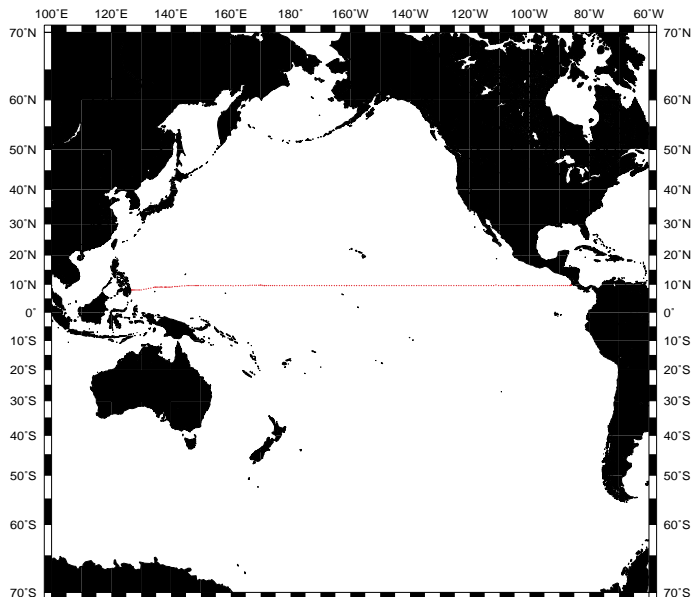# A.   Cruise Narrative P04 (10 N TRANSPACIFIC CRUISE)

A.1.   Highlights

WHP Cruise Summary Information

WOCE section designation	**P04**
Expedition designation (EXPOCODE)	**32MW893_1-3**
Chief Scientist(s) and their affiliation	**J. Toole*, T. Joyce**. H. Bryden*****
Dates	1989.02.06 - 1989.05.19
Ship	R/V Moana Wave
Ports of call	Mindanao, Philippines to Puntarenas, Costa Rica
Number of stations	221 full ocean depth stations

Geographic boundaries of the stations

	9° 50.3 ' N	
126° 32.9' E		85° 45' W
	7° 58.1' N	

Floats and drifters deployed	none
Moorings deployed or recovered	none

It is difficult to apportion credit for the success of the 10 N trans-Pacific hydrographic section measurement program in a single author list. First of all, all of the cruise participants listed in Appendix A were essential. Authors of individual sections of the Data Report are noted at the head of each section. George Knapp and Lorraine Barbour drafted the property sections, Plates 1, 2, 3, & 4. Jane Dunworth-Baker and Ann Spencer prepared the data listings in Appendix C. Overall compilation and editing of this report were done by Marvel Stalcup, George Knapp, Barbara Gaffron, Harry Bryden and John Toole.

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WHP Cruise and Data Information

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

Cruise Summary Information	Hydrographic Measurements
Description of scientific program	CTD - general
	CTD - pressure
Geographic boundaries of the survey	CTD - temperature
Cruise track (figure)	CTD - conductivity/salinity
Description of stations	CTD - dissolved oxygen
Description of parameters sampled	
Bottle depth distributions (figure)	Salinity
	Oxygen
	Nutrients
	CFCs
Principal Investigators for all measurements	
	Other parameters
Underway Data Information	**Acknowledgments**
Navigation	**References**
Bathymetry	
Acoustic Doppler Current Profiler (ADCP)	**DQE Reports**
	CTD
	S/O2/nutrients
Atmospheric chemistry data	CFCs
	14C
	Data Processing Notes

NOTE: All figure captions and tables have been moved to the end of each section.

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Station Locations for P04
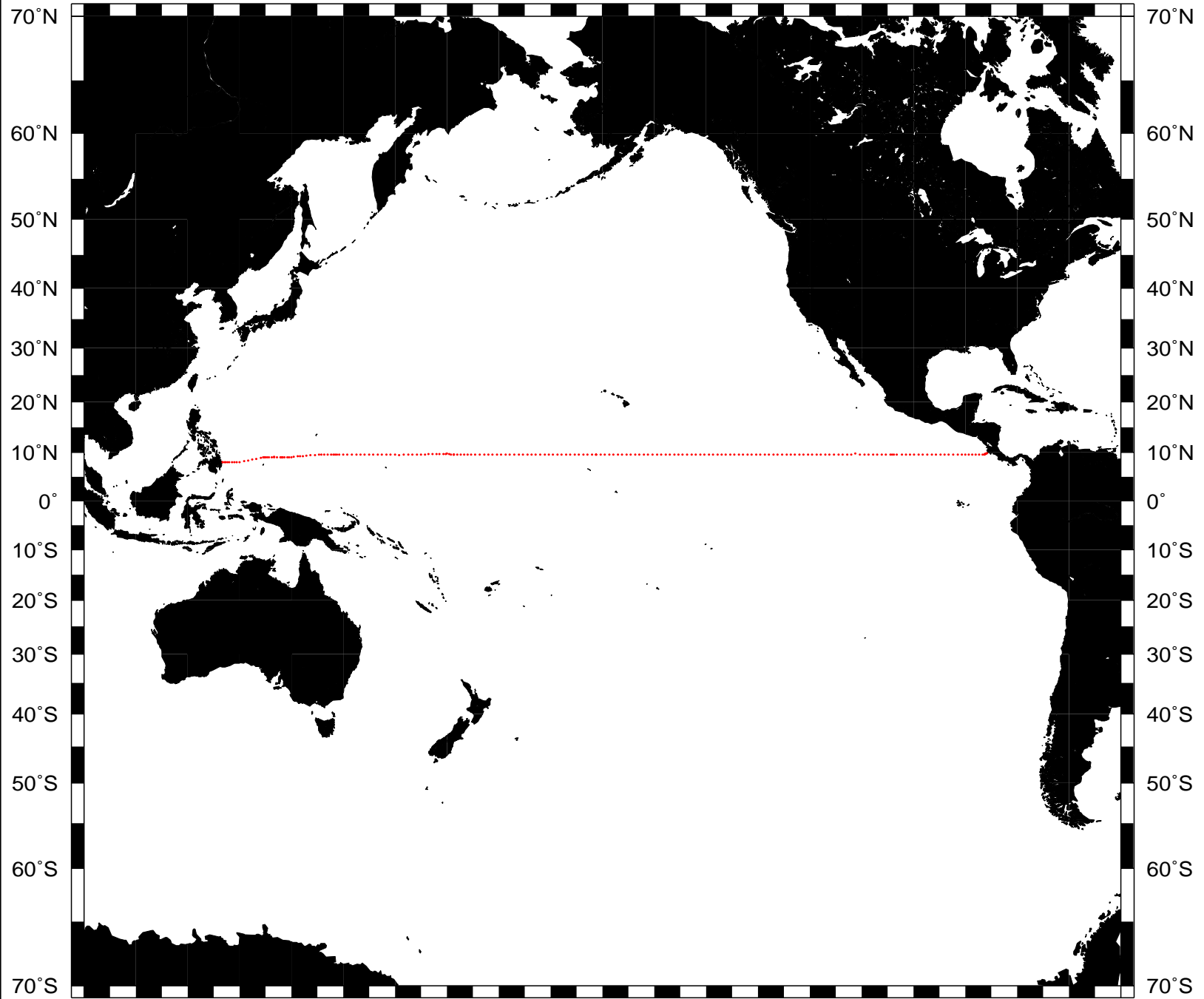
Produced from .sum file by WHPO-SIO

