Last Updated 2001.07.13

A.1 WHP CRUISE SUMMARY INFORMATION

WOCE section designation	I03
Expedition designation (EXPOCODE)	316N145_8
Chief Scientist(s) and their affiliation:	Worth D. Nowlin, Jr./TAMU
Dates:	1995.04.23 - 1995.06.05
Ship:	R/V KNORR
Ports of call:	Fremantle, Australia; Port Louis, Mauritius
Number of stations:	120
Geographic boundaries of the stations:	19? 58.77' S 48? 55' E 113? 45.59' E 28? 13.96' S
Floats and drifters deployed:	28 ALACEs
Moorings deployed or recovered:	20
Contributing Authors:	Barrie Walden Mike Kosro

WHP CRUISE AND DATA OUTLINE

A.2 Cruise Summary Information

A.2.a Geographic boundaries

A.2.b Stations Occupied

SUMMARY INFORMATION
120 full CTD/rosette stations were made (numbers 443-462), including one test station (443). Eleven CTD stations were made (563-573) with lowered ADCP and transmissometer measurements and samples analyzed for dissolved oxygen and salt only. Depths sampled are described in a later section. Parameters measured or for which samples were taken are given in the station summary (-.SUM) file.

A.2.c Floats and Drifters Deployed

Table 1 gives the positions and dates of deployments of the 28 ALACEs, with instrument serial numbers and numbers of CTD stations where deployed.

S/N	Deployment Date	Latitude (S)	Longitude (E)	CTD Station

485	27 04 1995	22 00.00	112 22.88	450
486	28 04 1995	21 09.09	110 09.25	454
482	29 04 1995	20 00.19	106 37.00	459
481	01 05 1995	20 00.02	103 06.79	463
480	02 05 1995	20 00.08	100 27.86	466
479	03 05 1995	20 00.07	96 57.05	470
483	04 05 1995	20 00.22	94 18.11	473
484	05 05 1995	20 00.49	91 19.52	478
494	08 05 1995	20 00.03	88 30.80	484
493	08 05 1995	20 00.14	86 53.91	488
492	09 05 1995	19 59.91	85 17.93	491
491	10 05 1995	19 59.93	82 44.02	495
497	11 05 1995	20 00.06	79 48.75	499
496	13 05 1995	20 00.03	76 54.49	503
458	17 05 1995	20 00.19	74 10.26	507
489	18 05 1995	20 00.14	71 15.07	513
490	19 05 1995	19 59.99	68 13.11	519
385	20 05 1995	20 00.09	65 26.14	524
386	22 05 1995	20 22.13	62 14.69	530
487	23 05 1995	20 21.97	59 13.57	535
488	28 05 1995	20 00.07	56 05.09	545
469	29 05 1995	20 00.09	53 19.62	550
468	30 05 1995	20 00.267	52 15.922	552
321	31 05 1995	20 00.01	51 17.90	554
476	31 05 1995	20 00.20	50 35.84	556
431	01 06 1995	20 00.16	50 04.03	557
478	01 06 1995	20 00.04	49 38.08	558
477	01 06 1995	20 00.12	49 23.33	559

A.2.d Moorings deployed or recovered

Twenty moorings were deployed in three arrays with a total of 60 current meters. Mooring positions are included in the station summary file.

A.3 List of Principal Investigators

ODF Operations

1) Water sampling package (Rosette and CTD)
2) CTD data acquisition system
3) CTD data Processing
4) Bathymetry acquisition and merging
5) Bottle sampling
6) Salinity analysis
7) Oxygen analysis
8) Nutrient analysis

Analysis	Institution	Principal Investigator
CFC	SIO	Ray Weiss
Shallow He/Tr	WHOI	Bill Jenkins
Deep He/Tr	LDEO	Peter Schlosser
AMS 14C and Ra-228	Princeton	Robert Key
TCO2 & Alkalinity	Miami	Frank Millero
TCO2	SIO	Charles Keeling
Barium	OSU	Kelly Falkner
Current Meters and Moorings	TAMU	Worth Nowlin
Moorings	TAMU	Tom Whitworth
	WHOI	Bruce Warren
	OSU	Dale Pillsbury
Transmissometer	TAMU	Wilf Gardner
Underway measurements		
ADCP and LADCP	OSU	Mike Kosro
PCO2	Princeton	Robert Key
Air chemistry	SIO	Ray Weiss
Meteorology (IMET)	WHOI	
Thermosalinograph	WHOI	
ALACE floats	SIO	Russ Davis

A.4 Scientific Programme and Methods

A.4 Scientific Programme and Methods

WOCE Hydrographic Program section I03 and the deployment phase of

WOCE current meter project ICM3 were carried out aboard the R/V KNORR (call sign KCEJ) on voyage 145_8. This voyage began in Fremantle, Australia on 23 April 1995 and ended in port Louis, Mauritius on 5 June 1995 with one intermediate call in Port Louis from 25 to 28 May. Worth D. Nowlin, Jr. was chief scientist for the voyage.

NARRATIVE

The scientific activities on this voyage were carried out along or near 20 S from Australia to Mauritius to Madagascar. The CTD/rosette stations occupied included the WOCE suite of measurements, as described later, as well as lowered transmissometer and ADCP measurements and sampling for the U.S. Department of Energy's Carbon Dioxide program and for barium samples.

Leaving Fremantle, a test CTD/rosette station was made off the west coast of Australia near 28 S. The cruise then proceeded to the 200-m isobath near 22 S where CTD/rosette stations were made along a line to the west-northwest to 20 S and approximately 108 E. The first seven of those stations bracketed the six Australian moorings of WOCE ICM6 which were in place at the time.

The cruise then proceeded westward along 20 S crossing the West Australian Basin, Ninetyeast Ridge, Central Indian Basin, and Central Indian Ridge. West of the latter, the track veered southward to 22 S around Rodriguez Island to maintain a deep water cruise path to the east coast of Mauritius.

Along the eastern flank of the Ninetyeast Ridge, seven moorings of ICM3 were deployed. The deployments were interspersed with CTD/rosette stations. On the eastern flank of the Central Indian Ridge another seven moorings were deployed. These moorings were deployed first, and then CTD/rosette stations were made between them from east to west.

Leaving Port Louis, Mauritius, where a 2-day port call was made, CTD/rosette stations continued westward along 20 S from the continental shelf of Mauritius to that of Madagascar. Six moorings of ICM3 were deployed at the western boundary of the Mascarene Basin, between CTD/rosette stations.

On reaching the eastern shelf of Madagascar, eleven CTD stations with lowered ADCP were made at the locations of earlier CTD/rosette stations bracketing the current meter deployments.

Twenty-eight Autonomous Lagrangian Circulation Explorers (ALACEs) were deployed along the cruise track with special attention to the western boundary region east of Madagascar. An underway program of meteorological, sea surface, and ADCP measurements was carried out along the track described as well as on the eastward return to Port Louis at the end of the voyage.

Continuous southeasterly winds of about 10-20 knots along with 4-6 ft southeasterly swells were the usual conditions for the entire leg. The first and last portions of the cruise were calmer than the rest. Seas turned choppy and stronger winds up to 30 knots in mid-May. This condition moderated somewhat toward the end of the month. Skies were usually partly sunny and fair marked with occasional overcast conditions and an occasional rain squall.

A.5 Major Problems and Goals not Achieved

A.6 Other Incidents of Note

Approximately 12 hours after leaving Fremantle at the beginning of voyage 145_8, Rhonda Kelly suffered a burn to her eye caused by a basic solution used in dissolved oxygen analysis. She was treated by the ship's medic and returned to Fremantle for continuing medical attention. Kelly rejoined the voyage in Port Louis.

Early in the voyage one conductor grounded in a new CTD cable installed in Fremantle. The ground was approximately 3000 meters from drum. The cable proved serviceable using the remaining pair of conductors. The second cable on the vessel was old with one broken outer strand about 3945 m from the bitter end. All conductors in that cable were serviceable, and it was used for the remainder of the cruise. This was because we experienced mild weather and wished to save the newer cable for future, perhaps worse, weather conditions.

A.7 List of Cruise participants

Scientific Personnel

Name	Title	Affiliation	Duties
Worth D. Nowlin, Jr.	Distinguished Professor	TAMU	Chief Scientist/ CTD Console
Bruce A. Warren	Senior Scientist	WHOI	Co-Chief/ Btl data/Rosette
Ann E. Jochens	Assoc. Research Scientist	TAMU	CTD Console/PDR
Steven B. Rutz	Research Associate	TAMU	Rosette
Carl W. Mattson	Pr. Electronic Tech	STS/ODF	TIC/Watch Leader/ ET/Rosette
John Boaz	Marine Tech	STS/ODF	Watch Leader/ O2/Rosette/Btl data
Doug M. Masten	SRA	STS/ODF	Nutrients
Barry Nisly	Dev. Engineer	STS/ODF	Nutrients/O2
Craig M. Hallman	SRA	STS/ODF	O2/Salt/Rosette
Mary C. Johnson	SRA	STS/ODF	CTD data processing
Jeff Skinner	Dev. Engineer	STS/SCG	Salt/Rosette
Frederick A. Van Woy	SRA IV	SIO/GRD	CFC
Dongha Min	Research Assistant	SIO/GRD	CFC
Kirk Hargreaves	Oceanographer	PMEL	CFC
P. Michael Kosro	Assoc. Professor	OSU	ADCP
Robert M. Key	Research Oceanographer	PU/OTL	C14/Ra-228/pCO2/Salts
Peter B. Landry	EA III	WHOI	He/Tr
Daniel Smith	Research Staff Assistant	LDEO	He/Tr
David G. Purkerson	Research Assistant	U Miami	CO2
Christopher Edwards	Lab Tech	U Miami	CO2
Joann Krenisky	Research Assistant	U Miami	CO2
Jennifer Aicher	Graduate Student	U Miami	CO2
Dennis C. Root	Senior Research Assistant	OSU	Moorings/LADCP
John Simpkins III	Senior Research Assistant	OSU	Moorings/Rosette
Richard Hevner	Research Assistant	OSU	Moorings/Rosette/Salts
Matthew P. Pillsbury	Instrument Tech	OwU	Moorings
Michael A. Thatcher	SSSG Tech	WHOI	Res Tech

The following personnel joined the ship in Mauritius 25-27 May

Rhonda M. Kelly	SRA II	STS/ODF	Nutrients
Noasy T. Razakafoniaina	Oceanographer	Madagascar	Observer
Jean Maharavo	Oceanographer	Madagascar	Observer

B. UNDERWAY MEASUREMENTS

B.1. Navigation and Bathymetry
(Barrie Walden 2001.04.06)

KNORR used P-Code GPS for navigation on this cruise and we recorded Position information once per minute onto the Sun Sparcstation.

Navigational data from three GPS receivers was recorded at one-minute time intervals. Two of the receivers were Magnavox MX200s and the third was a Trimble TANS P(Y) running in standard (non P-code) mode. The antennas for all of these receivers were mounted on the ship's mast at approximately mid-ships (frame 63). All position data includes the time and position extracted directly from the NMEA 183 CGS data stream. Additionally, the data provided by the Trimble receiver includes a final "source" indicator as follows: "1"=standard; "2"=diferential, "3"=P-Code.

Depth measurements were made using a hull-mounted 12 kHz echo sounder and a Raytheon recorder. Uncorrected depth (using a sounding speed of 1500 m/sec) was estimated to the nearest meter from the recorder every 5 minutes and manually entered into a data file that was subsequently merged with the 1-minute navigation data. This series of measurements began when the vessel left Fremantle and continued until the completion of the CTD stations, with a break for the intermediate port stop in Mauritius. While on CTD stations, depth measurements were not recorded except as required for the CTD log.

B.2. Meteorological Observations

The following IMET sensors were installed and in use during I03.

Type	Serial Number	Label
Air Temperature	119	TMP
Barometric Pressure	118	PR
Precipitation	113	PRC
Relative Humidity	unknown	HRH
Sea Surface Temperature	108	SST
Short Wave Radiation	003	SWR
Wind Speed and Direction	004	WND

The data were 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 underway or 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)
04/26	00:23	00:48	25 min.	UW	Return to old software (V 4.2B)	[all data]
05/11	17:37	17:58	21 min.	UW	Data logging computer down	[all data]
05/13	20:45	21:36	51 min.	UW	Data logging computer down	[all data]

NOTE:
No data logged during port stop Mauritius:
05/25, 13:40 GMT to 05/28, 02:42 GMT

In addition, data for 23 April (02:16 - 23:59 GMT) were lost in an attempted software upgrade to Athena V 4.2C. The majority of the missing data were recovered through data logged by the C14 group. The file format is different from that on other days of the cruise and has been given the extension .nav versus .met or .shp. It contains the following information:

GPS_TP	GPS time and position	
GYRO	Ship's heading	(Gyro syncro)
IMET_AIR	Air temperature	(degrees C)
IMET_BPR	Barometric pressure	(millibars)
IMET_SEA	Sea surface temp	(degrees C)
IMET_WNC	True wind direction	(THIS IS NOT RELIABLE!)
IMET_WND	Wind direction	(ship relative)
IMET_WNS	Wind speed	(m/s ship relative)
SPDLOG	Ship's speed	(EDO Speedlog)
SSCND	Sea surface conductivity	(mmho/cm)
SSTMP	Sea surface temperature	(degrees C)

B.3. Acoustic Doppler Current Profiler
(Mike Kosro)

DATA_DATES	1995/04/23 01:00:00 - to - 1995/06/05 04:25:00
LON_RANGE	48.90 E - to - 115.50 E
LAT_RANGE	31.88 S - to - 19.62 S
DEPTH_RANGE	17 - to - 489 m
SAC_CRUISE_ID	00373
PLATFORM_NAME	R/V Knorr
PRINCIPAL_INVESTIGATOR_NAME	Mike Kosro
PI_INSTITUTION	Oregon State University
PI_COUNTRY	USA
PROJECT	WOCE (One-time Line)
CRUISE_NAME	ship_tag=KN9504
woce_tag=I03,ICM03	EXPOCODE=316N145_8
PORTS	Fremantle, Australia to Port Louis, Mauritius
GEOGRAPHIC_REGION	South Indian Ocean
PROCESSED_BY	Oregon State University

NAVIGATION GPS
QUALITY_NAV good
GENERAL_INFORMATION
CRUISE NOTES
CHIEF SCIENTIST ON SHIP Worth Nowlin; Bruce Warren*
INSTITUTE Texas A&M University; *WHOI
COUNTRY USA
SIGNIFICANT DATA GAPS none
SPECIAL SHIP TRACK PATTERNS

ADCP INSTRUMENTATION
MANUFACTURER RDI VM150 narrowband
HARDWARE MODEL
SERIAL NUMBERS transducer s/n 171
FIRMWARE VERSION version 17.10

ADCP INSTALLATION

There is a hole in the hull plating slightly larger than the transducer clover leaf. Unfortunately, the hull is not flat and horizontal at the transducer's off-centerline location so the plate is at an angle to the plane of the transducer array. The transducers closest to the centerline are slightly recessed and the outboard pair are approximately flush. The transducer assembly is held in place by bolting its upper flange to the underside of a mounting "top-hat" adapter assembly. Therefore the entire assembly is in water and inspection of the electronics requires pulling the unit.

LOCATION/DEPTH ON HULL:
Transducer is located at frame 39, approximately 6 feet off centerline to the port side, at a depth of 14 feet.

REPEATABLE ATTACHMENT:
< YES > Mounting arrangement has alignment pins intended to allow repeatable installations but this seems to be a continuing problem.

DATE OF MOST RECENT ATTACH.:

COMMENT:
The adcp was removed from the hull earlier in the year in order to try to fix the loss of signal return in the kn9501 cruise. Inadvertently, the adcp was reinstalled with the nominal forward beam facing due aft, rather than 45 to port as it was when it was removed. Due to the lack of background of the tech on the cruise, this was not discovered until about 10 days into the cruise. At that time, the DAS software was adjusted accordingly.

ADCP INSTRUMENT CONFIGURATION
DEPTH RANGE 17m to 489m (bin centers)
BIN LENGTH 8m
NUMBER OF BINS 60
TRANSMIT PULSE LENGTH 8m
BLANKING INTERVAL 4m
ENSEMBLE AVERAGING INTERVAL 150 seconds
SOUND SPEED CALCULATION FUNCTION OF TEMP AT TRANSDUCER
BOTTOM TRACKING limited periods
DIRECT COMMANDS "FH00001" "E0004020099" "B0090001" "CF64"
COMMENTS

ADCP thermistor was bad, so recorded using constant sound speed of 1500 m/s. Used underway thermosalinograph to provide a time-varying sound speed in post-processing.

