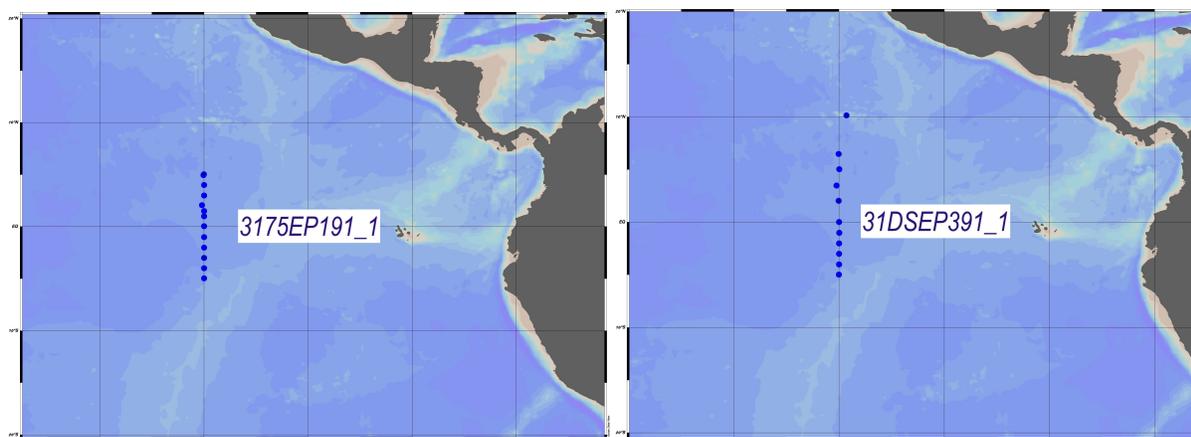


A. CRUISE REPORT: PR16

A REPEAT HYDROGRAPHIC SECTION ALONG 110W

(Updated OCT 2021)



A.1 Highlights

Cruise Summary Information

Section Designation	PR16			
Expedition designation (ExpoCodes)	Leg 1: 31MBEP191_1 Leg 2: 31DSEP391_1			
Chief Scientists	Linda J. Mangum / NOAA			
Dates	Leg 1: March 23 to April 19, 1991 Leg 2: October 15 to November 13, 1991			
Ship	Leg 1: RV <i>Malcolm Baldrige</i> Leg 2: RV <i>Discoverer</i>			
Ports of call	Leg 1: Rodman Naval Base, Panama to Honolulu, HI Leg 2: Seattle, WA to Honolulu, HI			
Geographic Boundaries	5.0407 -110.2005	-109.9898	10.1585 -110.2537	-109.291 -4.9797
Stations	Leg 1: 21		Leg 2: 26	
Floats and drifters deployed	Leg 1: 5 AOML satellite tracked surface drifting buoys Leg 2: 6 AOML satellite tracked surface drifting buoy			
Moorings deployed or recovered	Leg 1: 3 ATLAS moorings were recovered and redeployed 1 new mooring deployed			