ABSTRACT

A trans-Pacific hydrographic section along approximate latitude 10 N was occupied in February-May, 1989, from the R/V Moana Wave. A description of the instrumentation employed and data reduction techniques is given. Listings of the observations and plates of contoured sections of the water property distributions are presented, along with statements of data accuracies and uncertainties.

1. INTRODUCTION

The trans-Pacific hydrographic section across 10 N was initially proposed by Drs. Harry Bryden and John Toole to the National Science Foundation in 1987. The motivations for this section were to help complete the first comprehensive survey of the water mass characteristics of the North Pacific Ocean; to determine the structure of the meridional circulation across 10 N and its associated meridional heat and fresh water transports; and, in conjunction with the trans-Pacific hydrographic section carried out along 12-15 S in 1988, to estimate the cross-equatorial exchange between the South and North Pacific oceans. Because this 10 N trans-Pacific section is the longest hydrographic section ever attempted (16,000 km in length or 40% of the earth's circumference) and because of the emphasis on determining the cross-equatorial exchange in the Pacific Ocean, we have taken to calling this program the Equatorial Pacific Interocean Circulation (EPIC) study. Following acceptance of this proposal by the National Science Foundation, the hydrographic section was scheduled for early 1989 and an announcement of opportunity was made for additional sampling programs to augment the temperature, salinity and dissolved oxygen measurement effort. Programs to measure nutrients, chlorofluorocarbons and helium/tritium concentrations were proposed, accepted and carried out on the 10 N hydrographic section. R/V Moana Wave cruise #89-3,-4,-6 consisted of three legs, which form one long hydrographic section, generally along 9.5 N, from the east coast of Mindanao in the Philippines to Puntarenas, Costa Rica in Central America. This report presents the CTD and water sample data collected on the 221 full ocean depth stations during the 10 N trans-Pacific hydrographic section carried out aboard the R/V Moana Wave during February to May 1989. The data set collected during this cruise is called the Moana Wave 89-3 data.

2. INSTRUMENTATION AND DATA ACQUISITION

Three EG&G/Neil Brown Instrument Systems (NBIS) Mark IIIB CTD/O2 (Conductivity/Temperature/Depth/Oxygen) profilers (WHOI instruments #8, #9, and #10) were employed on the cruise. The underwater package consisted of a CTD instrument, a 24-position General Oceanics, Inc. (GO) rosette sampler, and a 12 kHz acoustic pinger, all mounted within a guard cage of WHOI design. Several hundred pounds of lead weight were added to the cage to facilitate rapid lowering of the package. A detailed description of the CTD instrumentation can

be found in Brown and Morrison (1978). Ten-liter PVC sample bottles, manufactured by GO and Scripps Institution of Oceanography were employed. Several additional 2.4-liter bottles, designed by J. Bullister, were attached to the rosette frame and tripped simultaneously with adjacent 10-liter bottles. All of the 10 liter Niskin and SIO sampling bottles were shipped to Palau in an insulated 20l container. The container was mounted on the Moana Wave for the entire voyage where it served as storage space for spare equipment.

The Markey winch system used on the cruise was originally located on the R/V Thomas Thompson. It was transferred to R/V Moana Wave purposely for the 10 N trans-Pacific cruise. Leg one commenced with 10,000 m of 0.322" three-conductor electromechanical cable installed on the winch. A spare drum holding approximately 6000 m of wire was secured on deck. Lowering rates during the voyage averaged 60 m/min, limited chiefly by the relatively slow terminal velocity of the large rosette package. Raising rates were typically 70 m/min leading to average station times of 3.5 hrs in 5000 m of water.