ADCP DATA ACQUISITION SYSTEM
DATA LOGGER RDI DAS 2.48, HPIB interface
USER BUFFER VERSION 1920 (UE3)
CLOCK PC clock reset if drift greater than 2 sec from GPS clock by UE3

SHIP HEADING
INSTRUMENT MAKE/MODEL Sperry MK37
SYNCHRO OR STEPPER synchro
SYNCHRO RATIO 1:1
COMPENSATION APPLIED No

```
    GPS ATTITUDE SYSTEM          Yes, Ashtech 3DF, firmware 6H-1.1

LOCATION OF ANTENNAS:
Antennas are aircraft type with 10" dia ground planes, mounted in a
rectangular array above the aft deck observational tower.  All antennas
are at the same height; approximately 5 feet above the tower top, 52 feet
above the baseline. One fore/aft pair is spaced at 3 meters, the other pair
at 2 meters.  There is 2 meter spacing between the pairs (p/s separation).
The array center is approximately 2 feet port of ship centerline, at frame
106.

ANCILLARY MEASUREMENTS
  SURFACE TEMP AND SALINITY    transducer temperature and ship's T&S
  PITCH/ROLL MEASUREMENTS      not used; statistics from Ashtech attitude data
                               in user buffer
  HYDRO CAST MEASUREMENTS      Yes
  BIOMASS DETERMINATION        No
    DATE OF LAST CALIBRATION   unknown
    COMMENT                    Flagg's agcave used

ADCP DATA PROCESSING/EDITING
  PERSONNEL IN CHARGE          Mike Kosro
  SOUND SPEED CORRECTIONS      Applied in post-processing from underway T and S
  DATE OF PROCESSING           Most recently modified Dec 22 1999
  ADDED TO NODC DB             DEC 1999
  NOTABLE SCATTERING LAYERS:
  COMMENTS:

NAVIGATION
  GPS MAKE/MODEL
    SELECTIVE AVAILABILITY     Yes
    P-CODE                     No
    DIFFERENTIAL               No
    SAMPLE INTERVAL            1 Hz
    LOCATION OF ANTENNA
    TIME OBTAINED RELATIVE TO
      START/END OF ENSEMBLE    start and end of ensemble
    AVERAGING/EDITING APPLIED  ensemble position is average of start and end
                               fix for the ensemble
    LOGGED WITH ADCP DATA      Yes using UE3 (including Ashtech GPS attitude)
    LOGGED INDEPENDENTLY       No
    COMMENTS                   Knorr's P-code receiver was not available for
                               this cruise (expired key)
    OTHER                      bottom tracking available for limited periods

CALIBRATION
  GYROCOMPASS CORRECTION       Yes using Ashtech heading information,
profile by profile rotation.
  BOTTOM TRACK METHOD          N No O
  WATER TRACK METHOD           Yes
    REFERENCE LEVELS USED      3 to 10
    TIME SLIP APPLIED          No
    TOTAL No. CALIBRATION PTS  257
    TOTAL No. AFTER EDITING    173
    TIME VARIANT               Yes, based on Ashtech
    COMMENT                    Corrected for time-dependent error, then
                               computed mean offset below. In addition, there
                               was a -179.9 rotation applied when the data were
                               originally taken, to correct for the rotated
                               transducer.
    FINAL SELECTION            AMPLITUDE = 1.007 PHASE = -0.1
    COMMENTS                   Data were processed in 2 parts: before and
                               after port stop starting on 5/28/99 amp/phase
                               were 1.006, -0.3 degrees

NAVIGATION CALCULATION
  NAVIGATION USED              GPS
  REFERENCE LAYER DEPTH RANGE  bins 3 to 10
  FILTERING METHOD FOR
    SMOOTHING REFERENCE LAYER
    VELOCITY (FORM/WIDTH)      Blackman
                               w(t)=0.42-0.5*cos(2pi*t/T)+.08*cos(4pi*t/T),
                               1-hr halfwidth
  FINALIZED SHIP VEL/POSITIONS
  STORED IN DATABASE           Yes

GENERAL_ASSESSMENT
  VECTOR, CONTOUR, STICK PLOTS:ok
```

REFERENCES (DATA REPORTS,ETC.):

LOWERED ADCP

Profile measurements of quasi-instantaneous horizontal current components were made to full ocean depth during I03 using a lowered ADCP (LADCP), which was mounted to the rosette system with the CTD. The primary unit was a broadband, self-contained 150 kHz system manufactured by RD Instruments, model BBCS 150, serial no. 1246, firmware version 4.18, with 15 depth cells, depth cell size of 16m and blank-after-transmit interval of 16m. We used single ping ensembles with this instrument. For the first 16 stations (stations 443-458), an older narrowband, self-contained 307 kHz system was used instead (serial no. 447, firmware version 17.10); this instrument was operated with 16m bins, 16m pulse, 8m blanking and 18 pings per ensemble.

With either instrument, vertical shear of horizontal velocity was obtained from each ensemble. 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 (Fischer and Visbeck, 1993). Depth can be obtained by integrating the vertical velocity component; a better estimate of the depth coordinate was made by incorporating the preliminary CTD profile data into the LADCP, and data will be reprocessed after final processing of 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 443-573 on the I03 cruise. LADCP casts were made at all stations. One cast, 444, was too shallow (less than 150 m) to obtain useful results. On one other cast, 550, the BroadBand LADCP turned off prematurely during the downcast. This behavior had been observed infrequently during previous legs and had been reported to the manufacturer; a firmware bug is suspected. The deep casts often have noise problems below 3000 meters or so due to poor instrument range. Interference from the return of the previous ping is often observed 750 m from the bottom.

Example velocity profiles, obtained on stations 566 and 567, are shown in Figures 2 and 3 respectively; U and V are the eastward and northward component of the current profile. The dashed line corresponds to the profile estimated from the downward cast, the dotted line corresponds to the upward cast, and the solid line represents the average over all valid returns, whether up or down. On station 566 (Figure 2), the up-, down- and average- profile agree very well with each other, giving confidence in the result. For station 567, however, the up and down profiles are offset from one another by as much as 10-15 cm/s at some depths (Figure 3). Further processing is expected to help eliminate some of the up/down differences, some of which must arise by integrating across large, invalid shears; this interpretation is strengthened by the agreement of many of the small-scale features between the up and down profile, even when the integrating profiles are separated. Figure 3 should serve as a caution against over-interpreting the preliminary results which are included in this report.

Contour plots made from the preliminary average velocity profiles for all stations on I03 are provided as Figure 4; separate plots are provided for each basin.

B.4 Analyses for CFC-113 and Carbon Tetrachloride

SAMPLE COLLECTION

All water samples were collected from 10 liter Niskin bottles using 100 ml glass syringes. Close ended Luerlock fittings were used to seal filled syringes. Rubber bands were applied to keep the seawater under positive pressure.

EQUIPMENT AND TECHNIQUE

Carbon-tetrachloride, methyl-chloroform, and chlorofluorocarbons CFC-11, CFC-12, and CFC-113 were measured on a total of 31 stations. A complementary analysis of CFC-11 and CFC-12 was performed by SIO as well. The analytical system was designed by Lamont-Doherty Laboratories and uses a 10 cm, 1/16" "Carbograph" trap cooled to -60?C. Desorption was with boiling water at 100?C. Gases were forward flushed into a DB VRX capillary pre-column and column. A 10 cm 1/16" "Carbograph" precolumn which had been inline with the DB VRX pre-column was removed for improved peak sharpness and resolution. Unfortunately, this caused CFC-113 to interfere with methyl iodide and made the CFC-113 measurements more difficult.

Most samples were run within 12 hours of sampling. However, a few were run as late as 48 hours after sampling. This delay does not seem to have had an adverse effect on the samples. Duplicate samples were run for most casts. Air samples were run weekly on average. This was limited by time available.

CALIBRATION

All gases were calibrated using a 6 to 10 point calibration curve from an artificial standard calibrated against Weiss SIO standards. A standard intercomparison was also performed at sea, but this shows differences for which there has been no accounting yet. Standard was stored in an "Acculife" cylinder. The gas concentrations in the artificial working standard were chosen to have ratios comparable to that in seawater.

B.5 Helium and Tritium Sampling

Helium and tritium samples are processed in the Helium Isotope Van on extraction and degassing systems designed by Dr. William Jenkins and Dempsey Lott of the Woods Hole Oceanographic Institute.

The systems each comprise basically of two rough pumps which evacuate the system to 1.0 x 10-3 torr, (one rough pump is used as a fore pump for the diffusion pump) one diffusion pump which reaches a high vacuum of 1.0 x 10-8 torr, a cryotrap chilled to - 132?C to trap water vapors before they reach the vacuum pumps, and a self contained cooling system that services both vacuum lines, keeping the diffusion pumps at 21.5?C for optimum diffusion pump efficiency. Helium samples are drawn from the Rosette in 90 cc cylinders. They are gently tapped to shake loose any air bubbles that may be on the inside cylinder walls that would affect the helium data. The cylinders are mounted on an extraction system but are isolated from the vacuum. After the system has been under vacuum for an hour at approximately 1.0 x 10-7 torr, the vacuum is isolated from it. The samples are then emptied into a holding can. The cans are heated to boil, forcing the gasses out of the sample. The gasses are collected in a glass bulb which sits in an ice bath to attract the gas vapors. After 10 minutes the bulbs are sealed with a torch. The samples are sent back to the lab at Woods Hole where the helium content can be measured on a mass spectrometer.

Tritium samples are drawn from the Rosette in 500 cc cylinders. They do not get tapped since the gasses will be removed by the vacuum system. The sample cylinders are mounted on the degassing system. Below the cylinders is a sled with the glass bulbs that will be used for storing the sample. After the bulbs have been pumped on by the diffusion pump for a half an hour to 1.0 x 10-7 torr or less, the sample is placed in the bulb. They then go through a series of shaking and pumping for two and a half hours to remove all of the gasses. The samples will be directly pumped on by the vacuum and sealed at a pressure of approximately 1 x 10-6 torr. These samples will be stored for approximately 1 year before they can be measured. Tritium, the radioactive element attached to the water molecule breaks down into helium isotope. After 1 year there is enough of the helium isotope to measure on a mass spectrometer and then calculate the amount of tritium that was originally in the sample.

Helium and matching tritium samples are taken from approximately 2000 m to the surface, 16 of each per sampled station.

Deep helium samples 1000m to the bottom and 2000 m to the bottom on matching upper helium/tritium stations are analyzed in Dr. Peter Schlosser's lab at Lamont.

B.6 Radiocarbon Sampling

A total of 480 samples were collected at 20 stations for radiocarbon analysis using the AMS technique. Ten of the stations were full water column profiles of 32 samples each and the remaining profiles covered the thermocline and had 16 samples each. All of these samples will be returned to the NOSAMS facility at WHOI for analysis. Once analysis is complete the results will be quality controlled and interpreted at Princeton by Ocean Tracer Lab members and other interested scientists. Princeton is responsible for all of the Indian Ocean WOCE 14C sampling except for legs I8S and I9S. The station layout for the entire basin was designed to be merged with the deep water results from the GEOSECS program. Upper water column results will demonstrate the penetration of bomb radiocarbon since GEOSECS. Some penetration of bomb radiocarbon may be evident in deep and bottom waters of southern origin.

B.7 Radium Sampling
(Robert Key 2001.04.04)

My group collected radium samples on several WOCE legs in the hope of being able to analyze them "in the background". We never received any funding for this work and the analytical capability no longer exists at Princeton. It is safe to assume that nothing will ever come from this effort. For those sample collection efforts currently recorded in WOCE bottle files, the simplest thing would be to drop the column altogether. Lacking that, all recordings on U.S. legs can be flagged 5.

B.8 CO2 Sampling

SAMPLE COLLECTION

All water samples were collected from 10 liter Niskin bottles using 100 ml glass syringes. Close ended Luerlock fittings were used to seal filled syringes. Rubber bands were applied to keep the seawater under positive pressure.

EQUIPMENT AND TECHNIQUE

Carbon-tetrachloride, methyl-chloroform, and chlorofluorocarbons CFC-11, CFC-12, and CFC-113 were measured on a total of 31 stations. A complementary analysis of CFC-11 and CFC-12 was performed by SIO as well. The analytical system was designed by Lamont-Doherty Laboratories and uses a 10 cm, 1/16" "Carbograph" trap cooled to -60?C. Desorption was with boiling water at 100?C. Gases were forward flushed into a DB VRX capillary pre-column and column. A 10 cm 1/16" "Carbograph" precolumn which had been inline with the DB VRX pre-column was removed for improved peak sharpness and resolution. Unfortunately, this caused CFC-113 to interfere with methyl iodide and made the CFC-113 measurements more difficult.

Most samples were run within 12 hours of sampling. However, a few were run as late as 48 hours after sampling. This delay does not seem to have had an adverse effect on the samples. Duplicate samples were run for most casts. Air samples were run weekly on average. This was limited by time available.

CALIBRATION

All gases were calibrated using a 6 to 10 point calibration curve from an artificial standard calibrated against Weiss SIO standards. A standard intercomparison was also performed at sea, but this shows differences for which there has been no accounting yet. Standard was stored in an "Acculife" cylinder. The gas concentrations in the artificial working standard were chosen to have ratios comparable to that in seawater.

B.9 Barium Sampling
(Kelly Falkner 2001.03.23)

All water samples were collected from 10-liter Niskin bottles into 20-ml polyethylene vials which had been pre-cleaned by acid leaching in 0.2N HCl overnight at 60?C followed by rinsing in distilled de-ionized water. The vials were rinsed with sample and then filled directly from the Niskin spigot with no draw tube.

The quality of the Ba data from most WOCE legs in the Indian Ocean turned out to be quite poor; far worse than attainable analytical precision (+/-20% as opposed to 2%). We recorded many vials which came back with loose caps and evaporation associated with that seems to be the primary problem. The only hope I have of producing a decent data set is to run both Ba and a conservative element simultaneously and then relating that to the original salinity of the sample. We will be taking delivery on a high resolution ICPMS here at OSU sometime this winter which would make the project analytically feasible and economical. I do not presently have the funds in hand to do this and so have archived the samples for the time being. I don't think the WHPO would derive any benefit from the present data set.

B.10 Current Meter Array ICM3 Deployment

Twenty intermediate, subsurface current meter moorings were deployed during the ICM3 cruise. Recovery of these moorings is expected in about 2 years. Each mooring contains 2, 3, or 4 recording current meters attached to 3/8" dacron rope. Buoyance is provided by clusters 17" Benthos glass spheres at each instrument location. The mooring is attached to the anchor using an EG&G DACS 723A transponding acoustic release. After deployment an acoustics/GPS survey was undertaken to refine the estimate of each mooring's geographic location and bottom depth.

The current meters used are Aanderaa RCM-8, vector averaging, solid state recording instruments. Speed and direction are sampled every 36 seconds to produce a 30 minute vector average. Temperature is sampled at the end of the 30 minute interval. The top instrument on each mooring records pressure in addition to temperature. The instruments have enough power and data capacity for a 3-year deployment.

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World Ocean Circulation Experiment
Indian Ocean I3
R/V Knorr Voyage 145 Leg 8
23 April 1995 - 5 June 1995
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Chief Scientist: Dr. Worth D. Nowlin, Jr.
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I3 Cruise Track

Oceanographic Data Facility (ODF)
Final Cruise Report
4 September 1998

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. 131 CTD/rosette casts were made, usually to within 5-10 meters of the bottom. Two additional casts are not reported: station 498 cast 1 was aborted for signal problems before the cast entered the water, and station 505 cast 1 was a test cast for wire/voltage problems.

Station 443 was completed approximately two days after leaving port, near latitude 28S. Stations 444-539 were completed along a line roughly following latitude 20S from NW Australia to the east coast of Mauritius. Stations 540-562 were done along 20S from the west coast of Mauritius to the east coast of Madagascar, with a 2-day port stop in Port Louis between stations 544-545. Stations 563-573 re-occupied stations 551-561 in reverse order. Salts and oxygen were the only bottle samples taken on this repeated section.

Three sections of current meter moorings (ICM3) were deployed along the I3 line: ICM3 moorings 20-14 were deployed at positions between I3 stations 475-485, moorings 13-7 between stations 506-517, and moorings 6-1 between stations 551-559. There was a 3.25-day delay between the end of station 505 and the start of station 506, where moorings 13-7 were placed before back-tracking to the station 506 position for the next CTD cast.

4006 bottles were tripped resulting in 3999 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 1.1.

Figure 1.0 I3 sample distribution, stas 444-497
Figure 1.1 I3 sample distribution, stas 498-562

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. Upon arrival on station, time, position and bottom depth were logged by the console operator. The rosette was deployed from a position on 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 or the bottom depth exceeded the range of the instrumentation.

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. The only exception was on station 454, where bottle 37 was placed in trip sequence 23 while bottle 23 was being repaired.