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A.2 CRUISE SUMMARY

Cruise Tracks

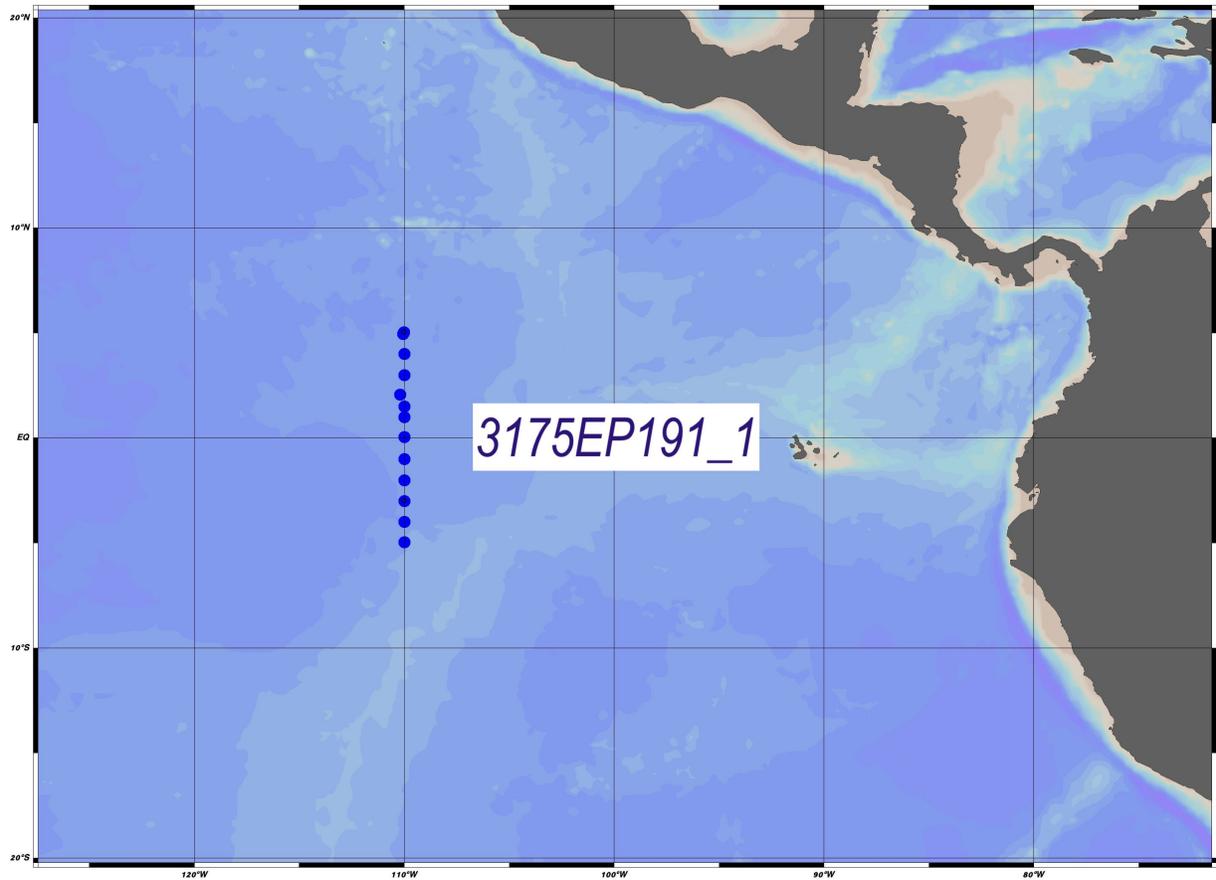


Figure 1 shows the cruise track and CTD/rosette station locations for 31MBEP191/1.