Binary data from the CTD were obtained via MkIII deck units equipped with a WHOI built interface which shifted the output data rate from its 5000 baud default to 9600 baud. The primary data acquisition system consisted of a Digital Electronics Corporation (DEC) Microvax computer (MicroVax II BA23 enclosure with a 71 MB hard disk and 3 MB of memory) running the VAX/VMS operating system, version 4.4. The Aqui89 WHOI CTD Data Acquisition Software (pre 1.0 version) was employed to scale the data to physical units as well as to list and display the data graphically in real time. Raw data were concurrently archived to disk and 9-track digital tape. Audio tape back-up analog recordings were also collected. Data were organized and processed on the MicroVax II as described by Millard and Galbraith (1982), with only minor updates and enhancements. Because the MicroVax system had only been previously tested in the laboratory and was a preliminary version, data were logged concurrently to a NEC Powermate 286 microcomputer, using the EG&G Oceansoft MkIII/SCTD Acquisition software package.

Water sample analysis for salinity and dissolved oxygen was conducted in a WHOI portable laboratory secured to the main deck of the ship. The portable laboratory is capable of maintaining a constant environmental temperature within +/- 1 C. The nominal laboratory temperature was 22 C. Two Guildline Autosal Model 8400A salinometers were utilized to determine water sample salinities (WHOI instrument numbers 8 and 9). Water sample analysis for dissolved oxygen was also performed in the constant temperature laboratory using a modified Winkler titration technique. The measurements were conducted on 50 ml aliquots of the samples. A Metrohm Titroprocessor controlling a Metrohm Dosimat was used to titrate to an amperometric endpoint as described by Knapp et al. (1989).

Analyses of water sample nutrient concentrations were performed by a team of analysts from Oregon State University, using an Alpkem Corp. Rapid Flow Analyzer, Model RFA?-300. This instrumentation was setup in one of Moana Wave's laboratories. In an adjacent laboratory, the concentrations of the dissolved atmospheric chlorofluorocarbons (CFCs) F-11 (trichlorofluoro-methane) and F-12 (dichlorodifluoromethane) were measured by shipboard electron-capture gas chromatography. The shipboard CFC program was multi-institutional, and the equipment was supplied by R. Weiss's group at Scripps Institution of Oceanography. Finally, selected water samples were collected during the cruise for subsequent shore-based analysis of 3He and Tritium at the WHOI facility.

The ship's equipment inventory included an acoustic Doppler velocity profiling (ADCP) system, RD 150-kHz profiler with an IBM PC compatible acquisition computer running a customized version of the RDI data acquisition software developed by Dr. Eric Firing, U. Hawaii. A shipboard computer system (Sun workstation based) was employed to archive navigation information (transit and GPS fixes) from which all CTD station navigation information was updated after each leg. Relative wind speed and direction were also recorded by the Sun computer. Analog bathymetric recordings from a 3.5 kHz sounding system were made continuously while underway between stations. A hull-mounted 12 kHz transducer was employed on leg 1 to monitor the CTD underwater package height off the bottom. This transducer did not function well. A portable transducer was employed on legs 2 and 3 with intermittent success.

3. CRUISE OVERVIEW

Leg 1 of the trans-Pacific section, R/V Moana Wave cruise #89-3, began in Palau in early February, 1989 when the first party of scientists joined the ship to prepare the instrumentation and equipment. A list of the scientific participants, including responsibilities and affiliations is presented in Appendix A. The bulk of the equipment had previously been shipped to Hawaii and loaded on the vessel. The R/V Moana Wave subsequently transited from Honolulu to Palau, arriving in port on February 2. While setting up the instrumentation in port, leaks were discovered in the water baths in Autosal Salinometers #8 and #9 around their heat exchangers. Both instruments were disassembled and repaired before the ship left Palau. Autosal #8 was designated as the primary instrument for the voyage.

Departure from Palau for the Philippine coast occurred on February 6. En route, two stations near 9.3 N, 130.8 E were occupied to test instrumentation. These test stations revealed a level-winding problem with the hydrographic winch/wire system. Subsequent tests determined that the wire and leibus grooving on the drum were incompatible (the wire diameter was smaller than specification). After extensive deliberation it was decided to initiate work with the existing wire/drum

set-up, deferring a drum change until the next port stop. Results from the test station also motivated selection of CTD #8 as the primary instrument.

Station 3 was occupied in 125 m of water at 8 N off the coast of Mindanao Island, Philippines at longitude 126.5 E. Sampling proceeded to the east on 8 N to longitude 130 E, reoccupying sites sampled by the U.S./P.R.C. Cooperative Program (Cook et al., 1990). The cruise track was then angled slightly to the north to avoid a region of complicated bathymetry. As the water sample salinity data from the Philippine Basin accumulated, a subtle problem with the CTD derived salinity became apparent. (This problem is detailed in Section 5c, below.) Thus on station 27, CTD #9 was designated the primary instrument, and was subsequently utilized for the bulk of the stations across the Pacific. Stations 26 (with CTD #8) and 27 (with #9) were in the same location to facilitate calibration of the complete data set.

During leg 1, monitoring the CTD underwater package height above the bottom using the 12 kHz pinger proved problematic. No recognizable bottom echo was observable on the analogue recorder in water depths greater than 1000 m. Consequently, operational CTD station depths were calculated from the 3.5 kHz echosounder data (which included a generous margin of safety). We estimate that leg one casts terminate within 100-200 m of the bottom.

A problem developed with the General Oceanics rosette tripping mechanism during the first leg of the cruise which resulted in both mis-firing and double-tripping of the water sampling bottles. This problem was eventually traced to slippage between the stepping motor and the tripping mechanism caused by excessive tension on the tripping lanyards. The higher than normal tension was the result of mounting several Bullister style, 2.4 liter, water sampling bottles to the rosette frame and attaching their tripping lanyards to some of the lanyards used to trip the Niskin bottles. This problem was identified and corrected during leg one and did not recur during the cruise.