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 O2 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 port-side CTD winch was used during stations 443 through 497 and stations 500 through 503. The starboard winch was used on stations 498 (cast 2), 499, and 504 through 573. New ctd wire was installed on the port winch at the start of the leg; however, at the start of station 498, a short developed in one of the conductors about 6000 meters from the termination end. The port wire was reterminated using only two conductors.

The starboard winch and cable were used for stations 498 (cast 2) and 499. There were voltage dropouts and CTD signal noise during station 499; further investigation revealed an intermittent contact problem on the starboard winch slip rings and a broken armor strand on the wire 50m from the termination end. The slip rings were replaced, and the starboard wire was shortened by 100m and reterminated. Stations 500 through 503 used the port winch and wire while the starboard winch problems were being resolved. The starboard winch was then used for the remainder of the leg. The CTD wire on the starboard winch was an older wire that had been on the port winch on the previous legs. A broken armor strand at about 4000m on this wire was inspected on every up-cast deeper than 4000 meters, and re-taped as needed.

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 O2 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 O2 sensor mountings; ODF-designed sensor interfaces for O2, 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 I3.

Station(s)	ODF CTD@ ID#	SensorMedics Oxygen Sensor	SeaTech Transmissometer (TAMU)	Winch
443-453		3-03-10		

454-456	1	4-05-16	151D	Port
457-498/1		5-01-04		
498/2-499				Stbd.
500-503				Port
504-573				Stbd.
NOTE: large LADCP stas 443-458, small LADCP from sta 459 (S/Ns unknown)				

@ ODF CTD #1 sensor serial numbers:

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

Table 3.0 I3 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 O2 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 O2 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 I3.

There were 2 random bad trip confirmations during I3, which both succeeded when a re-position/re-trip was attempted. There were voltage dropout problems, especially at bottle trips, during station 499 (see Section 2). The resulting signal noise caused more than 1500 false trip detects by the acquisition software. The initial trip detects at each bottle level were positive confirmations, so the excess trip levels were merely edited out during post-cast processing. Only the surface bottle at station 504 had the same voltage dropout problem, and the trip level was recovered from clean CTD data prior to the dropout. None of bottles 7-36 at station 537 confirmed positively; the pylon had to be re-set/re-positioned manually prior to each trip attempt. 3 of those bottles came up open, as detailed in Appendix D.

4. Navigation and Bathymetry Data Acquisition

Navigation data were acquired from the ship's Magnavox MX GPS receiver via RS-232. 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 was 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:

o Convert raw CTD scans into scaled engineering units, and assign the data to logical channels;
o Filter various channels according to specified filtering criteria;
o Apply sensor- or instrument-specific response-correction models;
o Provide periodic averages of the channels corresponding to the output time-series interval; and
o 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 O2. 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 O2 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. O2). 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 0.02 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 db, caused by chopping off going-in-water transition data at pressure-sequencing.

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 deg.C. The conductivity channel also can shift by 0.001-0.002 mmho/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+/-150 db (~3.75+/-0.15 deg.C theta) during I3 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.

A down-cast stop/slowdown nearly always caused a problem in fitting CTD O2 data because the raw oxygen signal shifted as oxygen became depleted in water near the sensor. A small shift was often noted as the winch slowed down for the bottom approach. The signal shift could usually be compensated for by applying a small constant offset to the raw oxygen current values from the stop/slowdown until the bottom of the cast, then re-fitting the oxygen data to the bottles. Raw CTD O2 offsets that resolved shifts at winch stops or slowdowns are noted in Appendix C.

Appendix C contains a table of CTD casts requiring special attention; I3 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 deg.C to a maximum loading pressure of 6080 db, and 30.41/31.24 deg.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 deg.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 deg.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, 12/94.

Figure 7.3 Primary PRT Temperature Calibration for ODF CTD #1, 9/95.

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 third 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 O2 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

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 I3 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 I3 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 0.05 db, thus indicating no problems with the final pressure corrections. Figure 8.1.0 shows the offset pre-cruise laboratory calibration used to correct I3 CTD #1 pressure data.

Figure 8.1.0 I3 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. I3 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 and all of I8N/I5E was deployed as the secondary PRT during the entire I3 leg. The differences between the CTD #1 primary PRT and the FSI PRT drifted slowly during I9N, then stabilized at about -0.01 deg.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 drift noted in the PRT1-PRT2 differences during I8N/I5E or I3; the differences remained stable near the value observed at the end of I9N. Figure 8.2.0 summarizes the comparison between the primary and secondary PRT temperatures.

Figure 8.2.0 I3 Shipboard comparison of CTD #1 primary/secondary PRT temperatures, pressure > 1000 db.

The primary temperature sensor laboratory calibrations indicated a -0.001 deg.C shift at 0 deg.C, a -0.0006 deg.C shift at mid-range temperatures, and a -0.0014 deg.C shift at 32 deg.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 less than half the magnitude of the WOCE accuracy standard of 0.002 deg.C. Since an average of the two calibrations was applied to the data, I3 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 station 269 during I9N, then remained stable thereafter. Cast-by-cast comparisons showed minimal conductivity sensor drift during I8N/I5E and I3.

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 swabbed with alcohol. 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 I3 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 I3 preliminary conductivity offset residual values.

Figure 8.3.1 I3 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. 12 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. 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 at least one CTD cast sandwiched in between each mooring deployment for the first and third groups of moorings, causing a typical 6 to 8.5-hour delay between the end of one CTD cast and the start of the next. Mooring 6 required two attempts, causing a 13.5-hour gap between CTD casts. There was no apparent effect on conductivity offsets from these delays or the 3.5-day and 2-day gaps between stations 505/506 (7 consecutive mooring deployments) and stations 544/545 (mid-leg port stop).

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 I3 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 I3 CTD #1 conductivity slope corrections by station number.

Figure 8.3.4 I3 CTD #1 conductivity offsets by station number.

I3 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 I3 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 I3 Salinity residual differences vs pressure (after correction).
Figure 8.3.6 I3 Salinity residual differences vs station # (after correction).
Figure 8.3.7 I3 Deep salinity residual differences vs station # (after correction).

The CTD conductivity calibration represents a best estimate of the conductivity field throughout the water column. 3-sigma from the mean residual in Figures 8.3.6 and 8.3.7, or +/-0.0048 PSU for all salinities and +/-0.0007 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 I9N, I8N, I4 and I10 legs were compared with I3 data. Deep Theta-Salinity comparisons for casts at four positions where the WOCE lines crossed showed less than 0.001 PSU difference for each group of casts. GEOSECS station 452 was compared with I3 station 499, casts taken at nearly the same positions. The GEOSECS data were +0.001 to +0.002 PSU compared to I3 data, the same difference seen on multiple casts comparing GEOSECS to I9N and I8N/I5E data. WOCE95 I3 data were also compared with final data from the 37 positions repeated during WOCE97 ICM3. Deep CTD Theta-Salinity data showed less than a 0.001 PSU difference for most casts; the difference increased half again as much as cast positions approached the Madagascar coast.

The WOCE95 minus GEOSECS average difference becomes closer to -0.0005 PSU if GEOSECS salinity values are corrected for Standard Seawater batch (P-63) differences [Mant87]. The Standard Seawater batches from the five consecutive WOCE95 ODF legs (P-126) and from WOCE97 ICM3 (P-125) have not been compared to other batches. A cross-calibration is planned for late 1998; however, recent batches from OSI have been quite reliable, requiring, at worst, a +/-0.001 PSU correction [Mant97].

8.4. CTD Dissolved Oxygen

The same oxygen sensor used on I9N and I8N/I5E was used on the first 11 casts of I3. The first sensor was switched out for a used spare sensor for stations 454-456, during which there were excessive CTD O2 noise and offsetting problems. An apparently new oxygen sensor was installed beginning station 457: there were extremely noisy large sections, both down- and up-cast, on this station. After station 457, the cable/connectors between the sensor and the CTD were reseated, and the noise problems disappeared. This third sensor was used for the remainder of the I3 leg.

There are a number of problems with the response characteristics of the SensorMedics O2 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 O2 profile. Such shifts could usually be corrected by offsetting the raw oxygen data from the stop or slow-down area to the bottom of the cast. All offset sections, winch stops or slow-downs that affected CTD oxygen data are documented in Appendix C.

Because of these same stop/slow-down problems, up-cast CTD rosette trip data cannot be optimally calibrated to O2 check samples. Instead, down-cast CTD O2 data are derived by matching the up-cast rosette trips along isopycnal surfaces. The differences between CTD O2 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 O2 and the bottle O2 (ml/l) for each station.

Figure 8.4.0 I3 O2 residual differences vs station # (after correction).

Figure 8.4.1 I3 Deep O2 residual differences vs station # (after correction).

The standard deviations of 0.06 ml/l for all oxygens and 0.02 ml/l for deep oxygens are only intended as metrics of the goodness of the fits. ODF makes no claims regarding the precision or accuracy of CTD dissolved O2 data.

The general form of the ODF O2 conversion equation follows Brown and Morrison [Brow78] and Millard [Mill82], [Owen85]. ODF does not use a digitized O2 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 Taup, and two temperature responses TauTs and TauTf are fitting parameters. The Oc gradient, dOc/dt, is approximated by low-pass filtering 1st-order Oc differences. This gradient term attempts to correct for reduction of species other than O2 at the cathode. The time-constant for this filter, Tauog, is a fitting parameter. Oxygen partial-pressure is then calculated:

$$Opp=[c1*Oc+c2]*fsat(S,T,P)*e^{(c3*Pl+c4*Tf+c5*Ts+c6*dOc/dt)} \quad (8.4.0)$$

where:

```
Opp          = Dissolved O2 partial-pressure in atmospheres (atm);
Oc           = Sensor current (uamps);
fsat(S,T,P) = O2 saturation partial-pressure at S,T,P (atm);
S            = Salinity at O2 response-time (PSUs);
T            = Temperature at O2 response-time (deg.C);
P            = Pressure at O2 response-time (decibars);
Pl           = Low-pass filtered pressure (decibars);
Tf           = Fast low-pass filtered temperature (deg.C);
Ts           = Slow low-pass filtered temperature (deg.C);
dOc/dt       = Sensor current gradient (uamps/secs).
```

I3 CTD O2 correction coefficients (c1 - c6) 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:

- o CFCs;
- o 3He;
- o O2;
- o Total CO2;
- o Alkalinity;
- o AMS 14C;
- o Tritium;
- o Nutrients;

- o Salinity;
- o Barium.

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

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

Once individual samples had been drawn and properly prepared, they were distributed to their 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, and 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 O2) 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 O2 sensor was present on this cast.

Note that all CTDOXY values were derived from the down-cast pressure-series CTD data. 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 O2 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 443-573

	Reported Levels	WHP Quality Codes 1	2	3	4	5	7	9
Bottle	4006	0	3994	4	1	0	0	7
CTD Salt	4006	0	4006	0	0	0	0	0
CTD Oxy	4006	0	3936	66	4	0	0	0
Salinity	3996	0	3942	46	8	1	0	9
Oxygen	3990	0	3930	43	17	6	0	10
Silicate	3872	0	3866	0	6	1	0	133
Nitrate	3872	0	3834	32	6	1	0	133
Nitrite	3872	0	3866	0	6	1	0	133
Phosphate	3872	0	3849	17	6	1	0	133

Table 10.0 Frequency of WHP quality flag assignments for I3.

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 the stations; its water bath was set at 24 deg.C for stations 443-461. The bath temperature was lowered to 21 deg.C for stations 462-573 after the lab air temperature cooled. Autosal #57-396 was set at 24 deg.C as a backup unit but was never used. 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 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 salinometer cell was flushed until two groups of readings met software criteria for consistency, both within and between groups; the two averages of the groups of measurements were then averaged for a final result.

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. 3996 salinity measurements were made and 265 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 deg.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 3 flask volumes. The sample 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 the data were then merged with the cruise database.

Thiosulfate normalities were calculated from each standardization and corrected to 20 deg.C. The 20 deg.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.

3990 oxygen measurements were made, with no major problems with the analyses. The auto-titrator generally performed very well. One minor problem noted on the expedition was that there was a gradual decrease in the UV detector output voltage. It was discovered later that the window material between the lamp and detector was slowly becoming opaque. At the time, the oxygen analysts were able to overcome the voltage drop by increasing a gain control.

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 are "reagent grade" and are 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 6 hours at 2-6 deg.C. All samples were brought to room temperature prior to analysis.

The methods used are described by Gordon et al. [Gord92], Hager et al. [Hage72], Atlas et al. [Atla71]. 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 PO4 color development. The sample was passed through a 15mm flowcell and the absorbance measured at 820nm. ODF's methodology is known to be non-linear at high silicate concentrations (>120 uM); a correction for this non-linearity is applied through ODF's software.

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 not present, 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 deg.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 40 ml polypropylene, screw-capped 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 dry, pre-weighed primary standards. Sets of 5-6 different standard concentrations were analyzed periodically to determine the deviation from linearity as a function of concentration for each nutrient.

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. 3872 nutrient samples were analyzed. No major problems were encountered with the measurements, other than a continuing difficulty in holding the lab temperature constant. The pump tubing was changed one time. An aliquot from a large volume of stored deep seawater was run with each set of samples as a substandard. The efficiency of the cadmium column used for nitrate reduction was monitored throughout the cruise and ranged from 99.8-100.0%.

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 deg.C.

Standards

Na2SiF6, the silicate primary standard, was obtained from Fluka Chemical Company and Fisher Scientific and was reported by the suppliers to be >98% pure. Primary standards for nitrate (KNO3), nitrite (NaNO2), and phosphate (KH2PO4) were obtained from Johnson Matthey Chemical Co. and the supplier reported purities of 99.999%, 97%, and 99.999%, respectively.

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APPENDIX A

WOCE95-I3: 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
443/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.85295e-03	0.01101
444/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.85268e-03	0.01105
445/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.85240e-03	0.01110
446/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.85212e-03	0.01115
447/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.85184e-03	0.01119
448/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.85157e-03	0.01124
449/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.85129e-03	0.01128
450/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.85101e-03	0.01133
451/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.85074e-03	0.01137
452/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.85046e-03	0.01142
453/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.85018e-03	0.01147
454/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.84990e-03	0.01151
455/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.84963e-03	0.01156
456/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.84935e-03	0.01160
457/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.84907e-03	0.01165
458/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.84879e-03	0.01170
459/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.84852e-03	0.01174
460/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.84824e-03	0.01179
461/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.84796e-03	0.01183
462/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.84768e-03	0.01188
463/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.84741e-03	0.01192
464/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.84713e-03	0.01197
465/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.84685e-03	

0.01202

466/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.84658e-03	0.01206
467/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.84630e-03	0.01211
468/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.84602e-03	0.01215
469/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.84574e-03	0.01220
470/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.84547e-03	0.01225
471/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.84519e-03	0.01229
472/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.84491e-03	0.01234
473/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.84463e-03	0.01238
474/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.84436e-03	0.01243
475/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.84408e-03	0.01247
476/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.84380e-03	0.01252
477/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.84352e-03	0.01257
478/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.84325e-03	0.01261
479/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.84297e-03	0.01266
480/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.84269e-03	0.01270
481/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.84242e-03	0.01275
482/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.84214e-03	0.01279
483/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.84186e-03	0.01284
484/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.84158e-03	0.01289
485/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.84131e-03	0.01513
486/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.84103e-03	0.01363
487/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.84075e-03	0.01363
488/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.84047e-03	0.01363
489/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.84020e-03	0.01363
490/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.83992e-03	0.01363
491/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.83964e-03	0.01363
492/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.83936e-03	0.01363
493/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.83909e-03	0.01363
494/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.83881e-03	0.01363
495/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.83853e-03	0.01363
496/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.83825e-03	0.01363
497/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.83798e-03	0.01363
498/02	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.83770e-03	0.01363
499/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.83742e-03	0.01363
500/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.83715e-03	0.01363
501/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.83687e-03	0.01363
502/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.83659e-03	0.01363

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
503/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.83631e-03	0.01363
504/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.83604e-03	0.01413
505/02	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.83576e-03	0.01425
506/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.83548e-03	0.01518
507/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.83520e-03	0.01460
508/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.83493e-03	0.01453
509/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.83465e-03	0.01363
510/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.83437e-03	0.01363
511/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.83409e-03	0.01363
512/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.83382e-03	0.01363
513/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.83354e-03	0.01516
514/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.83326e-03	0.01509
515/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.83299e-03	0.01502
516/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.83271e-03	0.01395
517/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.83243e-03	0.01387
518/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.83215e-03	0.01380
519/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.83188e-03	0.01373
520/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.83160e-03	0.01365
521/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.83132e-03	0.01358
522/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.83104e-03	0.01351
523/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.83077e-03	0.01343
524/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.83049e-03	0.01336
525/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.83021e-03	0.01329
526/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.82993e-03	0.01321
527/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.82966e-03	0.01314
528/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.82938e-03	0.01307
529/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.82910e-03	0.01199
530/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.82882e-03	0.01192
531/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.82855e-03	0.01285
532/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.82827e-03	0.01277
533/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.82799e-03	0.01270
534/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.82772e-03	0.01263
535/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.82744e-03	0.01256

