meters.

The two most notable features of the TCO2 distribution were found along the I5W transect. At the shoreward end of the transect, high TCO2 levels shoaled up onto the continental slope region from their typical depth of greater than 1000 meters up to about 600 meters depth. A band of relatively low concentration TCO2 water (2200 uM/Kg vs. 2250 uM/Kg) was apparent at Stations 611-650, both in the Natal Valley and the Mozambique Basin, in a depth range of 2000-3500 meters. This seems to be coincident with a high salinity water mass, perhaps, North Atlantic Deep Water. This feature is also evident between 2200-3200 meters depth at stations 585-599 on transect I4.

11. Total alkalinity

Ernie Lewis
Brookhaven National Laboratory

Total alkalinity is one of the measurable parameters of the CO2 system in the ocean and is determined by titrating the seawater sample with HCl and fitting the resulting titration curve. Typical values for the oceans are 2100 - 2400 micro-equivalents per kilogram of seawater.

Samples were taken at all 134 stations occupied during I4, I5W, and I7C. Two different cells were used to analyze the samples. Normally, full profiles were taken at every other station, with samples taken to cover the mixed layer only for the rest. A total of just over 2000 samples were analyzed. These include approximately 180 replicates for quality control. In addition, around 75 CO2 Certified Reference Materials of Batch 26 (supplied by Dr. Andrew Dickson of SIO) and 50 secondary standards were analyzed. The reference materials are not certified for alkalinity, but are expected to be stable. The secondary standards were surface seawater which was collected before each leg.

For replicates which were run on the same cell, the mean difference was between 4 and 5 micro-equiv/kg for each cell. The mean difference for replicates run on both cells was zero, to within one standard deviation of this difference. For the certified reference materials, the mean values on both cells were within 1 micro-equiv/kg of each other, with standard deviations 3 to 4 micro-equiv/kg. For secondary (surface) standards, the mean values (which would be different for each of the three legs) of the two cells agreed to within one standard deviation of each other, which was in the range from 2 to 7 micro-equiv/kg.

Of the more than 2000 samples analyzed, over 95% had alkalinities in the range 2300-2400 micro-equiv/kg. Only about 3% had values greater than 2400 micro-equiv/kg, and less than 1% were less than 2300 micro-equiv/kg. For a typical profile, the surface would have a value of between 2300 and 2350, increasing (with depth) through the mixed layer to 2350, decreasing to 2300 at 1000 m, and increasing to around 2400 at a depth of around 3000 m. For depths below this, the values would remain almost constant or decrease slightly, often showing signs of another increase around 5000 m.

13. Chlorophyll

Alistair Hobday, SIO/UCSD

Chlorophyll sampling was undertaken as a side project by the observing biologist. Nine depths between the surface and 200m were sampled, providing total chlorophyll for each depth, as well as an integrated water column large cell fraction. Between Madagascar and Africa, 24 of 26 stations were sampled, while on the southern leg, intense sampling was carried out between stations 612 and 668. From preliminary comparisons between these two transects a major difference in upper water column stratification is obvious. Stations on the northern transect had a subsurface chlorophyll maximum, indicating a shallow mixed layer, while on the southern leg, no such maximum occurred. Chlorophyll was high throughout the deeper mixed layer. Nitrate, temperature and stability measures (N^2), will be used in the complete analysis to explore the observed chlorophyll patterns and the role of upper ocean dynamics in producing such features.

14. Barium

Kelly Faulkner, Oregon State University

As an ancillary program to the WHP effort, samples were collected for shoreside analysis of barium. The collection was at the request of Dr. Kelly Faulkner of Oregon State University. Dr. Faulkner's sampling plan was to collect water from every bottle at alternate stations. However at cruise beginning a 50% shortfall of empty sample containers to meet this requirement was identified. A contingency plan to collect water at each odd station, from each odd water sample bottle was initiated and the lead scientist emailed for further instructions. Receiving none, that plan stood for the leg; the exception being the final stations where water was drawn from every bottle to round out the chest of available sample containers.

15. Underway sampling

Michael Thacher, WHOI

The following sensors were installed and in use during I4.