On February 27, at station 67, one transducer of the ADCP array failed. The problem was finally diagnosed two days later and the system was run with 3 transducers, beginning with station 71. (Three acoustic beams are sufficient to estimate the relative velocity profile, the 4-beam. standard configuration provides redundant information.) A two day gap exists in the final ADCP record, spanning the longitude range 161.7-165.0 E.

The first leg measurement program was completed with stations 82 and 83 at 9.5 N, 171.3 E on March 4. Station 82 was with CTD #9, 83 with #8; the double station was an effort to monitor relative sensor drift in the two instruments. From this location the ship departed from the cruise track to change scientific parties and CTD cables at Majuro in the Marshall Islands.

Stations 84 and 85, the first two made during the second leg, were occupied at the same position as stations 82-83, and again utilized both CTD instruments, 8 and 9, respectively. The time interval between stations 83 and 84 was 5 days. Station 90 marked the first use of the portable 12 kHz transducer. Subsequent casts were made to within 10 m of the ocean floor. The ship crossed the international dateline between stations 96 and 97, with 97 signaling the start of West longitudes. Once away from the western boundary of the Pacific Central Basin, station spacing opened up to 50 nm, the maximum spacing employed on the transect. Late in leg 2, water sample salinity data became somewhat noisy (scatter on deep water potential temperature/salinity plots was somewhat in excess of 0.001). Poor flushing of the Autosal conductivity cell was ultimately discovered to be the problem. Station 119 at 9.5 N, 161.2 W completed work on the second leg of the cruise. The ship then steamed to Hawaii in order to meet a prior commitment to the Hawaii Ocean Time Series (HOTS) station. The HOTS work occupied 9 days of ship time. During this interval, the bulk of the scientific equipment remained setup aboard the vessel. The two CTD instruments were stored ashore (with the sensors covered and immersed in distilled water.) Because CTD #8 was considered suspect, a third instrument (WHOI CTD #10) was prepared and air-shipped to Hawaii for leg 3. While in port, the ADCP transducer was replaced by a new unit.

Leg 3 departed from Hawaii on April 2. The transit south was extended by 3 days because of a medical emergency. Stations 120 and 121 (with CTD instruments 10 and 9 respectively), the first two made during the third leg, were made near the position of station 119, about 19 days later. Autosal instrument #9 was used to measure all of the salinities during leg three. Careful examination of the final salinity data reveals a subtle shift of order 0.0015 at a potential temperature of 0.90 to 0.95 C between stations at the end of leg 2 and the beginning of leg 3. The shift is in both the water sample data and the CTD data which were calibrated to the bottle salts. It is conceivable that the shift is instrumental; Autosal #8 was experiencing problems at the end of leg 2. The shift might also be real, the break between legs 2 and 3 occurred near the Line Islands ridge separating the Central and Northeast Pacific basins. As we have no additional information to guide interpretation of these measurements, the shift has been retained in the final data set.

Stations on leg 3 continued at latitude 9.5 N with nominal 50 nm spacing using CTD #9. There was a tendency for the conductivity cell on CTD #9 to drift fresh with time, consistent with conductivity cell coating. on leg 3, the CTD salinity shifts became bi-directional between stations 174-178. Large jumps in conductivity then became evident during stations 193-195. The decision was made at this point to switch over to the third instrument, CTD #10. Post-cruise examination of CTD #9 revealed a crack in the conductivity cell.

Stations 215-217 were made in deep water at the same geo- graphical position, 9.6 N and 86.2 W, to compare the data from the three CTDs used during this

cruise. On approach of the Central American coast, the cruise track was diverted north so as to intersect the coast at approximately right angle. Station 221, the last of the cruise, was made in 312 m of water near the coast of Costa Rica. R/V Moana Wave then transited to Puntarenas, Costa Rica where the scientific party left ship. The bulk of the scientific equipment, which was loaded into the portable laboratory and shipping van, rode the ship through the Panama Canal and was shipped back to WHOI from Jacksonville, Florida, the Moana Wave's next port of call.

4. WATER MASS PROPERTY DISTRIBUTIONS

Plate 1 contains a chart showing the location of the stations and the section of potential density along the ship's track. Plates 2, 3 and 4 are profiles showing the distribution of potential temperature and salinity, dissolved oxygen and silica, and nitrate and phosphate. The horizontal axis of the plots is along-track distance (hence the uneven longitude scales) and the vertical axis is depth in meters. The upper portion of each figure displays an expanded view of the first 1000 m of the water column with a vertical exaggeration of 1250:1. Below these are the full-depth sections with a vertical exaggeration of 500:1. The bottom topography shown in these sections is from the acoustic bathymetry measured along the ship's track and has been corrected for the speed of sound in seawater according to Carter (1980). The sections showing potential temperature, potential density, salinity and oxygen were prepared from the calibrated CTD data. The locations of the water samples used to construct the nutrient sections are shown by the dots at each station position. All property distributions were contoured by hand.

The CTD data are presented for each station at standard depths, and the hydrographic data at observed depths in Appendix C. The listing for each station also includes the calculated variables, potential temperature, potential densities relative to 0, 2000 and 4000 dbar, dynamic height, Brunt-Vaisala frequency and depth. A complete description of the station listing including units, algorithms, and references is presented in Appendix C.