536/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.82716e-03	0.01248
537/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.82688e-03	0.01141
538/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.82661e-03	0.01234
539/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.82633e-03	0.01226
540/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.82605e-03	0.01219
541/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.82577e-03	0.01212
542/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.82550e-03	0.01204
543/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.82522e-03	0.01197
544/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.82494e-03	0.01190
545/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.82466e-03	0.01289
546/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.82439e-03	0.01289
547/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.82411e-03	0.01289
548/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.82383e-03	0.01289
549/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.82356e-03	0.01289
550/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.82328e-03	0.01289
551/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.82300e-03	0.01289
552/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.82272e-03	0.01289
553/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.82245e-03	0.01289
554/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.82217e-03	0.01289
555/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.82189e-03	0.01289
556/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.82161e-03	0.01289
557/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.82134e-03	0.01289
558/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.82106e-03	0.01289
559/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.82078e-03	0.01289
560/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.82050e-03	0.01289
561/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.82023e-03	0.01289
562/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.81995e-03	0.01289
563/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.81967e-03	0.01289
564/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.81940e-03	0.01289
565/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.81912e-03	0.01289

PRT		ITS-90 Temperature Coefficients			Conductivity Coefficients		
Sta/	Response	corT = t2*T**2 + t1*T + t0			corC = c2*C**2 + c1*C + c0		
Cast	Time (secs)	t2	t1	t0	c2	c1	c0
566/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.81884e-03	0.01289
567/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.81856e-03	0.01289
568/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.81829e-03	0.01289

569/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.81801e-03	0.01289
570/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.81773e-03	0.01289
571/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.81745e-03	0.01289
572/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.81718e-03	0.01289
573/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.81690e-03	0.01289

APPENDIX B

Summary of WOCE95-I3 CTD Oxygen Time Constants

Temperature Fast(TauTf)	Temperature Slow(TauTs)	Pressure (Taup)	O2 Gradient (Tauog)
1.0	400.0	24.0	16.0

WOCE95-I3: Conversion Equation Coefficients for CTD Oxygen
(refer to Equation 8.4.0)

Sta/ Cast	OcSlope (c1)	Offset (c2)	Plcoeff (c3)	Tfcoeff (c4)	Tscoeff (c5)	dOc/dtcoeff (c6)
443/01	5.24604e-04	5.08875e-01	-1.28008e-04	-1.43647e-03	-1.78811e-02	9.42061e-06
444/01	4.09534e-03	5.82154e-01	-1.93546e-03	-1.94793e-02	-6.24300e-02	1.74186e-06
445/01	1.59369e-03	-4.13140e-01	-2.41892e-04	-1.11285e-02	-3.15643e-02	8.47185e-06
446/01	1.80168e-03	-1.40451e-01	-7.63024e-05	3.03338e-03	-5.26259e-02	2.89488e-06
447/01	9.46805e-04	-2.34407e-02	2.14854e-04	1.64348e-03	-2.97044e-02	1.92008e-05
448/01	1.45234e-03	-7.59775e-02	2.07696e-05	4.19242e-03	-4.56202e-02	3.92619e-06
449/01	1.02780e-03	-1.94939e-02	1.54478e-04	4.39120e-03	-3.29510e-02	4.44761e-06
450/01	9.78695e-04	6.12081e-03	1.47661e-04	2.41014e-04	-2.96147e-02	1.55949e-06
451/01	1.01443e-03	-1.74535e-02	1.57855e-04	2.07253e-03	-3.25091e-02	3.06853e-06
452/01	1.08463e-03	-4.57847e-02	1.64979e-04	3.69554e-03	-3.51764e-02	4.11824e-06
453/01	1.05280e-03	-3.30893e-02	1.59866e-04	2.60034e-03	-3.32375e-02	2.82671e-06
454/01	1.00986e-03	9.89291e-04	1.44061e-04	-2.41474e-03	-2.37060e-02	3.07918e-06
455/01	9.97421e-04	1.48810e-02	1.38342e-04	1.05087e-04	-2.70563e-02	2.51310e-06
456/01	1.01547e-03	1.02616e-02	1.40971e-04	2.74715e-03	-2.84619e-02	2.99904e-07
457/01	1.09835e-03	-5.61964e-03	1.52594e-04	4.95375e-03	-3.35657e-02	-2.51402e-06
458/01	1.06775e-03	1.66512e-02	1.42948e-04	-2.22013e-03	-2.99718e-02	-1.97404e-06
459/01	1.15182e-03	-2.37854e-02	1.55684e-04	5.89182e-03	-3.37317e-02	-1.78252e-06
460/01	1.04308e-03	2.14059e-02	1.43712e-04	2.93938e-03	-2.92100e-02	3.85552e-06
461/01	1.09541e-03	7.86400e-03	1.45260e-04	-9.93293e-04	-3.03536e-02	-3.51458e-06
462/01	1.10818e-03	2.83447e-03	1.45293e-04	1.86379e-03	-3.11622e-02	-1.69174e-06
463/01	1.08650e-03	1.14055e-02	1.43492e-04	2.22981e-03	-3.08549e-02	

						1.20690e-06
464/01	1.10582e-03	4.51199e-03	1.45531e-04	-4.22755e-03	-2.88840e-02	-1.04423e-06
465/01	1.12088e-03	-1.99721e-03	1.47229e-04	2.23455e-03	-3.18809e-02	4.69823e-07
466/01	1.11800e-03	5.20052e-03	1.42536e-04	3.02798e-03	-3.16855e-02	5.93234e-06
467/01	1.11800e-03	4.05728e-03	1.45664e-04	-5.65006e-03	-2.91712e-02	-1.30588e-06
468/01	1.12315e-03	4.85684e-04	1.45213e-04	1.89116e-03	-3.17920e-02	1.39097e-05
469/01	1.09730e-03	1.06015e-02	1.43196e-04	2.91867e-04	-3.02902e-02	5.84872e-07
470/01	1.07515e-03	1.78781e-02	1.44219e-04	-4.86181e-03	-2.78690e-02	4.50950e-07
471/01	1.11919e-03	6.69558e-05	1.46331e-04	-5.62501e-05	-3.06127e-02	-5.21759e-07
472/01	1.05730e-03	2.47007e-02	1.40302e-04	3.86527e-03	-3.07740e-02	5.06567e-06
473/01	1.09273e-03	1.51423e-02	1.42724e-04	-3.96151e-03	-3.01607e-02	-1.49672e-06
474/01	1.07705e-03	1.94738e-02	1.41408e-04	3.57593e-03	-3.18829e-02	4.30401e-06
475/01	1.11120e-03	7.05685e-03	1.41939e-04	4.55625e-03	-3.23268e-02	2.25701e-06
476/01	1.10488e-03	5.46969e-03	1.46118e-04	-3.14273e-03	-2.92413e-02	3.64184e-08
477/01	1.06173e-03	1.61171e-02	1.45385e-04	2.81088e-03	-3.03922e-02	5.44719e-06
478/01	1.06976e-03	1.52997e-02	1.43564e-04	3.11059e-03	-3.08673e-02	1.05523e-05
479/01	1.10651e-03	4.07324e-03	1.45971e-04	-3.00065e-03	-2.94177e-02	2.59808e-06
480/01	1.09731e-03	6.78862e-03	1.45741e-04	-9.58801e-04	-2.96328e-02	2.79816e-06
481/01	1.07996e-03	1.02816e-02	1.45970e-04	5.35777e-03	-3.22206e-02	-2.45226e-06
482/01	1.07370e-03	8.95338e-03	1.48622e-04	8.95965e-04	-2.87555e-02	7.96268e-07
483/01	1.09691e-03	1.16333e-04	1.49939e-04	3.68823e-03	-3.13551e-02	6.58897e-06
484/01	1.06553e-03	1.23952e-02	1.46032e-04	5.72961e-03	-3.21447e-02	-2.45900e-06
485/01	9.86263e-04	2.65290e-02	1.56047e-04	1.10657e-03	-2.62662e-02	1.02526e-07
486/01	1.05008e-03	2.52799e-02	1.30258e-04	1.44535e-03	-2.87977e-02	1.05829e-06
487/01	1.07630e-03	2.05947e-02	1.13947e-04	3.48840e-03	-3.05074e-02	-1.04639e-06
488/01	1.01111e-03	9.30096e-03	1.61887e-04	2.09861e-03	-2.76433e-02	5.02050e-06
489/01	1.07688e-03	2.74815e-03	1.50703e-04	4.59180e-03	-3.06524e-02	-6.23783e-06
490/01	1.06172e-03	9.16137e-03	1.49042e-04	2.86919e-03	-3.04415e-02	2.33969e-06
491/01	1.08989e-03	7.37636e-03	1.44957e-04	2.07593e-03	-3.11475e-02	2.26998e-06
492/01	1.09439e-03	-2.30557e-03	1.49705e-04	8.02575e-03	-3.54601e-02	2.68545e-06

Sta/ Cast	OcSlope (c1)	Offset (c2)	Plcoeff (c3)	Tfcoeff (c4)	Tscoeff (c5)	dOc/dtcoeff (c6)
493/01	1.10072e-03	-2.86152e-03	1.48369e-04	4.71987e-03	-3.25191e-02	-8.42091e-07
494/01	1.09194e-03	2.63569e-03	1.46867e-04	-1.06389e-03	-3.00606e-02	-1.21770e-06
495/01	1.11509e-03	-4.98955e-03	1.46086e-04	5.52357e-03	-3.29908e-02	2.67995e-07
496/01	1.09827e-03	-1.33337e-03	1.46547e-04	2.90691e-03	-3.17842e-02	1.10393e-06
497/01	1.06069e-03	1.27106e-02	1.46806e-04	-7.93608e-03	-2.58547e-02	-2.30914e-06

498/02 1.07191e-03 6.72747e-03 1.47424e-04 -1.15187e-03 -2.94050e-02
1.44469e-06
499/01 1.06803e-03 1.05282e-02 1.43874e-04 5.53977e-03 -3.23868e-02 -
1.95392e-07
500/01 1.07797e-03 1.14175e-02 1.43025e-04 -3.31482e-03 -2.89639e-02 -
2.77988e-06
501/01 1.07320e-03 1.50740e-02 1.40856e-04 2.49790e-03 -3.13063e-02
1.16771e-06
502/01 1.11952e-03 -3.81513e-03 1.44491e-04 2.03978e-03 -3.13867e-02 -
3.55006e-06

503/01 1.08890e-03 3.25107e-03 1.44930e-04 4.45852e-03 -3.19118e-02
3.57650e-06
504/01 1.09072e-03 5.10271e-03 1.45306e-04 4.90155e-04 -3.01307e-02
1.68524e-07
505/02 1.06466e-03 7.80966e-03 1.47582e-04 1.04091e-04 -2.91506e-02
4.30725e-06
506/01 1.09763e-03 3.08555e-03 1.44119e-04 1.24315e-03 -3.27067e-02
3.26401e-07
507/01 1.08357e-03 5.23438e-03 1.44586e-04 -3.15323e-04 -3.07945e-02
1.43540e-06
508/01 1.06556e-03 1.36354e-02 1.41739e-04 3.59388e-03 -3.36870e-02
3.29657e-06
509/01 1.07267e-03 -5.09354e-03 1.54707e-04 8.78140e-03 -3.58642e-02 -
4.00924e-06
510/01 1.05016e-03 7.18126e-03 1.49676e-04 6.84311e-03 -3.47527e-02
5.91472e-06
511/01 1.04414e-03 -4.30573e-04 1.57538e-04 5.43559e-03 -3.33926e-02 -
9.30481e-07
512/01 1.02777e-03 8.90130e-03 1.55921e-04 1.35290e-03 -3.06702e-02 -
4.39226e-06

513/01 1.08604e-03 -4.53306e-03 1.50887e-04 9.03041e-03 -3.73435e-02
6.11307e-06
514/01 1.08330e-03 -4.92620e-03 1.50389e-04 1.30966e-02 -4.01073e-02
7.36763e-07
515/01 1.07295e-03 -5.43946e-03 1.53426e-04 7.68342e-03 -3.50948e-02
1.28165e-07
516/01 1.07262e-03 5.41963e-03 1.45492e-04 4.14298e-03 -3.33916e-02 -
6.73634e-07
517/01 1.08530e-03 9.91808e-04 1.45906e-04 -1.79845e-04 -3.14865e-02
2.03003e-07
518/01 1.05328e-03 6.39805e-03 1.48215e-04 6.27946e-03 -3.39373e-02
5.64098e-06
519/01 1.09566e-03 -1.58465e-02 1.52540e-04 8.85351e-03 -3.66697e-02
4.61836e-06
520/01 1.09815e-03 -2.81835e-03 1.41541e-04 5.34060e-03 -3.38047e-02 -
4.16464e-07
521/01 1.05331e-03 6.18857e-03 1.50910e-04 4.01803e-03 -3.15793e-02 -
2.97739e-06
522/01 1.02115e-03 8.17092e-03 1.57619e-04 9.03984e-04 -2.92108e-02
3.85834e-06

523/01 1.09873e-03 -4.87389e-03 1.44302e-04 3.38773e-03 -3.29384e-02
6.09634e-06
524/01 9.96859e-04 1.96654e-02 1.52379e-04 1.79464e-03 -2.77111e-02
3.26357e-06
525/01 1.11127e-03 -1.73699e-02 1.50513e-04 2.41111e-03 -3.30414e-02
6.16169e-06
526/01 1.07151e-03 9.23713e-04 1.44564e-04 3.99663e-03 -3.28863e-02
1.28185e-05
527/01 1.04474e-03 5.85622e-03 1.45923e-04 4.29580e-03 -3.15578e-02
9.97883e-07
528/01 1.11547e-03 -1.48611e-02 1.41128e-04 5.51463e-03 -3.51246e-02
1.12387e-05
529/01 1.04619e-03 6.02644e-03 1.44130e-04 3.54593e-03 -3.11027e-02
2.88649e-06
530/01 1.08311e-03 -1.83239e-02 1.54307e-04 1.43582e-03 -3.17420e-02 -
2.34701e-06
531/01 1.05156e-03 -5.14630e-03 1.49243e-04 4.26948e-03 -3.29268e-02
2.29673e-06
532/01 1.02171e-03 -1.59140e-02 1.69613e-04 4.82534e-03 -3.15460e-02 -
1.80699e-07

533/01 1.07187e-03 -2.54663e-02 1.64638e-04 8.25539e-03 -3.71143e-02
3.35437e-06
534/01 1.07659e-03 -1.79196e-02 1.59640e-04 -2.75467e-03 -3.15689e-02
2.20294e-07

535/01	1.16725e-03	-6.53292e-02	1.74434e-04	5.96083e-03	-3.96295e-02	3.11800e-07
536/01	1.08642e-03	-3.05928e-02	1.64550e-04	8.53337e-03	-3.70283e-02	1.46029e-06
537/01	1.07519e-03	-2.70075e-02	1.65035e-04	9.15048e-03	-3.74040e-02	4.50782e-06
538/01	9.95882e-04	-8.64931e-03	1.78136e-04	2.01006e-03	-2.94659e-02	-3.72223e-06
539/01	1.11024e-03	-1.59356e-02	1.50837e-04	6.64321e-03	-3.70566e-02	-1.16543e-06
540/01	1.09450e-03	-3.26538e-02	1.69930e-04	8.00364e-03	-3.78710e-02	1.97302e-06
541/01	1.09414e-03	-2.07201e-02	1.54305e-04	5.04929e-03	-3.49309e-02	-1.60395e-06
542/01	1.06024e-03	-1.40187e-02	1.54613e-04	8.12216e-03	-3.56530e-02	1.57558e-07
543/01	1.07760e-03	-2.17304e-02	1.57772e-04	6.66478e-03	-3.48579e-02	-1.72881e-06
544/01	1.07140e-03	-2.68877e-02	1.61482e-04	3.51692e-03	-3.29937e-02	2.94126e-06
545/01	1.05908e-03	-4.82464e-02	1.76031e-04	-5.02270e-03	-3.09428e-02	1.58515e-06
546/01	1.06188e-03	-4.73697e-02	1.66534e-04	5.25464e-03	-3.40723e-02	-2.75824e-06
547/01	9.55558e-04	-3.65329e-03	1.58976e-04	3.17996e-03	-2.82568e-02	1.41211e-06
548/01	1.12039e-03	-6.04212e-02	1.62686e-04	1.09729e-02	-3.93283e-02	2.26415e-05
549/01	9.51792e-04	2.34797e-04	1.67501e-04	5.92366e-03	-3.16345e-02	-1.97001e-06
550/01	1.01453e-03	-3.05633e-02	1.74864e-04	4.05916e-03	-2.90084e-02	2.36647e-06
551/01	1.02587e-03	8.88221e-03	1.49679e-04	7.00149e-03	-3.18196e-02	2.28662e-06
552/01	1.13572e-03	-1.98346e-02	1.52351e-04	3.48093e-03	-3.64251e-02	5.46748e-06
553/01	1.03818e-03	9.01354e-03	1.52433e-04	2.41897e-03	-2.95076e-02	4.49451e-07
554/01	1.05541e-03	5.99117e-03	1.52033e-04	6.02580e-03	-3.29286e-02	-1.84304e-06
555/01	1.07183e-03	5.29849e-03	1.49138e-04	4.77424e-03	-3.17941e-02	-1.37593e-06
556/01	9.88458e-04	3.50818e-02	1.46486e-04	-2.56890e-03	-2.45470e-02	2.38202e-06