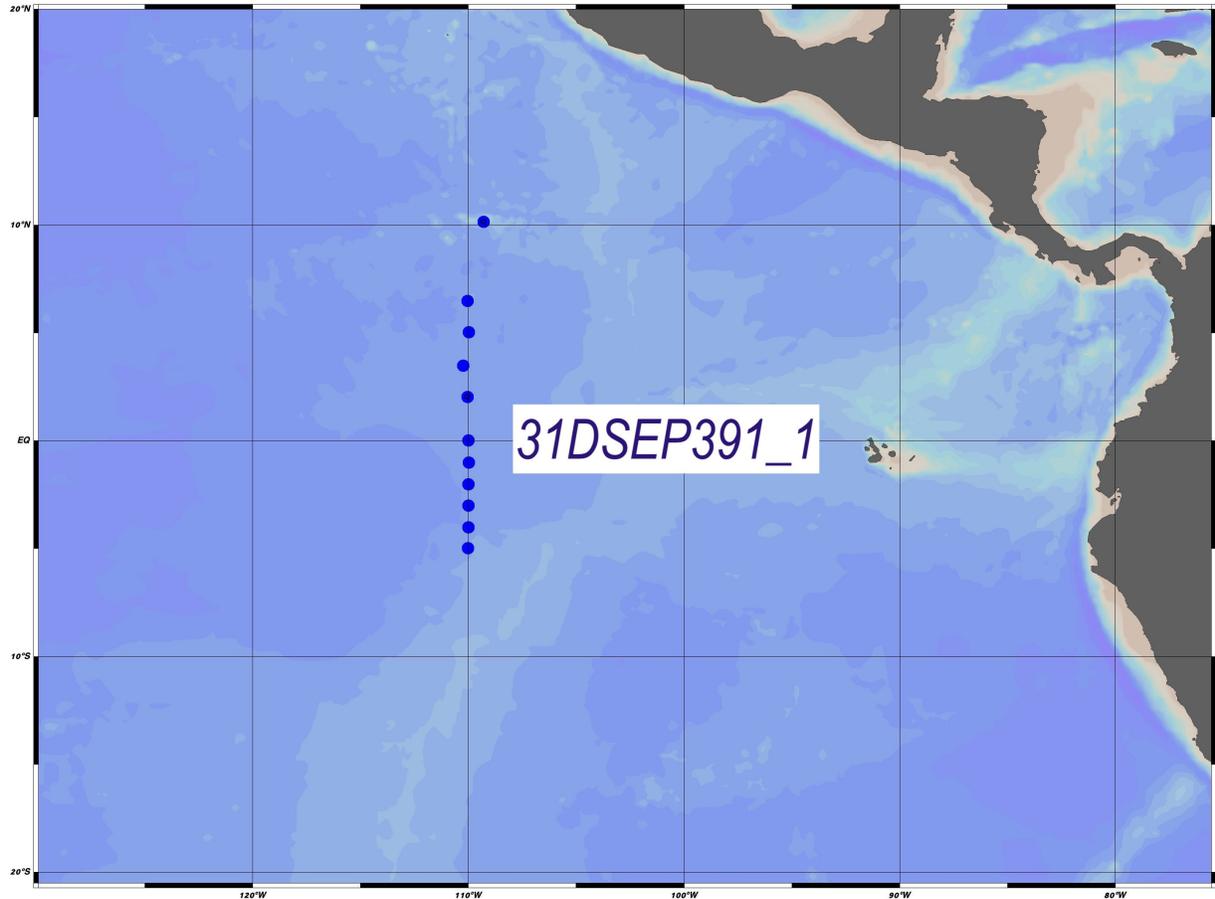


Figure 2 shows the cruise track and CTD/rosette station locations for 31DSEP391/1.

Number of Stations

A total of 21 CTD/rosette profiles were collected on leg 1 of the spring EPOCS cruise (31MBEP191/1) using a Neil Brown Mark IIIb CTD equipped with a Beckman oxygen sensor, and General Oceanics 12 bottle rosette equipped with 12 10-liter Niskin water sample bottles. Thirteen of the 21 profiles were collected along 110W from 5S to 5N.

Twenty-six CTD/rosette profiles were collected on leg 1 of the fall EPOCS cruise (31DSEP391/1) using a Neil Brown Mark IIIb CTD, and General Oceanics 12 bottle rosette equipped with 12 10-liter Niskin water sample bottles. Fourteen of the 26 profiles were collected along 110W from 5S to 10N.

Sampling

Usually, 8 of the 12 Niskin water sample bottles were sampled for salinity and dissolved oxygen analysis each cast during 31MBEP191/1, with a duplicate salinity sample taken from the deepest bottle to monitor the drift of the Autosal instrument. Nominal sampling depths were 1000, 900, 800, 700, 500, 250, 100, and 0 meters. Fifteen casts were to a depth of 1000 meters, 3 casts were to within 200 meters of the bottom, and 3 casts were to 500 meters.

During 31DSEP391/1, all 12 Niskin bottles were sampled for salinity each cast, with a duplicate salinity sample taken from the deepest bottle to monitor the drift of the Autosol instrument. Nominal sampling depths were 1000(2), 900, 800, 700, 600, 500, 400, 250, 100, and 0(2) meters. Twenty casts were to a depth of 1000 meters, 3 casts were to within 200 meters of the bottom, and 3 casts were to 500 meters.

Floats and Drifters

Five AOML satellite tracked surface drifting buoys (Low Cost Tropical Drifters) were deployed during 31MBEP191/1 at 6N, 85W; 6.3N, 90W; 6N, 95W; 0N, 110W; and 0N, 125W. Six AOML drifting buoys were deployed during 31DSEP391/1 at 2N, 0N, and 2S along 110W, 2S and 0N along 125W, and at 0N, 140W.

Moorings

Three ATLAS moorings were recovered and redeployed along 110W at 5N, 2N, and 5S during 31MBEP191/1 and a new mooring deployed at 0N, 125W. Visual inspections were made of an ATLAS mooring at 2S, 110W and a current meter mooring at 0N, 110W. Both moorings looked fine with no signs of vandalism.

Beginning 31DSEP391/1, a pressure/temperature gauge (PTG) was recovered and deployed in approximately 110 feet of water off Clipperton Island at approximately 10N, 110W. ATLAS moorings were deployed at 8N (new site), 2N (redployment), and 2S (recovery and redeployment) along 110W. ATLAS moorings at 5N and 5S were inspected and found to be in good condition. ATLAS moorings were also deployed at new sites at 5S and 2S along 125W and the ATLAS mooring at 0N, 125W was visited. Equatorial current meter moorings were recovered and redeployed at 110W and 140W.

A.3 LIST OF PRINCIPAL INVESTIGATORS

Dr. Stan Hayes, NOAA/PMEL	ATLAS moorings, CTD
Dr. Mike McPhaden, NOAA/PMEL	current meter moorings
Dr. Dave Behringer, NOAA/AOML	drifting buoys
Dr. Don Hansen, NOAA/AOML	drifting buoys
Dr. David Ainley, PRBO	bird observations

Abbreviations

NOAA National Oceanic and Atmospheric Administration
 PMEL Pacific Marine Environmental Laboratory, Seattle, WA
 AOML Atlantic Oceanographic and Meteorological Laboratory, Miami, FL
 PRBO Point Reyes Bird Observatory, Point Reyes, CA

A.4 SCIENTIFIC PROGRAMME AND METHODS

The NOAA-sponsored EPOCS research program is designed to further understanding of the role of the tropical ocean in modifying the world's climate. A primary goal of this research is to investigate the dominant mechanisms that produce large scale, interannual variations of sea surface temperature in vast regions of the tropical Pacific Ocean. Studies indicate that such sea surface temperature anomalies are linked to perturbations in the mid-latitude atmospheric pressure fields and hence to weather.