5. DESCRIPTION OF ANALYSIS PROCEDURES AND CALIBRATION METHODS

5a. UNDERWAY MEASUREMENTS

The suite of continuous underway measurements collected during the cruise was processed as follows. The analogue bathymetric sounding records were manually digitized on board (using a digitizer board integrated into the shipboard computer system) by the R/V Moana Wave's marine technicians. The relative wind speed and direction information were processed to one minute averages, as were ship navigation, heading and speed information. Absolute wind speed and direction were determined from merging the navigation and relative wind

measurements. Stick plots of the time series wind vectors during the 10 N cruise (Figure 5a-1) show that the cruise occurred during a period of reasonably steady northeast trade winds. The ADCP data were vector averaged in 5 minute blocks, yielding estimates of east and north relative velocity profiles to 200 to 300 m depth. These data were subsequently combined with ship navigation data to yield absolute ocean velocity data. This post-cruise processing was done in collaboration with Eric Firing of the Hawaii Institute of Geophysics at the University of Hawaii basically following the procedure described by Bahr et al. (1989). Time series of east and north velocities measured by the ADCP at depths of 20, 60, 100, 140, 180 and 220 m (Figures 5a-2 to 5a-7) show that the 10 N section occurred in the region of westward currents associated with the North Equatorial Current. Furthermore, these velocities were averaged over 5 deg. longitude bins for presentation in Tables 5a-1 and 5a-2.

FIGURE CAPTIONS SECTION 5a

Figure 5a-1: Stick plots of the time series wind vectors measured during the 10 N section.

Figure 5a-2: Time series of north velocities measured by the ADCP at depths of 20, 60, 100, 140, 180 and 220m for leg 1.

Figure 5a-3: Time series of east velocities measured by the ADCP at depths of 20, 60, 100, 140, 180 and 220m for leg 1.

Figure 5a-4: Time series of north velocities measured by the ADCP at depths of 20, 60, 100,140, 180 and 220m for leg 2.

Figure 5a-5: Time series of east velocities measured by the ADCP at depths of 20, 60, 100, 140, 180 and 220m for leg 2.

Figure 5a-6: Time series of north velocities measured by the ADCP at depths of 20, 60, 100, 140, 180 and 220m for leg 3.

Figure 5a-7: Time series of east velocities measured by the ADCP at depths of 20, 60, 100, 140, 180 and 220m for leg 3.

TABLE CAPTIONS SECTION 5a

Table 5a-1: ADCP velocities averaged over 5 longitude bins for legs 1-3, north component.

Table 5a-2: ADCP velocities averaged over 5 longitude bins for legs 1-3, east component.