Sta/ Cast	OcSlope (c1)	Offset (c2)	Plcoeff (c3)	Tfcoeff (c4)	Tscoeff (c5)	dOc/dtcoeff (c6)
557/01	1.08896e-03	-4.02204e-03	1.53635e-04	6.80873e-03	-3.35474e-02	4.07773e-06
558/01	1.08855e-03	-4.77789e-03	1.56112e-04	2.80255e-03	-3.12183e-02	4.03612e-06
559/01	1.00705e-03	4.50188e-02	1.28043e-04	4.44313e-03	-2.99470e-02	-6.32199e-06
560/01	1.08880e-03	2.55284e-02	1.17350e-04	7.69731e-03	-3.44170e-02	1.23149e-06
561/01	2.45956e-03	-1.51572e-01	-2.20226e-04	1.80822e-02	-7.08182e-02	4.12439e-07
562/01	4.88292e-03	1.96746e+00	-1.21707e-03	1.18110e-03	-9.23659e-02	-1.70071e-06
563/01	1.51430e-03	-2.50586e-02	-6.12079e-06	1.04577e-02	-4.96638e-02	5.10982e-06
564/01	1.10530e-03	1.97035e-02	1.20248e-04	5.82152e-03	-3.48037e-02	1.92829e-06
565/01	1.12199e-03	-1.79821e-02	1.56740e-04	4.70891e-03	-3.25363e-02	3.61991e-07
566/01	9.52398e-04	3.87832e-02	1.51030e-04	2.99126e-03	-2.56889e-02	9.52886e-06
567/01	1.09868e-03	-3.72498e-03	1.51283e-04	2.57322e-03	-3.13183e-02	4.93335e-06
568/01	1.02120e-03	1.94125e-02	1.48774e-04	5.64466e-04	-2.73593e-02	3.97245e-06

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569/01  1.05607e-03   1.12009e-02   1.47519e-04   7.02533e-03  -3.36722e-02
2.26436e-06
570/01  1.05474e-03   1.12820e-02   1.47429e-04   4.90640e-03  -3.25805e-02  -
3.69710e-08
571/01  9.66484e-04   4.13831e-02   1.42545e-04   4.12208e-03  -2.82877e-02
4.37037e-06
572/01  9.88135e-04   3.42355e-02   1.42888e-04   7.12805e-03  -3.17597e-02
4.76619e-07

573/01  9.86600e-04   3.67297e-02   1.41692e-04   4.73807e-03  -2.92275e-02  -
1.48253e-07
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APPENDIX C

WOCE95-I3: 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 0.02 ml/l or more compared to bottle data (plus nearby and/or duplicate-position ctd casts)
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
OL	ctdoxy fit low near surface: either slow cast start or low ctdoxy signal
ON	ctdoxy signal unusually noisy
OS	raw ctdoxy signal shifts
SS	probable sea slime on conductivity sensor
WS	winch slowdown/stop, potential shift in ctdoxy signal (also, see "OB")

Key to Solution/Action Abbreviations	
DO	despiked raw ctdoxy, despiked data ok unless otherwise indicated
DS	despiked salinity, changed temperature and/or conductivity - see .ctd file codes
EB	used nearby bottles and/or casts to estimate bottle oxygen value for ctdoxy fit
NA	no action taken, used default quality code 2
NR	cast not processed, not reported with final data
O3/O4	quality code 3/4 oxygen in .ctd file for pressures specified
OC	offset conductivity channel to account for shift/offset
RO	offset raw ctdoxy data to account for signal shift caused by slowdown/stop/yoyo; usually "DO" in transition area near offset

Cast	Problem/Comment	Solution/Action
443/01	start with ctdoxy sensor 3-03-10	
444/01	OB	RO +10/126-154db(btm)
445/01	WS/0.6 mins. at 354db, OB/ON/consistently noisy+low at bottom: matches bottles after despiking, not comparable to nearby casts	RO +10/408-410db, RO +20/412-414db(btm), DO/O3/348-414db(btm)
446/01	ON/OL/OK	DO/0-48db
447/01	OS/OL/OK	RO +100/0-58db, DO

448/01	OL/ctdoxy bulges low relative to nearby casts	DO/O3/0-40db
449/01	WS/1.5 mins. at 0-4db, DI -0.017/0-6db	NA
450/01	BQ/2018-4326db, 10 consecutive bottle oxys	EB/sta 451 deep bottle values used to fit ctdoxy
451/01	DI -0.021/0-2db; ON/intermittent	NA; DO/280-540db
	BQ/5020db bottom bottle	EB

Cast	Problem/Comment	Solution/Action
452/01	DI -0.022/0-6db; ON/intermittent	NA; DO/160-520db
	OB	RO +2/5030-5134db(btm)
454/01	spare ctdoxy sensor 4-05-16 installed prior to cast: ON/intermittent	DO/4722-4998db
456/01	OS/unknown cause; last cast for this ctdoxy sensor	DO/4320-4378db
	WS/0.6 mins. at 5082db, unusual rise in ctdoxy at bottom	DO/O3/5112-5138db(btm)
457/01	spare ctdoxy sensor 5-01-04 installed prior to cast; ON/constant, extreme noise in ctdoxy signal over large area: OK	
	up-cast reported shipboard despite noisy section (despiked) in high-gradient area	down-cast processed for final data
458/01	ctdoxy sensor connections reseated prior to cast: signal looks fine now	
459/01	OB	RO +1/5592-5622db(btm)
461/01	BQ/5860db bottom bottle; odd ~0.03 ml/l drop at 5562-5862db(btm)	EB; NA/matches bottle and nearby stas
463/01	BQ/5810db bottom bottle	EB
464/01	OF: 0.02 ml/l low	O3/4570-5182db
	end cast at 5990m (wire-out) to keep press within laboratory calibration range	
465/01	OF: 0.02 ml/l low compared to bottles, ok compared to nearby ctd casts	NA/3636-4570db
467/01	BQ/5926db bottom bottle; ctdoxy bulges ~0.03 ml/l high compared to nearby casts, no bottles to compare with	EB; O3/5686-5928db(btm)
468/01	OL/ctdoxy bulges low relative to nearby casts	DO/O3/0-50db
	BQ/6088db bottom bottle	EB
470/01	ctdoxy bulges ~0.03 ml/l high compared to nearby casts, bottom bottle	O3/5072-5424db(btm)
471/01	ON, very high ctdoxy: OK	RO -30/2-12db, RO -20/14-28db, RO -10/30-38db, DO/O3/0-50db
	OB	RO +1/5182-5192db, RO +2/5194-5198db(btm)
473/01	BQ/5179db bottom bottle	EB
474/01	OB	RO +1/5376-5388db(btm)
477/01	SS/CO -0.0025 mmho/cm	OC/DS/2252-2408db
478/01	OL/OF: 0.10 ml/l low	DO/O3/0-24db
	OF: 0.02 ml/l low, then high at bottom	O3/3702-4868db(btm)
480/01	OF: 0.02 ml/l low, drops before slowdown; bottom bottle also	O3/5444-5480db(btm)

	low, no nearby casts this deep: possibly real?	
481/01	WS/0.7 mins. at 0-4db; DI -0.019/0-6db	NA
	BQ/12db surface bottle; ON/OL/OK	EB; DO/0-76db
	pdr bottom ~500m shallower than wire out or CTD depth: ok, 400+m dropoff 10 mins after leaving station	

Cast	Problem/Comment	Solution/Action
483/01	ON/OL/~0.05 ml/l low compared to bottle, nearby casts	DO/O3/0-22db
	OB	RO +1/5058-5066db, RO +2/5068-5070db, RO +3/5072-5074db(btm)
484/01	OB	RO +2/3156-3196db(btm)
485/01	SS/CO -0.005 mmho/cm	OC/DS/1658-1700db
	unusual ~0.03 ml/l drop in ctdoxy at bottom, no slowdown; matches 4 of 5 bottles but not previous cast	NA/2014-2328db
487/01	WS/1.3 mins. at 518db to reposition ship: wire against the hull	NA/any ctdoxy effect lost in background noise
	OB/OF: to 0.03 ml/l low at bottom, slowdowns at 1842/1860db	RO +2/2024-2034db(btm), O3/1844-2034db(btm)
489/01	DI -0.017/0-10db	NA
	OS/OL/~0.08 ml/l low after offset compared to stas 487+488, ok compared to bottle and sta 490	RO +120/2-24db, RO +100/26-36db, RO +70/38-42db, DO/O3/0-42db
491/01	WS/0.8 mins. at 0-4db; DI -0.016/0-10db	NA
	ON/OL/OK	DO/0-68db
492/01	ON/OL/OK	DO/RO +20/0-24db
493/01	BQ/7db surface bottle	EB
	OB	RO -1/4870-4884db(btm)
496/01	ON/OL/OK	DO/2-70db
498/01	ABORT - wire trouble: no signal after acquisition started, before cast in water	NR
498/02	switch to stbd winch w/broken-strand wire prior to cast	
	C-sensor cover empty/dry prior to cast	NA/signal looks ok
	ON/OL/still ~0.05 ml/l low compared to nearby casts after despiking, but matches own 2 bottles this area=ok?	DO/2-68db
499/01	OS/OL/OK	RO +60/2-18db
	WS/1.3 mins. at 48db to check winch noises	NA/no apparent effect on ctdoxy signal
	BQ/4920db bottom bottle; OB	EB; RO -1/4918-4924db(btm)
	major signal noise/all channels/after bottom trip: jumpy/unstable voltage to ~ 1000m up; signal went crazy again when stopped to tape broken strand on wire ~50m up	cut off ~100m (stbd) wire after cast, reterminated
500/01	switch back to port winch with new termination using 2 conductors	
	OB	RO +1/4924-4938db(btm)
502/01	BQ/7db surface bottle	EB

	OB	RO +1/5202-5214db(btm)
504/01	switch to stbd winch prior to cast	
	cast position data missing, recovered from ship's computer	
505/01	TEST cast to check out potential wire/voltage problem	NR
	voltage drops at every test trip, sometimes sticks low even after winch starts moving: one of two conductors tied together staying open	crank up volts/current and continue to use stbd winch on cast 2

Cast	Problem/Comment	Solution/Action
505/02	WS/1.2 mins. at 3380-3390db, winch op. heard wrong target depth: inversion in ctdoxy near stop	DO/3386-3400db
	OB	RO -1/4434-4448db(btm)
506/01	(stbd) sliprings replaced/repaired	
	WS/1.4 mins. at 0-6db; choppy seas/20-30 knot winds; OL/very low raw ctdoxy: OK	DO/0-10db
509/01	conductivity signal noisy: +/-0.002 mmho/cm	DS/2500-4694db
	ON/much signal oscillation compared to upcast, nearby casts	O3/2500-4694db(btm)
515/01	WS/1.0 mins. at 0-6db, ON	DO/0-78db
	BQ/6db surface bottle	EB
	OF: 0.02 ml/l low	O3/3116-3350db(btm)
520/01	ON/OS/OL/overlays surface bottle and sta 519 after offset	DO, RO +40/2-64db
	WS/0.8 mins. at 2830db	DO/2830-2842db
	OB	RO +3/2964-2970db(btm)
521/01	OB/OF: 0.03 ml/l high	O3/2408-2478db(btm)
524/01	wind 20 knots; OS/OL/OK	RO +60/2-18db
525/01	OS/OL/OK	RO +100/2-32db, RO +40/34-48db, DO/0-48db
526/01	OL/OF: 0.10 ml/l low	DO/O3/0-54db
	WS/1.8 mins. at 1752-1766db: "wobble" in the wire	NA/ctdoxy effect on the order of background noise
528/01	DI -0.015/0-6db; OL/OF: 0.10 ml/l low	DO/O3/0-16db
	SS/CO -0.16 to -0.47 mmho/cm	DS/544-558db
530/01	wind 13 knots; OS/OL/OK	RO +40/8-30db
531/01	BQ/3439+3607db, bottom two bottles	EB
532/01	OS/OK	RO +60/2-18db, RO +20/20-28db
	OB	RO +1/3710-3726db(btm)
533/01	OS/OK	RO +20/2-24db, RO -40/26-44db
	OB	RO -1/3944-3952db(btm)
535/01	ON/OS/OL/OF: nearly 0.10 ml/l low	RO +30/16-40db, DO/O3/0-84db
536/01	wind 15 knots; OS/OL/OK	RO +60/2-26db
537/01	DI -0.016/0-10db; OS/OL/OK	RO +20/2-26db
538/01	DI -0.017/0-6db; OS/OL/OK	DO, RO +60/2-16db
539/01	OS/OK	RO +80/12-20db, RO +40/22-28db
	DI -0.012/850-854db, +0.09 deg.C temp. is real: LADCP noted unusual 1-kt. current 735-870db; bottom of shear/probable mixing here	NA/inversion probably real
541/01	OS/OL/OK	RO +50/0-12db, RO

		+20/14-20db, DO/0-20
	OB	RO +3/2606-2628db(btm)
543/01	OS/OL/OK	RO +20/0-18db, RO +50/20-52db, RO +20/54-70db, DO/0-70db
544/01	OL/OK	RO +80/2-8db, RO +40/10-52db, DO/0-52db
545/01	first cast in 3 days after port stop to pick up observers	NA/no apparent effect on sensors
	OF: up to 0.15 ml/l low	O3/474-656db
547/01	DI -0.018/0-6db; OS/OL/OK	RO +70/2-38db, RO +40/40-46db, DO/2-46db
548/01	OL/OF: 0.10 to 0.15 ml/l low	DO/O3/0-54db
	OF: 0.02 ml/l low, then high	O3/3070-4222db(btm)

Cast	Problem/Comment	Solution/Action
549/01	slowed at 4800m (wire-out) on down; OF: to 0.10 ml/l high at bottom	O4 4364-4946db
551/01	OS/OL/OK	DO/RO/0-26db
	OS	RO +50/0-10db
	OS	RO +40/12-26db
552/01	OS	RO +20/0-24db
	BQ/5017db bottom bottle	EB
553/01	OF: to 0.02ml/l high near bottom, matches better after OB	O3/4942-4990db
554/01	OS	RO +60/2-34db
	BQ/4978db bottom bottle	EB
555/01	BQ/4925db bottom bottle	EB
556/01	OL/OF: 0.15 ml/l low	DO/O3/0-60db
	OF: 0.03 ml/l low compared to bottles, ok compared to sta 555 and sta 568 (same position)	NA/3550-4226db
	OF: 0.02 ml/l high by bottom	O3/4284-4830db(btm)
	OB	RO -1/4814-4830db(btm)
557/01	OS/OL/OK	RO +80/2-20db, RO +40/22-24db, DO/0-24db
558/01	OS/OL/OF: 0.10 ml/l low	RO +60/2-26db, DO/O3/0-64db
559/01	OL/OF: 0.10+ ml/l low	DO/O3/0-50db
560/01	OS/OK	RO +40/0-44db
562/01	winch speed 45m/min. max	
564/01	BQ/8db surface bottle	EB
565/01	OB	RO +2/2928-2936db(btm)
566/01	OS/OK	RO +30/2-14db
	OF: 0.05+ ml/l high; bottle suspiciously high, no other bottles to rely on	O3/3080-3564db
569/01	OS/OK	RO +90/14-26db
570/01	OB	RO +2/4960-4978db(btm)
573/01	BQ/2db surface bottle	EB

APPENDIX D

WOCE95-I3: Bottle Quality Comments

Remarks for deleted samples, missing samples, PI data comments, and WOCE codes other than 2 from WOCE I03/ICM3 KN-145.8. 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 443

Cast 1 TIC:"Salinometers are not performing well. Electronics in both instruments need to be adjusted and air temp in room fluctuating badly."

136 Oxygen value 0.04 ml/l high compared to CTD oxygen and NB35 at same level. Footnote oxygen questionable.

133 Oxygen value 0.30 ml/l low compared to CTD oxygen. Small feature (low value) in salinity and nutrients all high. Couldn't be leaking bottle, though, since this is lowest oxygen value in water column. Footnote oxygen questionable.