Ocean currents play an important role in determining the local temperature change through heat advection. Therefore, an associated goal of the program is to study the horizontal, vertical and temporal variations of the currents and how they are affected by the wind field. Variability in currents, temperature, and winds are studied using numerous techniques including current meter moorings, thermistor chain moorings (ATLAS), underway acoustic doppler current profiling (ADCP), CTD profiles, drifting buoys, and other shipboard physical oceanographic and meteorological measurements.

The primary objectives of 31MBEP191/1 and 31DSEP391/1 cruises were to maintain the array of near-equatorial ATLAS and current meter moorings along 110W and 125W in the eastern tropical Pacific, and to conduct hydrographic measurements in the area.

Temperature and salinity sections along 110W for 31MBEP191/1 (figures 5 and 6) show a strong equatorial undercurrent in the upper 100 meters between 1S and 1N, with the 25C isotherm breaking the surface near the equator. The two subsurface countercurrents are evident between 3 and 5 degrees on either side of the equator. Strong westward flow of the South Equatorial Current is seen off the equator. An oxygen section for 31MBEP191/1 is given in figure 7. Temperature and salinity sections along 110W for 31DSEP391/1 (figures 8 and 9) show warm water throughout the section, with surface water warmer than 25C north of 2N and a well-developed thermocline deeper than usual, with the 15C isotherm deeper than 100 meters equatorward of +/- 3. The equatorial undercurrent appears well developed near the equator.

A description of the methods of measurement, calibration and processing of the NBIS CTD/O₂ data is given in section C.3 of this report.

A.5 PROBLEMS ENCOUNTERED ON THE CRUISE

Most shipboard equipment worked well throughout 31MBEP191/1, although the thermosalinograph stopped working on April 16 when the VAX DECServer failed. There were no rosette misfires noted during the cruise, however the 500 meter bottle for cast 11 at 1S, 110W did not close and no samples were collected. Also, the first 42 meters of data for cast 11 were lost due to operator error.

During 31DSEP391/1, the CTD conducting cable was reterminated prior to cast 13 at 5S, 110W due to intermittent spiking in the pressure channel and a broken strand on the outer armour about 5 meters above the mechanical termination. After the cable was reterminated, no further problems were observed. All other shipboard equipment worked well throughout the cruise.

A.6 OTHER INCIDENTS OF NOTE

A.7 LIST OF CRUISE PARTICIPANTS

31MBEP191/1

Ms. Linda Mangum, NOAA/PMEL	Chief Scientist, ATLAS moorings, CTDs
Mr. John LoConte, NOAA/PMEL	ATLAS moorings
Mr. Doug Fenton, NOAA/PMEL	current meter moorings
Mr. Dennis Holzer, NOAA/PMEL	current meter moorings
Mr. Larry Spear, PRBO	bird observations
Ms. Nina Karnovsky, PRBO	bird observations
Mr. Phil Henderson, PRBO	bird observations

31DSEP391/1

Ms. Linda Mangum, NOAA/PMEL	Chief Scientist, ATLAS moorings, CTDs
Mr. David Root, NOAA/PMEL	ATLAS moorings
Mr. Doug Fenton, NOAA/PMEL	current meter moorings
LT. Dave Zimmerman, NOAA/PMEL	current meter moorings
Mr. Larry Spear, PRBO	bird observations
Mr. Ian Gaffney, PRBO	bird observations

B. UNDERWAY MEASUREMENTS

B.1 XBT

XBT measurements were made in accordance with SEAS instructions (5.2.1). XBT data was collected and transmitted via the ship's SEAS unit. For each XBT cast, the following information was recorded on log sheets: wind direction, wind speed, barometric pressure, air temperature, bucket temperature, intake temperature, time, and ship's position.

B.2 ADCP

A ship-mounted ADCP system was used to continuously measure the currents in the upper ocean along each trackline. Ship personnel operated the ADCP system and continuously logged data during the entire cruise. The NOAA ship Malcolm Baldrige provided a fully operational Magnavox 1102 TRANSIT/GPS navigator with an atomic frequency standard integrated into the ship's Scientific Computer System (SCS) data collection system. For backup navigation, the ship provided a Magnavox 1105 OMEGA/TRANSIT satellite navigator with a remote ship speed input. The SCS data acquisition and logging system has become the sole method of logging navigation data on the NOAA ship Malcolm Baldrige and was fully operational at all times.