Figure 5a-1: Stick plots of the time series wind vectors measured during the 10°N section.
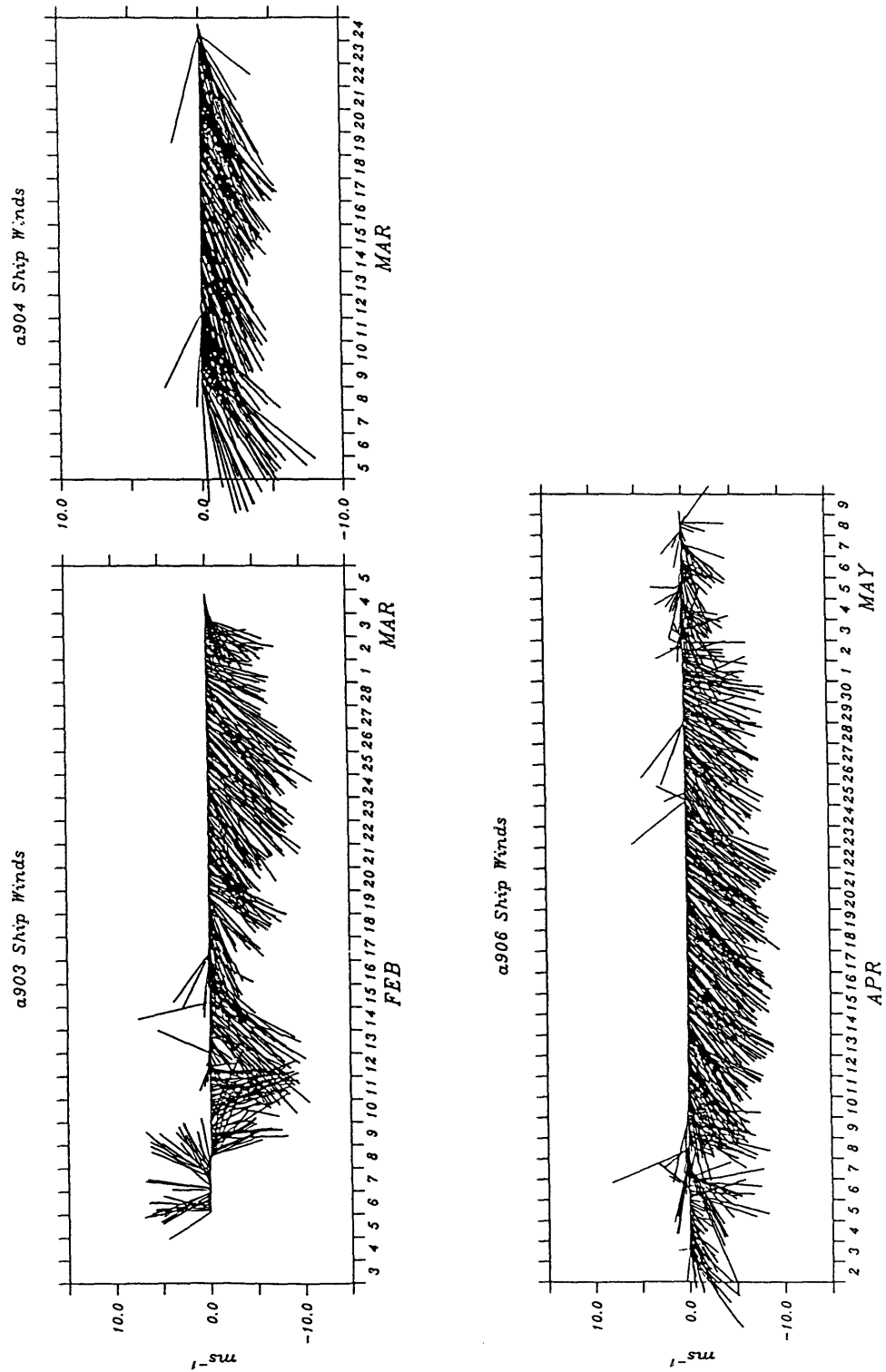
Figure 5a-2: Time series of north velocities measured by the ADCP at depths of 20, 60, 100, 140, 180 and 220m for leg 1.
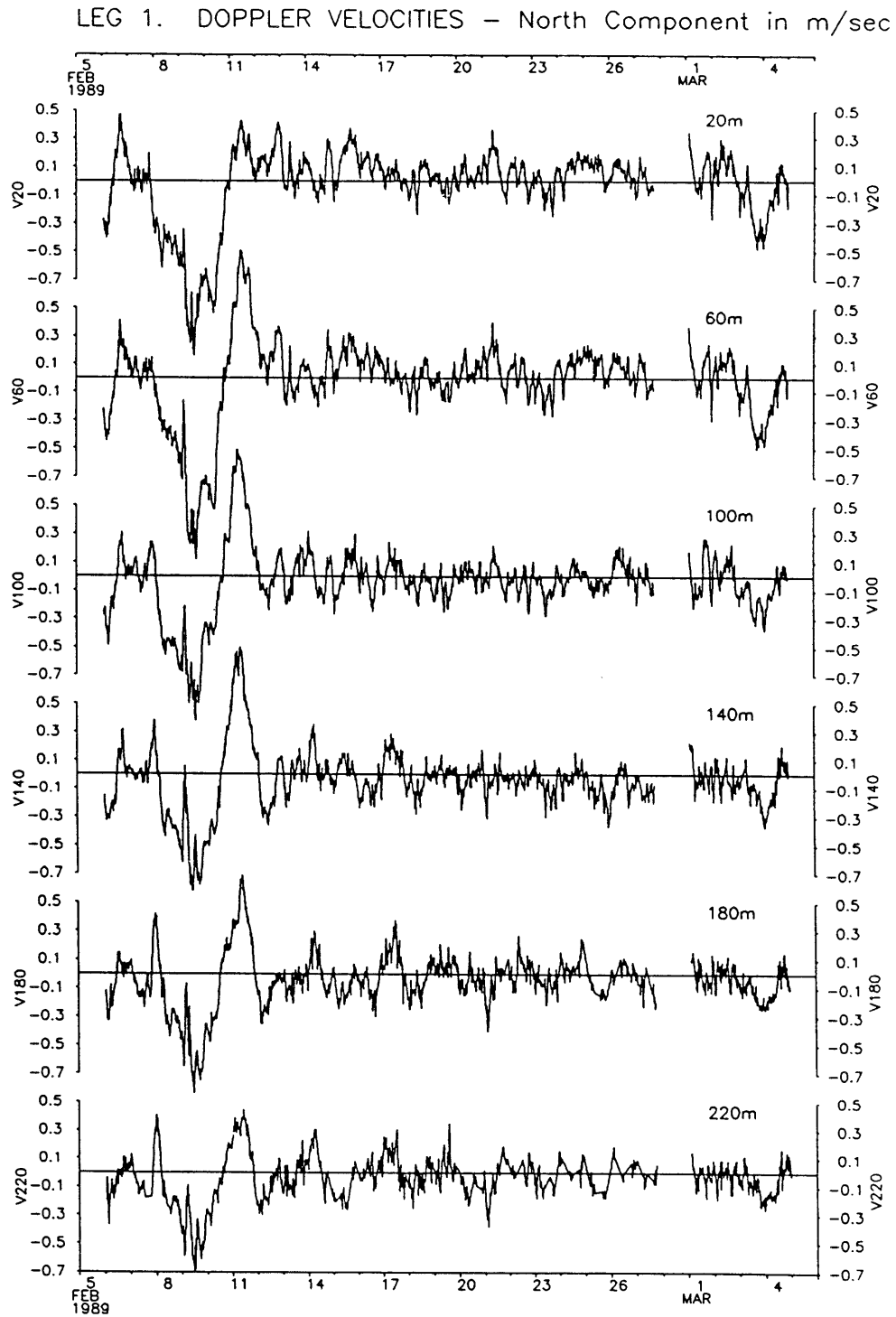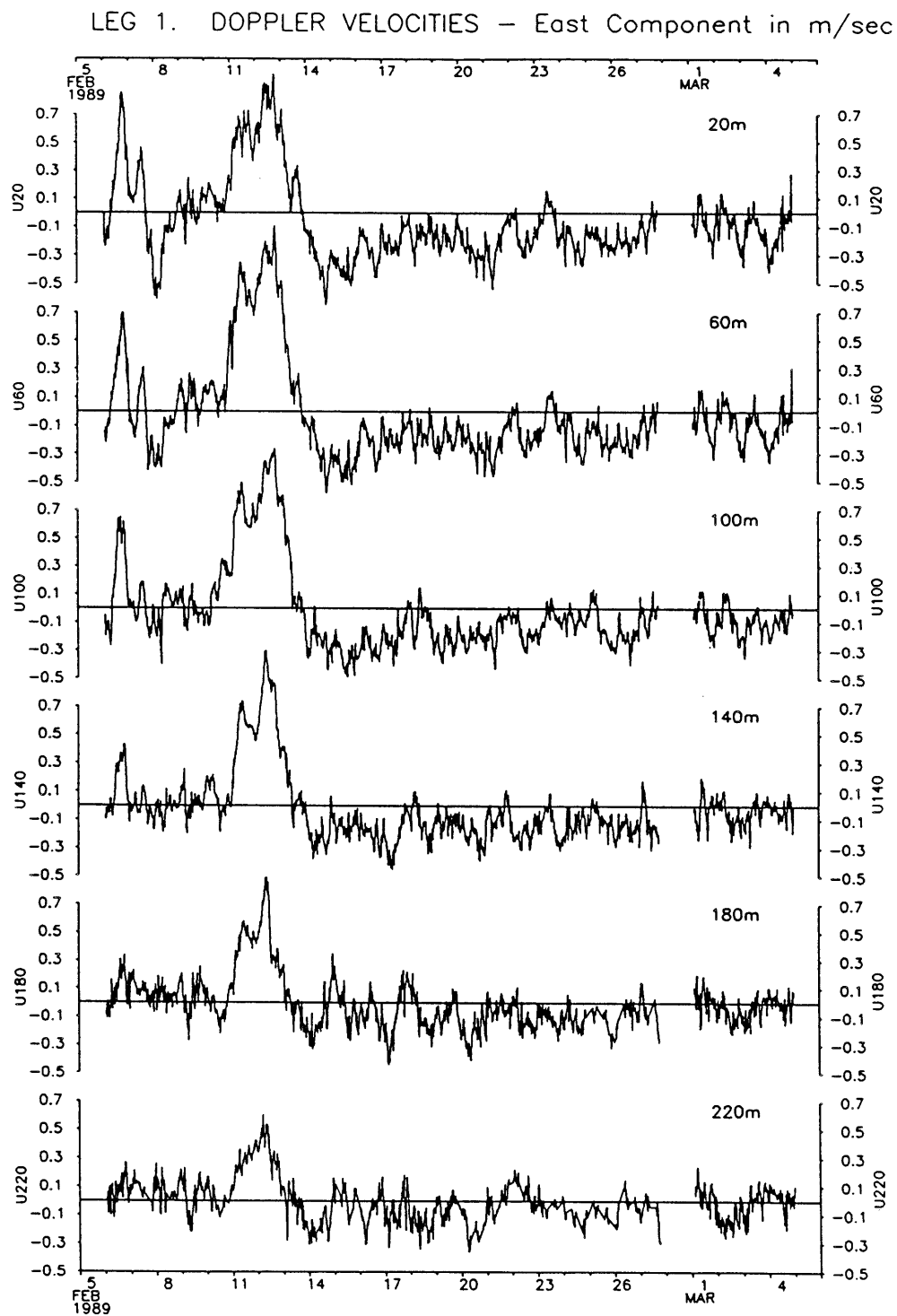
LEG 1. DOPPLER VELOCITIES — North Component in m/sec