IMET SENSORS - R/V KNORR

Sensor Type	Module ID	Sensor Mfg.	Location	Status	Comments
Air Temperature	TMP 119	Eaton Corp.	Tower	OK	Installed 1/95
Baromertric Pressure	BPR 118	Air Inc.	Tower	Needs Consts.	Installed 6/94
Precipitation	PRC 113	R.M. Young	Tower	OK	Installed ?
Relative Humidity	HRH 115	Rotronic	Tower	OK	Installed 6/9
Sea Surface	SST 108	Bow Dome	Installed 6/94		

Temperature		Noisy Data			
SW Radiation	SWR 003	Eppley	Tower	OK (?)	Installed ?
Wind Speed/Direction	WND 004	R.M. Young	Tower	OK	Installed 4/95

NAVIGATION SENSORS - R/V KNORR

Type	**Serial Number**	**Location**	**Status**	**Manufacture**
Computer Time		Science Chart Room	OK	Bancomm
Port MX200 GPS	190315	Ships Chart Room	OK	Magnavox
Stbd MX200 GPS	190317	Bridge	OK	Magnavox
P-Code GPS	4111000053	Ships Chart Room	Y-Code only	Trimble Nav.
Gyro	1203	IC Room	OK	Sperry
Speed log		Bow Chamber	Questionable	EDO
Sea Surface				
Conductivity	1329-121591	Bow Chamber	OK	Falmouth Sci.
Temperature	1322-121591	Bow Chamber	OK	Falmouth Sci.
12 KHz				
Echo Sounder	114-88	Bow Chamber	OK	Ocean Data Equ.

Data

The data was logged to ASCII text files, one containing ship navigational information, and the other containing meteorological information. There were a few large gaps in the data during the cruise. Any gap longer than 15 minutes while under way, and any gap longer than one hour while on station are listed below, with a short explanation of each. If only a subset of the data items are missing for the period indicated, the missing items will be listed along with the notes. In the table below OS stands for on station, and UW stands for under way.

Date	**Start**	**Stop**	**Length**	**UW/OS**	**Notes (Including data affected)**
06/22	07:26	07:53	27 min.	UW	P-Code installation [GPS_TP]
06/26	03:25	06:22	177min.	OS	Power reset needed [WND]
06/26	12:00	13:34	94 min.	OS	P-Code receiver replacement [GPS_TP]
06/26	15:13	15:31	18 min.	UW	Data Logging Computer Failure [all data]
06/27	11:54	12:34	40 min.	UW	Data Logging Computer Failure [all data]
06/27	17:47	18:06	19 min.	UW	Power reset needed [WND]
06/30	10:20	10:38	18 min.	UW	P-Code testing [GPS_TP]
07/07	08:27	09:29	62 min.	UW	Data Logging Computer Failure [all data]

Note: No data logged during port stop Durban: 06/21, 06:22 GMT to 06/22, 05:56 GMT

end of report

31 March 2000
>> revised 15 May 2000 - documentation ONLY, not data files
>> fixed minor errors and added pdf version

>>FINAL quality-coded WHP-format CTDO Data release for WOCE95-I4/I5W/I7C

The file named i4ctd.tar.Z contains the files listed below, which were tarred and compressed for easier transmission via ftp. To expand these files into the directory "./i4ctd", use the following UNIX command:

```
uncompress -c i4ctd.tar.Z | tar xvpf -
```

The file named "i4ctd.zip" was created with the UNIX zip utility for the benefit of PC users. The data can be expanded into the directory "./i4ctd" 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 2.0.1. Earlier versions are not compatible.

CONTENTS of the directory ./i4ctd (approximately 18.8 Mbytes expanded; 6.5 Mbytes of this are documentation):

README.ctd	comments regarding data release and documentation
DOC	final ODF processing documentation directory
i4i5wi7c.sum	WOCE-format station-cast description file (ODF version) (a more up-to-date version may be available from the P.I.)
ssscc.ctd	stations 574-707 ctd data files: 136 total casts (sss = station number cc = cast number)

The documentation is dated 31 March 2000 to match the date CTD PTCO data were finalized. The complete document is in DOC/i4doc.ps, DOC/i4doc.pdf or DOC/i4doc.asc. The files in DOC with a ".ps" suffix can be printed out on a postscript printer. The files in DOC with a ".pdf" suffix can be printed out using Adobe Acrobat Reader, freely available at the following website:

http://www.adobe.com/products/acrobat/readstep.html

The postscript and pdf versions have also been broken down into parts, as listed below, for those desiring only one section of the document:

ascii documentation:

DOC/i4doc.asc entire document, minus figures

postscript/pdf documentation ("sfx" = .ps or .pdf):

DOC/i4doc.sfx entire document (also in 3 parts, listed below)
DOC/i4cover.sfx cover sheet with cruise info & track map

DOC/i4body.sfx main body of document, including references
DOC/i4apps.sfx appendices A-D with tables of CTD temperature
& conductivity corrections, CTD oxygen
corrections, CTD processing comments,
and bottle data quality comments.

The version in DOC/i4doc.asc is available for those who cannot use the postscript or pdf versions. Note that figures in the documentation can only be printed with postscript or pdf versions and do not appear in the ascii version. Also, the ascii file is 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 P.I.s who wish to merge parts of the ascii file into other cruise documentation.

QUESTIONS:

These data may not be released without permission from the Chief Scientist/PI:

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