Aboard the NOAA ship Discoverer, the ADCP was interfaced with a Magnavox GPS navigator and received data at 2 second intervals through the selection of code 208, data control option 1. Intermittent problems with the gyro during 31DSEP391/1 eventually resulted in the loss of the gyro on November 4th for the remainder of the cruise. This impacted ADCP operations as no data were collected for the period that the gyro was down due to problems interpreting the data without the gyro input.

B.3 SST AND SSS

Near sea surface temperature (SST) and salinity (SSS) measurements were recorded continuously each cruise using a thermosalinograph. A bucket sample was collected with each XBT and the record annotated by date/time group and bucket temperature. Bucket samples were also taken hourly while underway during daylight hours and analyzed for SST and SSS.

B.4 STRUCTURE OF EQUATORIAL SEABIRD COMMUNITIES

(L. Spear)

Seabird observations were conducted from the flying bridge during daylight hours while the ship was underway. While the ship was stopped for mooring/CTD operations, PRBO scientists could be launched in the ship's Zodiak at the discretion of the Commanding Officer to collect samples.

The goals of this piggyback project were to relate seabird species assemblages to water masses in the eastern tropical Pacific, and to analyze patterns in distribution and ecology of these avifaunas in order to reveal structuring factors. Main activities included: 1) censusing seabirds to determine each species density, patchiness, and associations with other species and with foraging opportunities presented by predatory fish, 2) gathering data on sea surface temperature, salinity, depth and slope of the thermocline

for each census period; 3) collecting seabirds for diet analysis and measurement of aerodynamic morphology; and 4) photographing seabirds for visual aid in the presentation of results.

During 31MBEP191/1, 425 half-hour transects were conducted and 37 specimens of 5 major species at four locations were collected. Also, three neuston tows and one bongo tow were completed for the collection of 17 samples for use in seabird diet analysis. During 31DSEP391/1, 360 half-hour transects were conducted within 20 degrees latitude of the equator, 20 specimens of 5 major species at two locations were collected, and 5 rolls of 36-exposure film were exposed at four other locations.

C. DESCRIPTION OF MEASUREMENT TECHNIQUES AND CALIBRATIONS

C.1 Sample Salinity Measurements

The salinity analysis of samples was carried out exclusively on Guildline Autosol salinometers (model 8400A). The instruments were operated in the ship's constant temperature laboratory at a bath temperature of 24C. Standardization was effected by use of IAPSO Standard Seawater batch P1??. The commonly accepted precision of the Autosol is 0.001 psu, with an accuracy of 0.003 psu. The Autosols were standardized before and after each run. The drift during each run was monitored and individual samples were corrected for the drift during each run by linear interpolation. Bottle salinities were compared with computed CTD salinities to identify leaking bottles, as well as to monitor the conductivity sensor performance and drift.

C.2 Sample Oxygen Measurements

240 bottle oxygen samples were taken in calibrated clear glass bottles during 31MBEP191/1. Analysis followed the Winkler whole bottle method. Dissolved oxygen measurements were not made on 31DSEP391/1.

C.3 CTD Measurements

Equipment

The spring EPOCS cruise (31MBEP191/1) underwater package was comprised of a Neil Brown Mark IIIb CTD equipped with a Beckman oxygen sensor, a General Oceanics 12 bottle rosette, 12 10-liter Nisken water sample bottles, and a Benthos 12 kHz pinger mounted on a 12-bottle frame low and opposite the CTD sensors. A .322-inch diameter conducting cable was used on an Interocean winch to lower and raise the package at typical rates of 30 m/min from 0-50 m, 45 m/min from 50-200 m, 60 m/min greater than 200 m, and a maximum of 50 m/min during the upcast. Data from the underwater unit was transmitted in real time to a shipboard data terminal through the 3-conductor electro-mechanical cable in TELETYPE (TTY) format using a frequency shift key (FSK) modulated signal superimposed on the DC power supplied to the underwater unit. A Neil Brown Mark III deck unit received the data at 5000 baud, demodulated and converted it to a 9600 baud RS-232 serial compatible data stream. As a backup, the original audio FSK CTD data signal was recorded on video cassette tapes. A General Oceanics rosette 1015 deck unit was used to close the water sample bottles.