Figure 5a-3: Time series of east velocities measured by the ADCP at depths of 20, 60, 100, 140, 180 and 220m for leg 1.

LEG 1. DOPPLER VELOCITIES — East Component in m/sec

Figure 5a-4: Time series of north velocities measured by the ADCP at depths of 20, 60, 100, 140, 180 and 220m for leg 2.

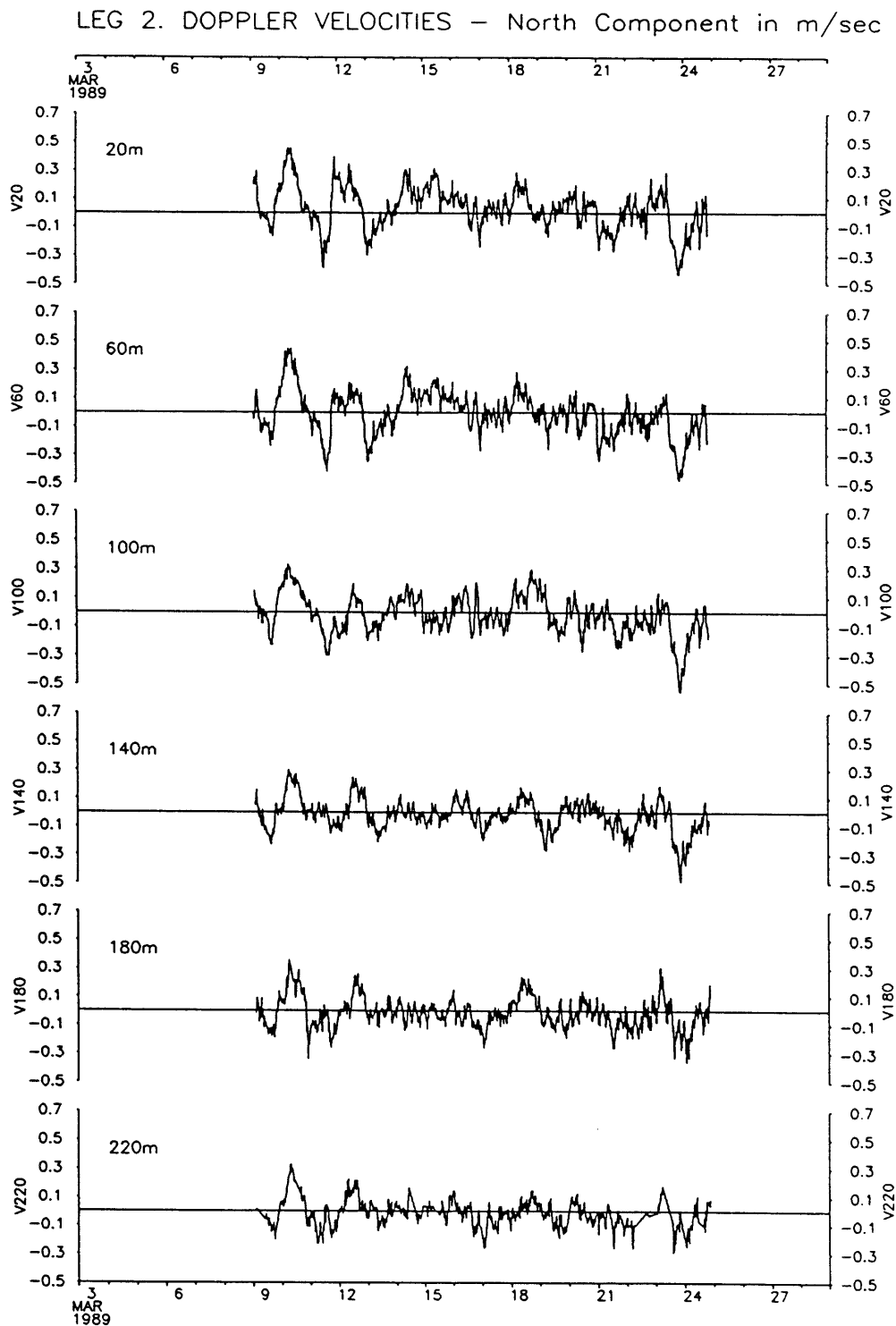LEG 2. DOPPLER VELOCITIES — North Component in m/sec