131-136 Footnote salinity questionable. See Cast 1 salinity comment.

130 Sample Log: "spigot in open position." Oxygen low; NO2, silicate, PO4 all high. Footnote all bottle parameters bad.

129 Sample Log: "bottom end-cap leak (C.H. reseated cap.)" Sample values appear to be OK.

117 Sample Log: "Oxygen on NB17 redrawn; stopper on flask defective. So flask replaced."

121 Sample Log: "bottom end-cap leak". Other than salinity, sample values appear to be OK.

110 Several bottles tripped together. Oxygen value 2.0 ml/l too low. Footnote oxygen bad.

101-129 Footnote salinity questionable. See Cast 1 salinity comment.

STATION 444

102 Oxygen comments:"Thio shaken/ x5" No apparent affect on oxygen values.

101 Oxygen comments:"No flush thio" No apparent affect on oxygen values.

STATION 445

101-102 CTD processor: "CTD oxy consistently noisy, low at bottom: matches btls after despiking." Footnote CTD oxy questionable.

STATION 446

112 Sample Log indicates salinity sample drawn, but sample not analyzed. No reason noted. Footnote salinity value not reported.

103 Sample Log:"NB3 slight drip on bottom cap, adjusted cap stopped drip." No apparent affect on bottle values.

STATION 447

121 Surface oxygen values on stations 447 and 448 are 0.10 ml/l higher than stations 444-446 and stations 449-450 and CTD oxygen values. Analyst notes there was a bubble in station 447 flask; there may have been similar problem in station 448 also. Footnote oxygen questionable.

115 Sample Log:"Bottom end-cap leaking". No apparent affect on bottle parameters.

STATION 448

121 Surface oxygen values on stations 447 and 448 are 0.10 ml/l higher than stations 444-446 and stations 449-450 and CTD oxygen values. Analyst notes there was a bubble in station 447 flask; there may have been similar problem in station 448 also. Footnote oxygen questionable.

120-121 CTD processor: "CTD oxy bulges low relative to nearby casts." Footnote CTD oxy questionable.

118 Sample log:"Top end-cap leaking." No apparent affect on data.

103 Oxygen Printout: "stir-bar late". Value close to 0.0, clearly a bad value compared to adjacent stations. Footnote oxygen bad.

STATION 449

Cast 1 Salinity analyst's log: "Salinity samples allowed to equilibrate for only 2 hours before run on salinometer." No apparent affect on data.

101-131 Nutrient Analyst notes: "NO3 F1s questionable due to Cadmium Column Change." NO3 values appear 0.5 um/l high. Footnote all nitrate values uncertain. Salinity samples allowed to equilibrate for only 2 hours before run on salinometer. However, bottle salinity values compare well with ctd salinities and adjacent stations. Salinity values OK.

STATION 450

Cast 1 Sample log: "O2 first draw from NB1 to NB22 had wrong amount of reagents added. Resampled w/ correct amount of reagent." Oxygen value OK unless otherwise noted.

119-120 Footnote oxygen questionable. NB19 to NB20 (at a Oxy minimum) look too high compared to both nearby casts and CTDOXY even though this is the middle of the Leeuwin current with a lot of variability. PI agrees.

102-111 Footnote oxygen questionable. Refer to cast 1 Sample Log oxygen comment. Oxygen values look 0.1 ml/l high compared to down and up traces on CTDOXY and station 451.

STATION 451

Cast 1 Standard Dial on salinometer was adjusted by 16 units downward from previous station. Suspect bad wormly standard at beginning of run. All sample values off by about 0.0026. That offset was applied and plots with ctd salinity agree.

123 Sample Log:"Bottom cap leaking". No apparent affect on data.

101 PI: "Oxygen value too low." Oxygen value appears 0.08ml/l low. Footnote oxygen questionable.

STATION 452

127 Oxygen sample mistakenly not drawn on NB27. Part of a systematic drawing error involving NB27 through NB31. Errors corrected except no value to report on NB27.

123 Sample Log: "Bottom cap leaks". No apparent affect on bottle values when compared to adjacent stations and CTD salinity.

122 Sample Log:"NB22 leaks at petcock (petcock open, vent closed)." No apparent affect on bottle values when compared to adjacent stations and CTD salinity.

STATION 453

132 Sample log: "bottom end-cap leaking (maybe)". Salinity value consistent with CTD and adjacent stations.

127 Sample log: "bottom end-cap leaking". Salinity value consistent with CTD and adjacent stations.

123 Sample log: "bottom end-cap leaking". Salinity value consistent with CTD and adjacent stations.

STATION 454

127 Sample log: "Small bottom cap leak". No apparent affect on bottle values.

125 Sample log: "Bottom cap leaks w/ vent open - small leak." No apparent affect on bottle values.

115 Analyst note: "Oxygen sample lost during analysis."

109-116 Nutrient Analyst: "Possible temperature stability problem in lab." Phosphate value 0.1 um/l high compared adjacent stations, Silicate a little low but within WOCE standards. Other bottle parameters unaffected. Footnote Phosphate questionable.

STATION 456

136 Sample log: "No nuts, Salinity, or Ba samples from NB36- H2O exhausted". Nutrient and salinity samples not drawn.

127 Sample log: "NB27 may be leaking from bottom end-cap." No apparent affect on bottle data.

119-120 All nutrient values from NB19 seem to indicate samples were switched with NB20. Other bottle parameters OK. Could be drawing error. PI agrees. Error corrected, nutrient values appear consistent with adjacent stations.

101 CTD processor: "Unusual rise in CTD oxy at bottom." Footnote CTD oxy questionable.

STATION 457

120-124 CTD processor: "Constant, extreme noise in CTD oxy signal over large area. Looks OK after extensive despike (new ctdoxy sensor)." Footnote CTD oxy questionable.

119 Oxygen value 0.10 ml/l high compared to adjacent stations and CTD oxy value. No analyst notes. Footnote oxygen questionable.

116 Oxygen value 1.5 ml/l too high compared to adjacent stations. No analyst notes. Recommend deletion. Footnote oxygen value bad.

111 Salinity value is slightly off compared to adjacent stations and CTD value. Footnote salinity questionable.

109 Value is slightly off compared to adjacent stations and CTD value. Footnote salinity questionable.

STATION 458

115 Sample log: "Top cap leaked air - repositioning stopped leak." No apparent affect on data.

STATION 459

124 Oxygen values from NB23 through NB35 to not compare well with CTDOXY and values from adjacent stations. Suspect flask intended for NB23 was drawn on NB24 and all following draws were then one off, till two flasks were mistakenly

drawn on NB35. Corrections were made, data fits profiles of adjacent stations and plots of Silicate vs Oxygen. Oxygen values now OK. PI agrees.

123 Oxygen sample mistakenly not drawn on NB23. See comments on 124.

106 NO-confirm from pylon at first trip attempt. Re-initialized, second trip confirmed ok. All bottles appear to have tripped at correct depths.

103 Sample log: "NB3 bottom end-cap leaking; small twist corrected it." No apparent affect on data.

STATION 460

132 Oxygen value 0.10 ml/l low compared to CTD oxy. Nearly same oxy value and draw temperature as NB33, could be duplicate draw. Footnote oxygen questionable.

125 Sample log: "NB25 bottom end-cap leak." No apparent affect on bottle data.

119 Oxygen values from NB18 through NB23 do not compare well with CTDOXY and values from adjacent stations. Suspect flask intended for NB18 was drawn on NB19 and all following draws were then one off, till two flasks were mistakenly drawn on NB23. Corrections were made to Oxygen File, data fits profiles of adjacent stations and plots of Silicate vs Oxygen. PI agrees. After changes oxygen values OK.

118 Oxygen sample mistakenly not drawn from NB18. See comments on 119. Footnote Oxygen not drawn.

103 Sample log: "NB3 bottom end-cap leaking; small twist corrected it." Delta-S -0.0022 PSU. Salinity value a little low compared to CTD salinity and adjacent stations. Footnote salinity questionable.

STATION 461

131 Sample log:"Lanyard caught, bottom end-cap failed to close". No samples drawn from NB31.

101 Bottle oxygen value 0.03 ml/l low when plotted against adjacent stations and CTD oxy value. Footnote questionable.

STATION 462

135 Sample log: "NB35 leaking; end caps OK, top valve presumed not completely closed." No apparent affect on data.

114 PI:"O2 number 114 looks high to me by about 0.1ml/l; mark it '3'.BW". Footnote oxygen questionable.

STATION 463

126 Oxygen Analyst notes he lost sample during analysis. Footnote oxygen not reported.

116 Nutrient Analyst: "Nutrients: No samples - Timer messed up and went to sw." No nutrient values reported.

104 Sample log: "NB4 leaking from bottom end-cap." No apparent affect to data.

101 PI: "Bottom O2 looks low to me by 0.08ml/l; mark it '3'.BW." Footnote oxygen questionable.

STATION 464

125 Sample Log: "Slight leak at bottom cap - adjusted cap stopped leak." No apparent affect on data.

108 Oxygen value 0.3ml/l too low compared to adjacent stations. Footnote oxygen value bad.

107 Sample log:"Slight leak at bottom cap - adjusted cap stopped leak." No apparent affect on data.

104-106 CTD processor: "CTD oxy looks about 0.02 ml/l low compared to bottles and nearby casts." Footnote CTD oxy questionable.

STATION 465

105-108 CTD processor: "CTD oxygen looks about 0.02 ml/l low compared to to bottle values, OK compared to nearby casts."

STATION 466

116-117 Sample log: "NB16 and NB17 failed to close." No bottle samples. Console Log: "Odd-confirm on NB16, NB17 - both came up open. Pylon manually re-posn'd prior to tripping NB18. Btl pressures for NB18 - NB36 look OK based on oxy fits."

STATION 467

121 Silicate value looks 2uM too high compared to adjacent stations. However, there is a small feature at that depth in CTDO, oxygen, CTD salinity and bottle salinity. Silicate value OK. PI agrees.

110 Sample Log: "NB10 leaked at petcock - repositioned top cap stopped leak." No apparent affect on data.

101 Bottle oxygen value 0.05 ml/l low when plotted against adjacent stations and CTD oxy value. Footnote questionable.

STATION 468

136 CTD processor: "CTD oxy bulges low relative to nearby casts." Footnote CTD oxy questionable.

125 Delta-S at 711db is -0.0105 PSU, salinity is 34.492 PSU. CTD trace shows complex salinity structure in this area. By comparison of adjacent stations, data OK. PI agrees.

124 Delta-S at 812db is -0.0112 PSU, salinity is 34.509 PSU. CTD trace shows complex salinity structure in this area. By comparison of adjacent stations, data OK. PI agrees.

101 Bottle oxygen value 0.03 ml/l low when plotted against adjacent stations and CTD oxy value. Footnote questionable.

STATION 469

130 Delta-S at 310db is -0.0279 PSU, salinity is 35.348 PSU. Area of steep salinity gradient. Salinity value OK. PI agrees.

122 Nutrient Analyst note: "NB22 nitrate value slightly high, looks real. Matches station 460." PI agrees.

112 Delta-S at 2831db is 0.0020 PSU. This slight difference is within guidelines. Footnote salinity OK.

STATION 470

128 Sample log:"Oxygen on NB28 was resampled after improper reagent addition." No affect on data.

109 Oxygen analyst note: "109 lost, hit escape while titrating." Footnote oxygen value not reported.

105 Sample log: "NB5 slight leak at bottom cap". No apparent affect on bottle samples.

101 CTD processor: "CTD oxy bulges 0.03 ml/l high compared to to nearby casts." Footnote CTD oxy questionable.

STATION 471

136 CTD processor: "Very high raw CTD oxy, better after despiking." Footnote CTD oxy questionable.

124 PI: "Oxygen looks too low to me - suspiciously like a repeated sampling of NB23. I think it should be rejected.BW" Footnote oxygen value bad.

STATION 472

102 Analyst notes: "PO4 looks high; no analytical problems." Phosphate value looks 0.01uM high compared to adjacent stations. Footnote phosphate questionable.

STATION 473

136 Sample Log:"NB36 ran out of water for salt." Footnote salinity not reported.

129 Sample Log: "Slight leak from bottom cap - stopped after cap adjusted." No apparent affect on data.

125 Sample Log:"Slight leak from bottom cap - stopped after cap adjusted." No apparent affect on data.

101 Oxygen value appears 0.4ml/l too high. No notes of any problems. PI: "Code should be a 4." Footnote oxygen bad.

STATION 474

131 Nitrate, phosphate and silicate all appear low compared to station 473. However, there is a feature seen in oxygen and salinity at this level. Data OK. PI agrees.

107 Sample log: "Slight leak - stopped after top cap adjusted." No apparent affect in data.

STATION 475

132 Delta-S at 209db is 0.0261 PSU, salinity is 35.690 PSU. Small feature in profile at this level with steep gradient. Footnote salinity OK.

110 Oxygen analyst note: "Found with wrong stopper in flask." PI: "This value looks just fine on the theta - oxygen plot. I don't think it deserves a finger of scorn. BW." Oxygen value OK.

109 Analyst note: "Nitrate looks high - no analytical problem." NO3 value OK. Oxygen analyst note: "Found with wrong stopper in flask." Oxygen value compares well with adjacent stations when plotted vs potential temp. Oxygen value OK. PI: "Nitrate and silicate both relatively high on theta plots, but oxygen is consistent in being relatively low. Salinity seems anomalous too (smidgen low). So these observations seem to hang together, and I think they are OK. BW."

STATION 476

133 Sample log: "Vent was open." No apparent affect on data compared to adjacent stations.

113 Delta-S at 2712db is 0.0023 PSU, salinity is 34.727 PSU.

PI: "This value looks fine on the theta - salinity plot, so I think it's OK. BW"

STATION 478

136 Sample log: "Leaks - bit of lanyard in top half." No apparent affect on data. CTD processor: "CTD oxy bulges low relative to nearby casts." Footnote CTD oxy questionable.

125 Sample log: "Leaking slightly from bottom end cap when valve open." No apparent affect on data.

101-105 CTD processor: "CTD oxy looks 0.02 ml/l low (high at bottom) compared to bottles and nearby casts." Footnote CTD oxy questionable.

STATION 479

125 Sample log: "Leak at bottom cap." No apparent affect on data.

115 Sample log: "Slight leak at bottom end cap - stopped after adjusted bottom cap." No apparent affect on data.

114 Sample log: "Oxygen temp was interpolated after draw."

STATION 480

131 Nutrient Analyst: "Nutrients: Sample tube empty." By mistake, no nutrient samples drawn on NB31.

116 Salinity value doesn't compare well with CTD salinity or adjacent stations. No log entries. Footnote salinity questionable. Delta-S at 2022db is -0.0073 PSU, salinity is 34.713 PSU.

115 Sample log: "Bottom end cap leaks". No apparent affect on data.

114 Sample log: "Bottom end cap leaks". No apparent affect on data.

101 CTD processor: "Unusual 0.02 ml/l drop in CTD oxy near, bottom bottle also low; no nearby casts this deep; could be real?" Footnote CTD oxy questionable.

STATION 481

136 Sample log: "Maybe suspect because brought out of water at surface check." Delta-S is small, -0.0006 PSU. and nutrient measurements look OK. However, oxygen value may be 0.05 ml/l high compared to CTD oxygen and values at adjacent stations. Footnote oxygen questionable.

125 Sample log: "Leaking a little at bottom." No apparent affect on data.

STATION 482

129 Sample log: "Bottom cap leak - slight." No apparent affect on data.

125 Sample log: "Bottom cap leak." No apparent affect on data.

122 Delta-S at 1012db is 0.0075 PSU, salinity is 34.600 PSU. No analyst note, only two runs on salinometer. Footnote salinity questionable.

115 Sample log: "Bottom cap leak." No apparent affect on data.

101 Sample log: "NB1 redrawn after oxygen reagent bottle fixed." No apparent affect on oxygen sample. Delta-S is -0.0022 PSU. Salinity value a little low compared to CTD salinity

and adjacent stations. Footnote salinity questionable.

STATION 483

Cast 1 PI: "I am uneasy about the phosphates on stations 483 and 484: at theta 1.5 - 4.5 C, they are high by about 0.1 uM/L compared with other stations. On Sta 484 oxygen is high in this temperature range and silica is correspondingly low (NO3 is ho-hum), so phosphate "ought" to have been low as well. But it's the other way around.BW." Nutrient Analyst note: "Bubble stuck in PO4 flowcell from peak 21 through end of run, these peaks were 0.030 units too high. Peaks corrected, factors and baselines adjusted." Phosphate values now acceptable.