A similar underwater package was used during the fall EPOCS cruise (31DSEP391/1), however there was no oxygen sensor installed on the CTD. Like cable was used on a Markey winch with the same typical lowering rates. Standards and Pre-cruise Calibrations

The EG&G conductivity sensor has a range of 1 to 65 mmho, an accuracy of +/- 0.005 mmho, resolution of 0.001 mmho, and stability of 0.003 mmho/month. The Rosemount platinum thermometer has a range of -32 to 32 C, an accuracy of +/-0.005 C (-3 to 32 C), resolution of 0.0005 C, and stability of 0.001 C/month. The Paine pressure sensor has a range of 0 to 6500 db, an accuracy of +/- 6.5 db, resolution of 0.1 db, and stability of 0.1%/month.

Pre-cruise calibrations for 31MBEP191/1 Neil Brown Mark IIIb CTD s/n 2769 were completed on March 8, 1991 at Woods Hole Oceanographic Institution, Woods Hole, Massachusetts (Millard and Yang, 1993). CTD s/n 2769 is owned by AOML. The following calibration coefficients for conductivity, temperature, and pressure were determined:

$$C = 0.9995477 * C_{\text{raw}} + 0.038996 \\ T = 1.0001479 * T_{\text{raw}} + 0.000917 \\ P = -0.518997e-06 * P_{\text{raw}}^{**2} + 1.00317 * P_{\text{raw}} + 0.746095$$

Pre-cruise calibrations for 31DSEP391/1 Neil Brown Mark IIIb CTD s/n 1111 were completed on September 10, 1991 at Northwest Regional Calibration Center (NRCC) in Bellevue, Washington. CTD s/n 1111 is owned by PMEL. The following calibration coefficients for conductivity, temperature, and pressure were determined:

$$C = 0.9997923 * C_{\text{raw}} + 0.0068 \\ T = 1.0003010 * T_{\text{raw}} + 0.0538 \\ P \text{ (increasing)} = -0.1657277e-09 * P_{\text{raw}}^{**3} + 0.151795e-05 * P_{\text{raw}}^{**2} + 0.9971329 * P_{\text{raw}} - 34.7978 \\ P \text{ (decreasing)} = -0.3257910e-09 * P_{\text{raw}}^{**3} + 0.316872e-05 * P_{\text{raw}}^{**2} + 0.9931632 * P_{\text{raw}} - 35.4661$$

CTD Data Capture and Reporting

Aboard the Malcolm Baldrige, CTD/O₂ data were collected using the shipboard Scientific Computer System (SCS) and AOML LOGGER software. Preliminary processing and calibration of the CTD/O₂ data were accomplished at sea using the shipboard microVAX system and PMEL programs.

Aboard the Discoverer, NBIS CTD data were collected using a 286-AT personal computer equipped with EG&G Oceansoft, NBIS Mark III CTD acquisition software. PMEL microVAX computers and programs were aboard the Discoverer for preliminary processing and calibration of NBIS data at sea.

Conductivity Calibration

31MBEP191/1 data files were restored to the VAX computer system at PMEL from Exabyte 8mm tapes. A calibration (.CAL) file was created at sea using the program CALDSK, which asks the user for CTD values at the time of sample bottle closures from handwritten cast logs completed during acquisition and sample salinity values received from ship's survey. Programs LINCALW and CALMSTRW and plotting command files CALMCONW and CALMDEEPW were used to find the best calibrations to apply to this data set (program descriptions are given below). Neither pre-cruise calibration coefficients or an overall linear least squares fit were satisfactory. A cast break was apparent between casts 15 and 16, corresponding to a two-day break in CTD operations between the end of the 110W line and the beginning of the 125W line. Final calibration coefficients applied to CTD conductivity were the results of linear least squares fits computed for each group:

Casts 1-15 (110W line):	bias = 5.3587079E-02
	slope = 0.9987972
	std dev = 9.1723865E-03

Casts 16-21 (125W line):	bias = 5.9156708E-02
	slope = 0.9984679
	std dev = 7.7077947E-03

In addition to the above conductivity calibrations, a salinity offset of -.010 psu was applied to part or all of the downcasts of casts 15, 16, and 17 (see CTD Data Processing section below).

The 31DSEP391/1 calibration (.CAL) file was created at sea using program CALDSKW, CTD values at the time of sample bottle closures from handwritten cast logs completed during acquisition, and sample salinity values received from ship's survey. Where CTD and bottle salinities differed greatly, a 60 scan average salinity value output by EG&G Oceansoft bottle file (.BTL) replaced the cast log value if it lessened the discrepancy. Programs LINCALW and CALMSTRW and plotting command files CALMCONW and CALMDEEPW were used to find the best calibrations to apply to this data set (program descriptions are given below). Final calibration coefficients applied to CTD conductivity were the results of a linear least squares fit to all bottles, all casts.