136 CTD processor: "CTD oxy 0.05 ml/l low compared to bottle value and nearby casts." Footnote CTD oxy questionable.

117 Delta-S at 1818db is -0.029 PSU, salinity is 34.680 PSU. No analyst notes. Could be drawing error. PI: "This seems almost certainly to be a duplicate of the one from the NB above. I agree that it should be rejected.BW" Footnote salinity value bad.

115 Sample log: "Bottom cap leak - slight." No apparent affect on data.

STATION 484

Cast 1 PI: "I am uneasy about the phosphates on sta's 483 and 484: at theta 1.5 - 4.5 C, they are high by about 0.1 uM/L compared with other stations. On Sta 484 oxygen is high in this temperature range and silica is correspondingly low (NO3 is ho-hum), so phosphate "ought" to have been low as well. But it's the other way around.BW" Nutrient Analyst note: "Bubble stuck in PO4 flowcell during run. PO4 factors and baselines adjusted." Phosphate values now comparable to adjacent stations.

116 Analyst note: "Lost Oxygen Sample". Footnote oxygen not reported.

115 Sample log: "Has a little drip." No apparent affect on data.

112 Sample log: "Leaks - some (?) end cap." No apparent affect on data.

107 Oxygen analyst note: "Forgot acid, retitrated." Value looks 0.05 ml/l low. Footnote oxygen bad.

STATION 485

129 Sample log: "Leak from bottom cap." No apparent affect on data.

123 Sample log: "Slight leak from bottom cap." No apparent affect on data.

116 NO-confirm from pylon at first trip attempt. Re-initialized, second trip confirmed ok. All bottles appear to have tripped at correct depths.

STATION 486

115 Sample log: "Bottom cap leak." No apparent affect on data.

110 Salinity value off compared to CTD salinity. Delta-S at 907db is -0.0623 PSU. Could be duplicate draw. Footnote salinity bad.

STATION 487

115 Sample log: 'Bottom cap leaks - stopped after cap adjusted." No apparent affect on data.

101-102 CTD processor: "0.03 ml/l drop in CTD oxy at bottom; low compared to nearby casts and bottle value after despiking. Footnote CTD oxy questionable.

STATION 488

128 Phosphate value appears 0.2uM high. No analyst notes. Footnote phosphate value questionable. PI: "I agree with "3". BW"

STATION 489

136 CTD processor: "CTD oxy 0.08 ml/l low compared to station 487 and 488, but OK compare to station 490." Footnote CTD oxy questionable.

127 PI: "Salinity wildly off - sample almost certainly drawn from NB below - give it the finger of scorn (4).BW" Footnote salinity value bad.

115 Sample log: "Bottom end leak." No apparent affect on data.

102 Sample log: "Top end-cap leak." No apparent affect on data.

STATION 490

135 Sample log: "Spigot leaks - stopped after bottom cap adjusted." No apparent affect on data.

123 Sample log: "Bottom cap leak." No apparent affect on data.

115 Sample log: "Bottom cap and spigot leak." No apparent affect on data.

112 Sample log: "Bottom cap leaked - stopped after adjusted."

109 Sample log: "Top cap leaked air - stopped after cap adjusted."

103 Sample log: "Bottom cap leak - stopped after cap adjusted." Salinity value looks about 0.0028 high compared to adjacent stations. Oxygen and nutrients look OK. Footnote salinity questionable.

STATION 491

135 Sample Log: "Top cap leaked air - stopped after cap adjusted." No affect on data.

121 Sample Log: "Slight leak from bottom cap." No affect on data.

105-109 Phosphate values a little high (0.03 uM/L) when compared with adjacent stations. Analyst's calculations OK. Footnote phosphate uncertain.

STATION 492

125 Sample log: "bottom end-cap leak, as usual." No affect on data.

123 Sample log: "leaking out of bottom." No affect on data.

STATION 493

136 Bottle oxygen value 0.10 ml/l high compared to CTD oxygen and adjacent stations. No analyst notes of problems. Footnote oxygen value questionable.

131 Salinity analyst note: "Low water sample, made manual entry." Salinity value compares well to CTD value and adjacent stations. Salinity value OK.

STATION 494

121 Sample log:"Lanyard caught in top cap." Footnote all bottle sample values bad, bottle leaking.

102 Bottle oxygen value appears 0.02 ml/l lower than CTD oxygen value. Nearly same value as NB3, could be double draw. Footnote oxygen questionable.

101 Oxygen appears 0.03 ml/l high when compared to adjacent stations. However, looks OK compared to CTD oxy value. When adjacent stations overlaid on plots of potential temperature, NO3 or salinity vs oxygen there may be indications of interleaving of water masses. Oxygen value acceptable.

STATION 495

126 Sample log: "Top leaked air - stopped when cap adjusted." No apparent affect on data.

117 Sample log: "Bottom cap leak - stopped when cap adjusted." No apparent affect on data.

STATION 496

135 Sample log: "Big leak when spigot opened - top end cap." No apparent affect on data.

106 Phosphate value a little high (0.02uM). No analytical problems. PI: "Yes, but it satisfies the 1% dictum. I think a '2' would be OK. BW"

105 Phosphate value a little high (0.04uM). No analytical problems. Footnote phosphate questionable.

STATION 497

134 Oxygen value looks too low, same value as NB33. May be double draw. Footnote oxygen value bad. PI: "I agree. NO corresponding anomalies in slt or nuts. Give it the finger of scorn (4). BW" Footnote oxygen bad.

129 Sample log: "Bottom cap leaks." No apparent affect on data.

124 Analyst note: "Low detector voltage." No affect on data.

115 Sample log: "Top cap leaked air - stopped after cap adjusted." No affect on data.

107 Silicate, nitrate and phosphate appear a little low. Oxygen and salinity look OK. PI: "All these nuts are bang on the theta plots for sta 499, and the high values just above are on the theta plots for stations just to the east. Moreover, the theta - oxygen plot for this station shows a jerk toward higher values at sample 107, consistent with lower nuts there. Relatively strong horizontal gradations in oxygen and nuts are to be expected at these levels because of the current patterns and I think that we are just seeing interleaving of 'eastern' and 'western' water here. I think these 107 nuts deserve a '2'. BW"

STATION 498

Cast 2 Sample log: "Thermometer used during oxygen draw giving erratic readings."

227 O2 analyst note: "Flask broken during titration, sample lost."

212 Sample log: "Top cap leaked air - reseated." No apparent affect on data.

201 Bottle oxygen appears 0.02 ml/l low compared to CTD oxygen value and nearby station 497. Next station, 499, has similar offset. No problems with titrations, could be problem with Niskin. Footnote oxygen questionable.

STATION 499

Cast 1 Multiple excess CTD trip levels and CTD signal noise caused by voltage dropouts; CTD trip data edited down to 36 levels based on trip numbers, time and confirmation number. CTD trip data should match actual trip times now.

136 Sample log: "Leaked out of bottom until bottom end-cap reseated." Delta-S is 0.0007 PSU but oxygen value looks 0.07 ml/l high compared to adjacent stations and CTD oxygen. Footnote oxygen questionable.

101 Oxygen value appears 0.05 ml/l low when compared to adjacent stations. Footnote oxygen questionable.

STATION 500

129 Sample log: "Bottom cap leaking - reseated." No affect on bottle data.

115 Sample log: "Leaking from top end cap." No apparent affect on data.

103 Delta-S is -0.0024 PSU. Salinity value is a little low compared to CTD salinity and adjacent stations. Footnote salinity questionable.

STATION 501

135 Sample log: "Top cap leaked air - reseated." No apparent affect on data.

131 Oxygen value looks 0.7ml/l too low when compared to CTDO and adjacent stations. No analyst notes. Footnote oxygen bad.

128 Sample log: "Bottom cap leaked - reseated." No apparent affect on data.

105 Bottle oxygen value 0.02 ml/l higher than CTD oxygen. Variability in oxygen values at adjacent stations for this depth make difficult to compare. Footnote oxygen questionable.

STATION 502

136 Bottle oxygen value 0.06 ml/l higher than CTD oxygen value. Also higher than surface value for adjacent stations, but in situ temperature is about 1 degC cooler. Footnote oxygen questionable.

115 Sample log: "A top-leaker." No affect on bottle data.

101 Sample log: "O2 sample redrawn." Oxygen values OK, consistent with adjacent stations.

STATION 503

129 Sample log: "Bottom end-cap leaking, reset." No affect on bottle Data.

STATION 504

136 CTD voltage dropped during surface trip; CTD trip data

generated using CTD values immediately prior to actual trip time.

129 Sample log: "Bottom cap leak - reseated." No apparent affect on bottle data.

114 Sample log: "Slight leak from bottom cap." No apparent affect on bottle data.

STATION 505

230 Sample log:"NB30 temp was low." Nutrient values all very high, oxygen and salinity values very low. Bottle tripped at wrong depth. Footnote all bottle samples bad, bottle did not trip correctly.

STATION 506

127 Sample log: "Slight bottom end-cap leak." No apparent affect on data.

108 Phosphate value looks 0.03uM high compared to adjacent stations. Analyst notes no problems. PI: "O2 looks correspondingly low here, I don't think I would question the PO4. BW." PO4 value acceptable.

105 Sample log: "O2 sample redrawn." No apparent affect on data.

STATION 507

133 Sample log: "Slight leak around spigot." No apparent affect on data.

110 Sample log: "Slight bottom cap leak - reseated." SiO3 and NO3 values look a little low, salinity and oxygen values are at a local maximum. Salinity and oxygen values track CTD values at this depth. Data OK.

STATION 508

126 Sample log: "Slight bottom cap leak - reseated." Data compares well with CTD parameters and adjacent stations. Bottle data OK.

123 Sample log: "Slight bottom cap leak." Data compares well with CTD parameters and adjacent stations. Bottle data OK.

117 Sample log: "Bottom cap leaked -reseated." Data compares well with CTD parameters and adjacent stations. Bottle data OK.

STATION 509

120 Sample Log: "Top end-cap leaks." No apparent affect on data.

101 Oxygen analyst note: "Bubble." No apparent affect on data.

101-111 CTD processor: "A large signal oscillation compared to upcast and nearby casts, look suspicious." Footnote CTD oxy questionable.

STATION 510

128 Sample log: "Lanyard hooked on recovery, much water lost." Oxygen and salinity values compare well with CTD parameters. Bottle data OK.

117 Sample log: "Wimpy bottom end-cap." No apparent affect on data.

109 Oxygen analyst note: "Forgot acid." Oxygen value less than

zero. Footnote oxygen value bad.

101 Oxygen analyst note: "Low voltage." No affect on oxygen data.

STATION 511

126 Salinity value low compared to CTDSAL and adjacent stations. Delta S = -0.0976 PSU. Footnote salinity questionable.

103 Delta-S is 0.006 PSU. Salinity value high compared to CTD value and adjacent stations. Footnote salinity questionable.

STATION 512

120 Sample log: "Leaking top end cap." No apparent affect on data.

103 Sample log: "Bottom cap leak." No apparent affect on data.

STATION 513

110 Oxygen value appears low compared to adjacent stations. However, value corresponds to local maximum values in nutrients. Data OK, PI agrees.

STATION 514

110 Phosphate, nitrate and silicate appear high, salinity high, corresponding oxygen a little low. Data OK, PI agrees.

STATION 515

128 Oxygen value appears 0.1 ml/l high compared to adjacent stations and CTD oxy value. Footnote oxygen questionable.

112 Sample log: "Top end-cap leak." No apparent affect on data.

109 Sample log: "Top end-cap leak." No apparent affect on data.

101-103 CTD processor: " 0.02 ml/l drop in CTD oxy; low compared to nearby casts and bottle values." Footnote CTD oxy questionable.

STATION 516

126 Sample log: "Slight leak from bottom cap." No apparent affect on data.

STATION 517

122 Sample log: "Bottom end-cap leak." No apparent affect on data.

103 Sample log: "Bottom cap bumped open during nut sampling." No apparent affect on data.

101 Phosphate values in this range appear about 0.03uM high. Analyst notes no problems. Peaks and calculations OK. PI: "These look OK to me in comparison with stas. 518, 519, 520. BW."

STATION 518

103 Footnote all bottle samples bad. Sample log: "Bottom cap leaked - reseated." Salinity value appears 0.006 higher than adjacent stations and CTDSAL. Oxygen may be 0.01ml/l high. Nutrient values also high. Recommend deletion of all values. PI: "I agree - looks like the NB was was

contaminated - reject all values (4). BW."

STATION 521

126 Sample log: "NB26 is a bottom leaker!" No apparent affect on data.

113 Sample log: "Spigot on 13 still sucks." No apparent affect on data.

101 CTD processor: "CTD oxy signal rises until 0.03 ml/l high compared to bottle and nearby casts at bottom." Footnote CTD oxy questionable.

STATION 522

124 Delta-S is 0.081 PSU. Salinity value high compared to CTD value and adjacent stations. Footnote salinity questionable.

122 Sample log: "Bottom cap leak - stopped when reseated." No apparent affect on data.

113 Sample log: "Lanyard caught in hose clamp - bottom didn't close - empty bottle." No samples for NB13.

103 Sample log: "Bottom cap leak - stopped when reseated." No apparent affect on data.

STATION 523

103 Sample log: "Bottom cap leak - reseated." No apparent affect on data.

STATION 526

131 CTD processor: "CTD oxy 0.10 ml/l low compared to bottle and nearby casts." Footnote CTD oxy questionable.

127 Sample log: "NB27 slight bottom end-cap leak, OK after reseating." No apparent affect on data.

117 Sample log: "Spigot on 17 sucks." No apparent affect on data. NB17 and NB18 have same oxygen value, but are consistent with CTDOXY.

STATION 528

128 CTD processor: "CTD oxy 0.10 ml/l low compared to bottle and nearby casts." Footnote CTD oxy questionable.

STATION 529

130 Bottle oxygen appears 0.04 ml/l high compared to surface bottles in adjacent stations and to CTD oxygen value. Footnote oxygen questionable.

STATION 530

126 Sample log: "Slight leak from bottom cap -reseated." No apparent affect on data.

122 Sample log: "Slight leak from bottom cap -reseated." No apparent affect on data.

STATION 531

130 Sample log: "Slight bottom cap leak -reseated." No apparent affect on data.

128 Sample log: "Slight bottom cap leak -reseated." No apparent affect on data.

102 Oxygen value appears 0.03 ml/l high compared to adjacent stations and CTD oxygen. Footnote oxygen value questionable.

101 Oxygen value appears 0.5ml/l low compared to adjacent stations and CTDOXY. Draw temp high. Salinity and nutrients OK. Footnote oxygen value bad.

STATION 532

114 Sample log: "Bottom end-cap needed reseating." No apparent affect on data.

STATION 533

128 Sample log: "Bottom end-cap reseated to stop leak." No apparent affect on data.

STATION 534

114 Sample log: "O2 flask 840 cap doesn't fit tight into flask." Oxygen data OK.

102 Nitrate value appears 0.1 uM/L low compared to adjacent stations. Analyst notes no problems. Value within specifications.

STATION 535

135 Sample log: "Slight top cap leak -reseated." No apparent affect on bottle data.

135-136 CTD processor: "CTD oxy still nearly 0.10 ml/l low compared to nearby casts and 58 db bottle after offset." Footnote CTD oxy questionable.

128 Sample log: "Slight bottom leak -reseated." No apparent affect on data.

126 Sample log: "Slight top cap leak -reseated." No apparent affect on data.

STATION 536

128 Sample log: "Usual bottom end-cap complaint." No apparent affect on data.

STATION 537

Cast 1 Console Log: "NO-confirm on every trip, NB7 - NB36: re-initialized/manually repositioned pylon for each bottle. At surface, btls 10,11,28 open: 10,11 not repositioned after re-initialization, 28 probably wrong bottle number entered when repositioning. Bottles tripped probably match planned depth; new pylon power supply installed after cast."

128 Sample log: "Open at retrieval." No samples.

126 Sample log: "Leaks from spigot when vent opened." No affect on bottle data.

111 Sample log: "Open at retrieval." No samples.

110 Sample log: "Open at retrieval." No samples.

101-109 PI: "The deep nutrients (101-109) are striking, but they are so chemically and regionally consistent with the equally striking, and independently measured, salinity and oxygen, that I think the measurements are rock solid, and not to be doubted."

STATION 538

126 Analyst notes oxygen sample missing, not reported.

123 Sample log: "Bottom cap leaks." No apparent affect on data.

STATION 541

105 Sample log: "Bottom cap leaked -reseated." No affect on data.

STATION 542

122 Analyst note: "Over titrated." Oxygen value appears 0.1ml/l high compared to CTDOXY and adjacent stations. Footnote oxygen sample bad.

103 Phosphate value appears 0.03uM high, nitrate 0.3uM low when compared to adjacent stations. Analyst notes peaks and calcs OK. Footnote phosphate and nitrate uncertain.