Casts 0-25 (all stations): bias = 1.0341031E-02 slope = 0.9995004 std dev = 2.7981878E-03

Conductivity Calibration Programs and PPLUS Command (.PPC) Files

CALDSKW creates .CAL raw data file of CTD observations at the time of bottle closures and analyzed water sample values. LINCALW reads .CAL raw data file (may be broken into groups), computes a linear least squares fit to CTD-bottle conductivity data, applies the model coefficients, discards observations greater than 2.8 times the standard deviation, then refits the remaining data. The process continues until no further observations are rejected. LINCALW writes .COEF file containing model coefficients and .LOG file. Water sample conductivity is obtained using the FORTRAN routine SAL78 described by Fofonoff and Millard (1983). CALMSTRW reads .CAL raw data file; applies pressure and temperature calibrations; corrects raw conductivity for cell material deformation according to:

$$C = C_{\text{raw}} [1 + \alpha(T-T_0) + \beta(P-P_0)]$$

where $\alpha = -1.6 \times 10^{-6}$, $\beta = 1.5 \times 10^{-8}$, $T_0 = 15$, and $P = 3$; applies conductivity calibrations; writes .CLB calibrated data file and .SEA calibrated data file in WOCE format. CALMCONW.PPC reads .CLB calibrated data file and makes five plots of discrete measurements: P, T, C, S, and cast number verses CTD-bottle conductivity. These are examined for cast breaks and drifts in the CTD. CALMDEEPW.PPC reads .CLB calibrated data file and makes two plots: CTD salinity and bottle salinity verses potential temperature from $\theta = 0.6$ to 2.2 C.

Temperature Calibration

Pre-cruise calibrations were the only corrections applied to temperature measurements collected on both cruises. Temperature measurements, calibrations, and computation of derived oceanographic variables used the 1968 temperature scale. Temperatures were converted to the ITS90 scale for WOCE reporting according to:

$$T_{68} = 1.00024 * T_{90}$$

as suggested by Saunders (1990):

Pressure Calibration

Pre-cruise calibrations were the only corrections applied to pressure measurements collected on both cruises.

Oxygen Calibration

The oxygen model has the following forma (Owens and Millard, 1985):

$$OX = A * (OXC+B*dOXC+C) * EXP(D*(T+E*(OXT-T))+F*P) * OXSAT(S,T)$$

where A is the slope, B is the time constant for oxygen diffusion through the membrane, C is the oxygen current bias, D is a temperature correction, E is the weighting factor of oxygen sensor and water temperatures, F is the pressure correction, and OXSAT(S,T) is the oxygen saturation value after Weiss, 1970.

The coefficients of the oxygen model are computed in program POXFITW which reads a .CLO file of downtrace CTD data records matched according to temperatures in the uptrace .CAL file by program OXDWNW, and minimizes the difference between CTD and bottle oxygens by varying the 6 parameters using the same least squares polynomial subroutine as LINCALW in fitting conductivities. One overall (casts 1-21) non-linear fit was made to 31MBEP191/1 oxygen data with the following results:

A = 2.404
standard deviation = 0.12223
B = 2.077
number of observations = 150
C = 0.023
dox = 0.342
D = -0.02794
E = 1.469
F = 0.1504e-03

CTD/bottle oxygen variance with pressure was unfortunately large.

Oxygen calibrations were applied to the bottle data (.CLB) using CALMSTRW and to CTD data files using EPCTDW. Nearly every cast had oxygen spikes around 200 db. All but casts 1, 3, and 4 had spikes removed, most of which were removed using NOMIT in EPCTDW. Casts 10, 15, 16, 17, 19, and 20 had sections around 200 db interpolated using EPIC (Soreide and Hayes, 1988) utility CTDINTERP.

Oxygen Calibration Programs and PPLUS Command (.PPC) Files

OXDWN2W reads .CAL raw data file and DLAGAVZ .CTD ASCII data files (see CTD Processing Programs), extracts down profile data record including oxygen current and oxygen temperature at calibrated CTD temperatures corresponding to the upcast bottle levels, computes CTD oxygen and oxygen saturation, and writes a .CLO data file. POXFITW reads .CLO data file, fits the coefficients of the oxygen model using a non-linear regression technique varying 6 parameters, and writes .PAR listing of the final coefficients and .REJ file of those scans where the CTD/bottle oxygens differed by more than 2.8 times the standard deviation throughout all iterations. CALOX2W reads the .PAR values and .CLO data, applies the calibration coefficients, and writes a calibrated .CLO file. DOX.PPC makes plots

of CTD oxygen verses bottle oxygen; and cast number, pressure, and temperature verses CTD-bottle oxygen to verify calibration coefficients applied.

CTD Data Processing

31MBEP191/1 files were restored from Exabyte 8mm tapes to the VAX at PMEL. Files produced at sea using DPDNZ and DLAGAVZ programs were retained. The minimum fall rate acceptable in DLAGAVZ was 0.5 db/60 scans and the pressure interval to skip after a fall rate failure was 1.2 db. EPCTDW applied conductivity and oxygen calibrations to the 1-meter averaged data set.

DEEPCTD, FULLTS, and density plots were looked at for any single point spikes, looping, or intermittent salinity offsets. Casts 6, 9, 10, 18, and 20 were despiked using EPCTDW subroutine NOMIT. Cast 15 displayed an offset in salinity between 485 db and 1009 db owing to possible sensor fouling. Program S_OFFSET.FOR was written to apply a correction of -0.040 psu to salinity in this area. Cast 16 showed some spiking in salinity and an immediate offset in salinity from 784 db to 1005 db. The offset was seen in the upcast and in the downcast of cast 17. S_OFFSET.FOR also applied a correction of -0.010 psu to the end of cast 16 and to all of cast 17. No offset was seen in cast 18. EPIC utility CTDINTERP linearly interpolated salinity between 740 db and 784 db of cast 16 to remove the interference.

FULLTS and density plots also revealed an anomalous jump in salinity for casts 1, 2, 6, 7, and 21. In all cases, salinity decreased by approximately 0.037 psu over 1 db change in pressure somewhere between 300-500 db. The offset occurred during the downcasts only and the deeper bottles matched well with the CTD trace. Since density profiles showed no instability in the water column above the jumps, there was no straight-forward way to correct for the offsets. They are noted here and a warning line included in the cast headers. 31DSEP391/1 processing took place at sea. The following standard processing programs and PPLUS (Denbo, 1992) command files were used to process the data. TSPLTEP and 3PLTNOX plots were looked at for any additional spiking but none were noted.

CTD Data Processing Programs and PPLUS Command (.PPC) Files

DPDNZ reads a raw CTD data file, computes a running fall rate over +/- 30 scans, and writes all data to a binary (.DPZ) file and an ASCII (.RECZ) file. A record range for the downcast is determined from the .RECZ file. DLAGAVZ reads .DPZ file, applies precruise calibrations, edits data for window outliers and first differencing outliers, fills gaps by linear interpolation, lags conductivity according to:

$$C(I) = (1-A) * C(I) + A * C(I-1)$$

where C is calibrated conductivity and A=.87, flags data exceeding fall rate criteria (default minimum fall rate acceptable is 0.8 db/60 scans (25 meters per minute) and pressure interval of 1.5 db), and computes 1-meter averages. DLAGAVZ writes an error file of outlier flags, interpolated values, and fall rate criteria failures; and an ASCII .CTD data file including computed salinity values. EPCTDW reads .CTD file of calibrated P, T, OXC, OXT, and CR (lagged but uncalibrated conductivity); applies any additional P and T calibrations, corrects conductivity for cell material deformation:

$$C = CR*(1-alpha(T-15)+beta(P/3))$$

where alpha=6.5e-06 and beta=1.5e-08, and applies conductivity calibrations. EPCTDW computes salinity, applies calibrations to oxygen when available, has an option to eliminate 1-point spikes

according to the gradients restrictions given in the source code (not used by default), omits additional spikes as specified in the command file, fills data by linear interpolation for a value to exist every whole meter, recomputes conductivity from salinity, and calculates other oceanographic variables. EPCTDW writes the final .CTD data file in EPIC format, and a .LOG file of edited and filled data points. EPICBOMSTRW reads .CLB calibrated bottle data file and .CTD EPIC data files (for header information) and writes final .BOT bottle data files in EPIC format. DEEPCTD.PPC reads .CTD EPIC pointer file and .BOT EPIC pointer file of deep casts only and overplots discrete bottle salinity data on the CTD salinity trace from theta=0.8 to 2.4 C. FULLTS.PPC reads .CTD EPIC pointer file and .BOT EPIC pointer file and overplots bottle and CTD salinity data from theta = 0 to 30 C for each cast. TSPLTEP.PPC reads .CTD EPIC pointer file and .BOT EPIC pointer file and overplots full water column bottle salinity and CTD trace as well as sigma-t lines for each profile. TSPLTB.PPC is used to include oxygen data. TEXTNOX reads .CTD EPIC pointer file and writes a PPLUS command file containing label commands for table listings of subsampled CTD data for each cast to be used with 3PLTNOX. 3PLTNOX.PPC reads TEXTNOX output and .CTD EPIC pointer file and overplots profiles of temperature, salinity, and sigma-t vs. pressure to 1000 db with subsampled CTD data listed in table form for each station. 4PLT1DB.PPC is used to include oxygen data.

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