STATION 543

135 Sample log: "Leaks, looks like bad o-ring seal on top." No affect on data.

STATION 544

Cast 1 Salinity analyst's log: "Salinity samples allowed to equilibrate for 3 days before run on salinometer." No apparent affect on data.

108 Bottle oxygen value appears 0.02 ml/l high on overlays with adjacent stations and CTD oxygen. No analyst notes. Footnote oxygen questionable.

STATION 545

135 Sample log: "Leaky bottles." No apparent affect on data.

125-126 CTD processor: "CTD oxy up to 0.15 ml/l lower than bottles, nearby casts." Footnote CTD oxy questionable.

124 Sample log: "Bottom cap leaks." No apparent affect on data.

122 Sample log: "Bottom cap leaks -reseated." No apparent affect on data.

110 Oxygen value appears 0.07ml/l low compared to CTDOXY PI:"Yes, but it's right on the temp. vs oxygen plot for stations 546 - 548." But when overlaid with station 544 at this depth, a progression from higher oxygen to lower is sequentially seen, with 545 having an intermediate value. Therefore NB10 should be a little higher, more in agreement with CTD oxygen. Footnote oxygen questionable.

STATION 546

114 Sample log: "Slight bottom cap leak -reseated." No apparent affect on data.

110 Sample log: "Top cap leaked air -reseated." No apparent affect on data.

STATION 547

122 Sample log: "Slight end-cap leak." No apparent affect on data.

114 Sample log: "Slight end-cap leak." No apparent affect on data.

STATION 548

136 CTD processor: "CTD oxy 0.10 to 0.15 ml/l low relative to nearby casts." Footnote CTD oxy questionable.

133 Sample log: "Slight end-cap leak." No apparent affect on data.

129 Sample log: "Slight end-cap leak." No apparent affect on data.

114 Sample log: "Slight end-cap leak." No apparent affect on data.

101-106 CTD processor: "CTD oxy 0.02 ml/l low, then high, compared to bottles and nearby casts." Footnote CTD oxy questionable.

STATION 549

133 Sample log: "Bottom cap leaks badly -reseated." No apparent affect on data.

126 Sample log: "Bottom cap leaks -reseated." No apparent affect on data.

123 PI:"Anomalously low salinity matched by anomalously high O2 -just a lump of 'newer' Antarctic Intermediate Water."

114 Sample log: "Bottom cap leaks -reseated." No apparent affect on data.

110 Sample log: "Slight top cap leak." No apparent affect on data.

109 Sample log: "Bottom cap leaks -reseated." No apparent affect on data.

101-104 CTD processor: "CTD oxy signal rises until 0.10 ml/l high compared to bottle oxygen." Footnote CTD oxy bad.

STATION 550

131 PI: "Here I think that we are seeing again that shallow, fresh, oxygen-poor, nutrient-rich tropical water from the S. Equatorial Current that caught our attention much farther east.BW."

122 Sample log: "Bottom cap leaks -reseated." No apparent affect on data.

112 Sample log: "Top cap leaks -reseated." No apparent affect on data.

STATION 551

121 Sample log:"Lanyard hung up, top cap open." All sample values look bad. Footnote all samples bad, bottle leaking.

STATION 552

122 Sample log: "Bottom cap leaks." No apparent affect on data.

101 Oxygen value appears 0.02 ml/l low when compared to CTD oxygen and stations 551 and 553 on potential temperature vs oxy overlays. However, value is within 0.01 ml/l on the reoccupation station, 572. Footnote oxygen questionable.

STATION 553

131 Sample log:"NB31 leaking ever so slightly." No apparent affect on data.

101 CTD processor: "CTD oxy bulges 0.02 ml/l high near bottom compared to nearby casts and station 571 (at same location)." Footnote CTD oxy questionable.

STATION 554

122 Sample log: "Leaking out bottom -wouldn't stop." No apparent affect on data.

101 Oxygen value appears 0.02 ml/l low compared to CTD oxygen value and stations 553 and 556. Overlays of pot temp vs oxygen show a similar shaped curve, and divergence from CTD oxygen, on stations 552, 554 and 555. On station 570, a reoccupation of the same location, the oxygen value is 0.01 ml/l higher. No analyst notes and titrations look good. Footnote oxygen questionable.

STATION 555

126 Sample log:"Bottom cap leaks." No apparent affect on data.

101 Oxygen value appears 0.02 ml/l low compared to CTD oxygen value and stations 553 and 556. Overlays of pot temp vs oxygen show a similar shaped curve, and divergence from CTD oxygen, on stations 552, 554 and 555. However, oxygen value on station 569, a reoccupation of the location, is within 0.001 ml/l. No analyst notes and titrations look good. Footnote oxygen questionable.

STATION 556

135-136 CTD processor: "CTD oxy bulges low relative to nearby casts and sta 568 (same position)." Footnote CTD oxy questionable.

126 Sample log:"Bottom cap leaks -reseated." No apparent affect on data.

106 Sample log:"Vent open." No apparent affect on data. Oxygen value OK compared to adjacent stations, but a little high (0.02 ml/l) compared to CTD oxy.

105 Sample log:"Vent open." No apparent affect on data. Oxygen value OK compared to adjacent stations, but a little high (0.02 ml/l) compared to CTD oxy.

105-107 CTD processor: "CTD oxy fits 0.03 ml/l low compared to bottles, OK compared to sta 555 and sta 568." Footnote CTD oxy OK.

101-103 CTD processor: "CTD oxy fits 0.02 ml/l high at bottom compared to bottle values, station 555 and station 568 (at the same position)." Footnote CTD oxy questionable.

STATION 558

130-131 CTD processor: "CTD oxy bulges low relative to nearby casts and station 566 (at same position)." Footnote CTD oxy questionable.

101-114 PI: "On theta plot the nitrates look a touch low (but not out by > 1%); might some adjustment to the standardization be in order? BW." Nitrate values within WOCE specifications, data OK.

STATION 559

126-127 CTD processor: "CTD oxy bulges low relative to nearby casts and station 565 (at same position)." Footnote CTD oxy questionable.

111 Sample log: "Bottom cap leaks." No apparent affect on data.

STATION 560

122 Sample log:"Leaking from bottom end-cap." Small delta-s, leak caused no apparent affect on data.

STATION 562

105 All nutrient samples look high compared to adjacent stations. Values are same as NB4, could be a accidental double draw. Footnote nitrate, nitrite, phosphate and silicate bad.

STATION 563

Cast 1 Sample log: "Oxygen and salinity only samples drawn."

107 Sample log: "Leaking from top -pretty big air leak." Small delta-s, no apparent affect on data.

STATION 564

Cast 1 Sample log: "Oxygen and salinity only samples drawn."

110 Bottle oxygen appears 0.1 ml/l high compared to CTD oxy value and surface values from nearby stations. Footnote oxygen questionable.

STATION 565

Cast 1 Sample log: "Oxygen and salinity only samples drawn."

STATION 566

Cast 1 Sample log: "Oxygen and salinity only samples drawn."

102 Oxygen value appears 0.04 ml/l high compared to CTD oxygen. Overlays with adjacent stations not helpful but comparison with station 558, the reoccupation twin station, is even more divergent. CTD oxy value from 3080 db to 3564 db also appears higher than station 558 but with few bottles, fit is uncertain. Footnote CTD oxy and bottle oxy questionable.

STATION 567

Cast 1 Sample log: "Oxygen and salinity only samples drawn."

STATION 568

Cast 1 Sample log: "Oxygen and salinity only samples drawn."

STATION 569

Cast 1 Sample log: "Oxygen and salinity only samples drawn."

STATION 570

Cast 1 Sample log: "Oxygen and salinity only samples drawn."

STATION 571

Cast 1 Sample log: "Oxygen and salinity only samples drawn."

106-107 Oxygen Analyst note: "Bubble in sample." No apparent affect on oxygen data.

101-103 Oxygen Analyst note: "Bubble in sample." No apparent affect on oxygen data.

STATION 572

Cast 1 Sample log: "Oxygen and salinity only samples drawn."

STATION 573

Cast 1 Sample log: "Oxygen and salinity only samples drawn."

112 Bottle oxygen is 0.02 ml/l high when compared to CTD oxygen value, stations 551, 571 and 572. Footnote oxygen questionable.

WHPO DATA PROCESSING:

Date	Contact	Data Type	Data Status Summary
8/15/97	Uribe	DOC	Submitted See Note: 2000.12.11 KJU

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

2000.10.11 KJU
Files were found in incoming directory under whp_reports. This directory was zipped, files were separated and placed under proper cruise. All of them are sum files. Received 1997 August 15th.

Date	Contact	Data Type	Data Status Summary
1/23/98	Rutz	SUM/SEA/CT	Preliminary, not for DQE
7/29/98	Johnson	CTD	Data with ODF

Est. date of ODF processing 8/98

Date	Contact	Data Type	Data Status Summary
12/22/98	Nowlin, Jr.	CTD/BTL	Data are Public
1/15/99	Muus	SUM	Data Update
1/22/99	Nowlin, Jr.	CTD/BTL/TRA	Data are Public
3/2/99	Bartolacci	CFC-11:12	Data Merged/OnLine I've

merged updated cfc-11/12 values (from Ray Weiss) into the i03 316N145_8 bottle data file, and updated the table accordingly.

Date	Contact	Data Type	Data Status Summary
3/3/99	Diggs	CFCs	Data Update see note:

units are PMOL/KG (instead of PMOL/L) Header now indicates that the units are PMOL/KG (instead of PMOL/L).

Date	Contact	Data Type	Data Status Summary
4/23/99	Nowlin, Jr.	DOC	Data Requested by Linda Huyhn

(e-version of 12/95 or later doc)

Date	Contact	Data Type	Data Status Summary
9/29/99	Falkner	BA	Data Update See note:

The quality of the Ba data from most WOCE legs in the Indian Ocean turned out to be quite poor; far worse than attainable analytical precision (+/-20% as opposed to 2%). We recorded many vials which came back with loose caps and evaporation associated with that seems to be the primary problem.

The only hope I have of producing a decent data set is to run both Ba and a conservative element simultaneously and then relating that to the original salinity of the sample. We will be taking delivery on a high resolution ICPMS here at OSU sometime this winter which would make the project analytically feasible and economical. I do not presently have the funds in hand to do this and so have archived the samples for the time being. I don't think the WHPO would derive any benefit from the present data set.
KKF

Date	Contact	Data Type	Data Status Summary
11/8/99	Kozyr	ALKALI/TCARBN	Final Data Rcvd @ WHPO

I have put the final CO2-related data file for the Indian Ocean WOCE Section I3 to the WHPO ftp INCOMING area. There are two CO2 parameters: Total CO2 and alkalinity with quality flags.

2/14/00 Kozyr TCARBN/ALKALI DQE Complete
I've just put a total of 13 files [carbon data measured in Indian (6 files) and Atlantic (7 files) oceans] to the WHPO ftp area. Please let me know if you get data okay.

6/2/00 Uribe HELIUM/NEON Final Data Rcvd @ WHPO
Files received were i3HeNe.DOC* i3HeNe.SEA*. Files contain no header, No related email was found. Could not determine who sent these files.

7/21/00 Bartolacci CFCs/CO2 Website Updated
cfc data merged into online file The I03 bottle file from ODF has been remerged with existing cfc data and carbon data from Alex Kozyr. New file has passed diagnostic formatting routiness and has replaced the current online bottle file. ODF sum file has also replaced current online sumfile. Table and index refs have been edited to reflect this change.

7/27/00 Diggs CTD Website Updated
Final data online CTD online and on CD2.0 site have been replaced with FINAL data from ODF (M. Johnson - Sept. 1998) All expocodes are now in the new format (without '/') and all tables and files have been updated.

8/1/00 Huynh DOC Website Updated
pdf, txt docs online

8/1/00 Kappa DOC Doc Update
pdf, txt versions created pdf needs reformatting, txt needs odf report inserted.

10/17/00 Jenkins TRITUM Submitted Preliminary
*Files for Tritium Data:

WOCE Indian Ocean = WITrit.dat Contains all legs
WOCE Pacific P10 = WP10Trit.dat
WOCE Pacific P13 = WP13Trit.dat
WOCE Pacific P14c = WP14cTrit.dat
WOCE Pacific P18 = WP18Trit.dat
WOCE Pacific P19 = WP19Trit.dat
WOCE Pacific P21 = WP21Trit.dat
SAVE South Atlnt = SAVETrit.dat

*Column Layout as follows: Station, Cast, Bottle, Pressure, Tritium, ErrTritium

*Units as follows: Tritium and ErrTritium in T.U.

*All data are unfortunately still preliminary until we have completed the laboratory intercomparision and intercalibration that is still underway.

10/17/00 Jenkins HELIUM/DELHE3 Submitted Preliminary
HELIUM, DELHE3, NEON *Files for Helium and Neon Data:

WOCE Indian Ocean = WIHe.dat Contains all legs
WOCE Pacific P10 = WP10He.dat
WOCE Pacific P18 = WP18He.dat
WOCE Pacific P19 = WP19He.dat
WOCE Pacific P21 = WP21He.dat

*Column Layout as follows:

Station, Cast, Bottle, Pressure, Delta3He, ErrDelta3He, ConcHelium, ErrConcHelium, ConcNeon, ErrConcNeon

*Units as follows:

Delta3He and ErrDelta3He in %
ConcHelium, ErrConcHelium, ConcNeon, and ErrConcNeon in nmol/kg

*Null values (for ConcNeon and ErrConcNeon only) = -9.000

*All data are unfortunately still preliminary until we have completed the laboratory intercomparision and intercalibration that is still underway.

11/8/00 Anderson HELIUM/NEON Reformatted by WHPO See Note:
I have put the Jenkins helium and neon in WOCE format. There were no quality codes so I set the HELIUM, DELHE3, and NEON to 2.

11/13/00 Anderson TRITUM Reformatted by WHPO See Note:
I have put the Jenkins tritium data into WOCE format. There were no quality codes so I set the TRITUM to 2.

2/7/01 Mantyla NUTs/S/O DQE Begun Hi Jim,
Sure, I would be glad to look over the Indian Ocean data for you. Sarilee has started plotting up I01 for me to start on. - Arnold

2/26/01 Schlosser Helium Deep Data are Public minor corrections may be needed post-intercal. effort following up on bill jenkins's message, i would like to ask you to make public all ldeo woce tritium/he data that have been submitted to you. because the tritium/he community has not yet finished the final calibration of the data, i might have to apply minor corrections to these data once the intercal. effort has been completed. our acce work was funded over a 5-year period that ended in 2000. consequently, this data set is further behind in quality control before submission, but i expect that we will get these data ready soon.

SR3 was never funded in a 'regular' fashion, but i used noaa corc funds to keep the measurements of this sample set moving. i expect to finish the analyses this summer and submit them in fall.
2/26/01 Jenkins He/Tr/Ne Data are Public See Note: It was brought to my attention that the WOCE Pacific/Indian He-Tr data was not as yet made public. After submitting it to you last year, I had intended on going through it one more time to ensure there were no problems with it. Unfortunately, I have not had the time to do this. Is it possible, therefore, to release it as public data, and if there are any subsequent minor revisions, to make changes? I suspect there might be a few samples in the set that might have got through our initial quality control.

3/20/01 Key RADIUM DQE Pending Not likely to happen,
My group collected radium samples on several WOCE legs in the hope of being able to analyze them "in the background". We never received any funding for this work and the analytical capability no longer exists at P'ton. It is safe to assume that nothing will ever come from this effort. For those sample collection efforts currently recorded in WOCE bottle files, the simplest thing would be to drop the column altogether. Lacking that, all recordings on U.S. legs can be flagged
5.

3/23/01 Falkner BA No Data Submitted See Note:
The quote of mine (9/29/99) about the Ba WOCE data summarizes the present status. I have not received supplementary funding to re-run the samples in a manner that includes an index element that could be related to the original salinity values. They are all archived here with the hope that it could happen at some point. It's a hard sell the the funding agents unfortunately.

4/5/01 Walden DOC Data Request Navigation Report

4/5/01 Caldwell DOC Submitted ADCP Report

6/19/01 Swift CTDTMP Update Needed See Note:
An oceanographically-insignificant error in CTDTMP data for this cruise has been found (ca. -0.00024*T - 0.00036 degC). A data update is forthcoming.

6/21/01 Uribe CTD/BTL Website Updated CSV File Added
CTD and bottle exchange files were put online. These are NOT the Updated CTD files referred to by J Swift on 6/19/01.

7/12/01 Kappa DOC Updated PDF Cruise Report
Added sections on Navigation/Bathometry and Hull Mounted ADCP; added figures, linked index page to locations in text, linked figures to locations in text, added WHPO data history record.

7/13/01 Kappa DOC Updated TXT Cruise Report
Added sections on Navigation/Bathymetry, ADCP and Meteorological

Observations; added WHPO data history record.