Figure 5a-5: Time series of east velocities measured by the ADCP at depths of 20, 60, 100, 140, 180 and 220m for leg 2.

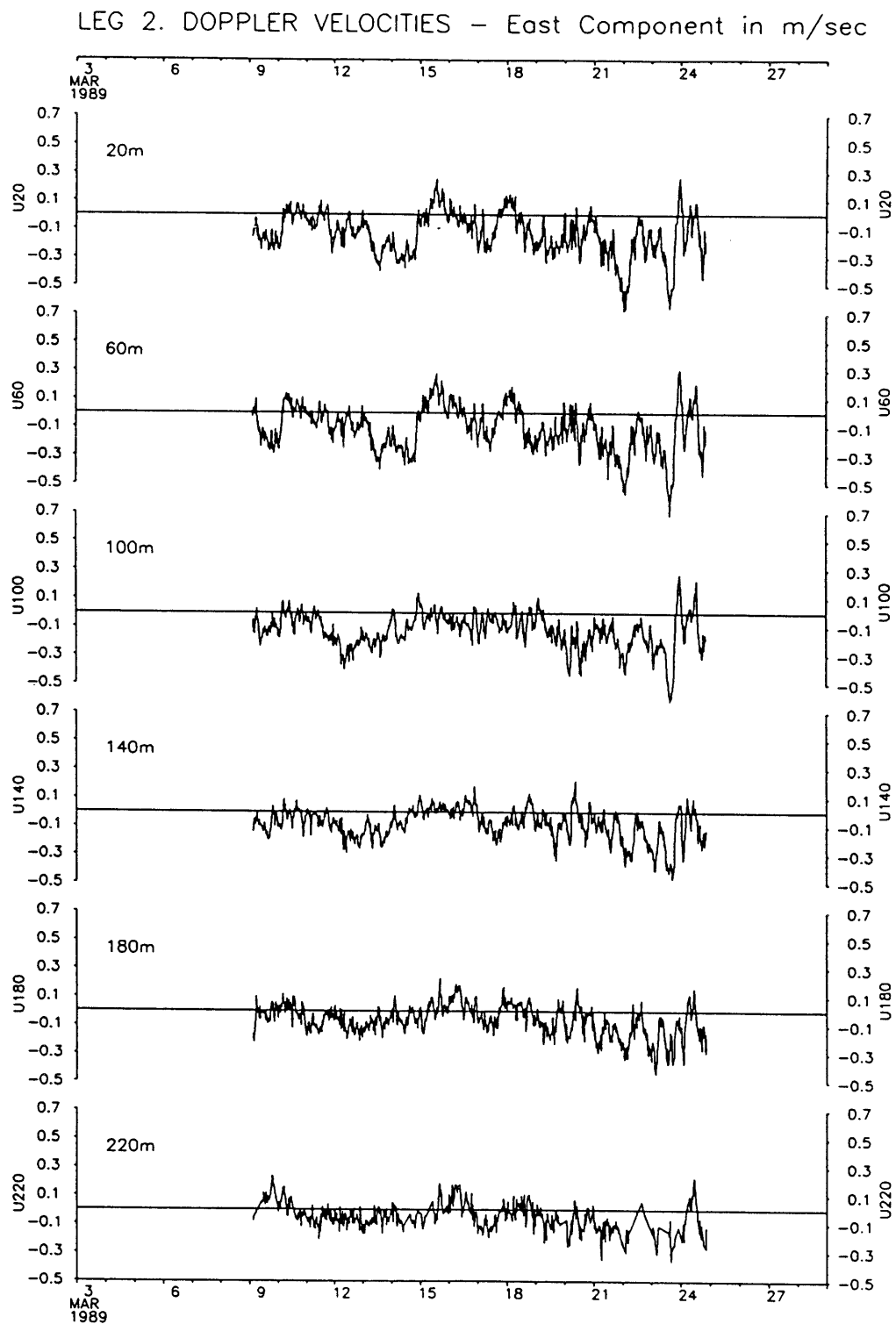LEG 2. DOPPLER VELOCITIES — East Component in m/sec

Figure 5a-6: Time series of north velocities measured by the ADCP at depths of 20, 60, 100, 140, 180 and 220m for leg 3.
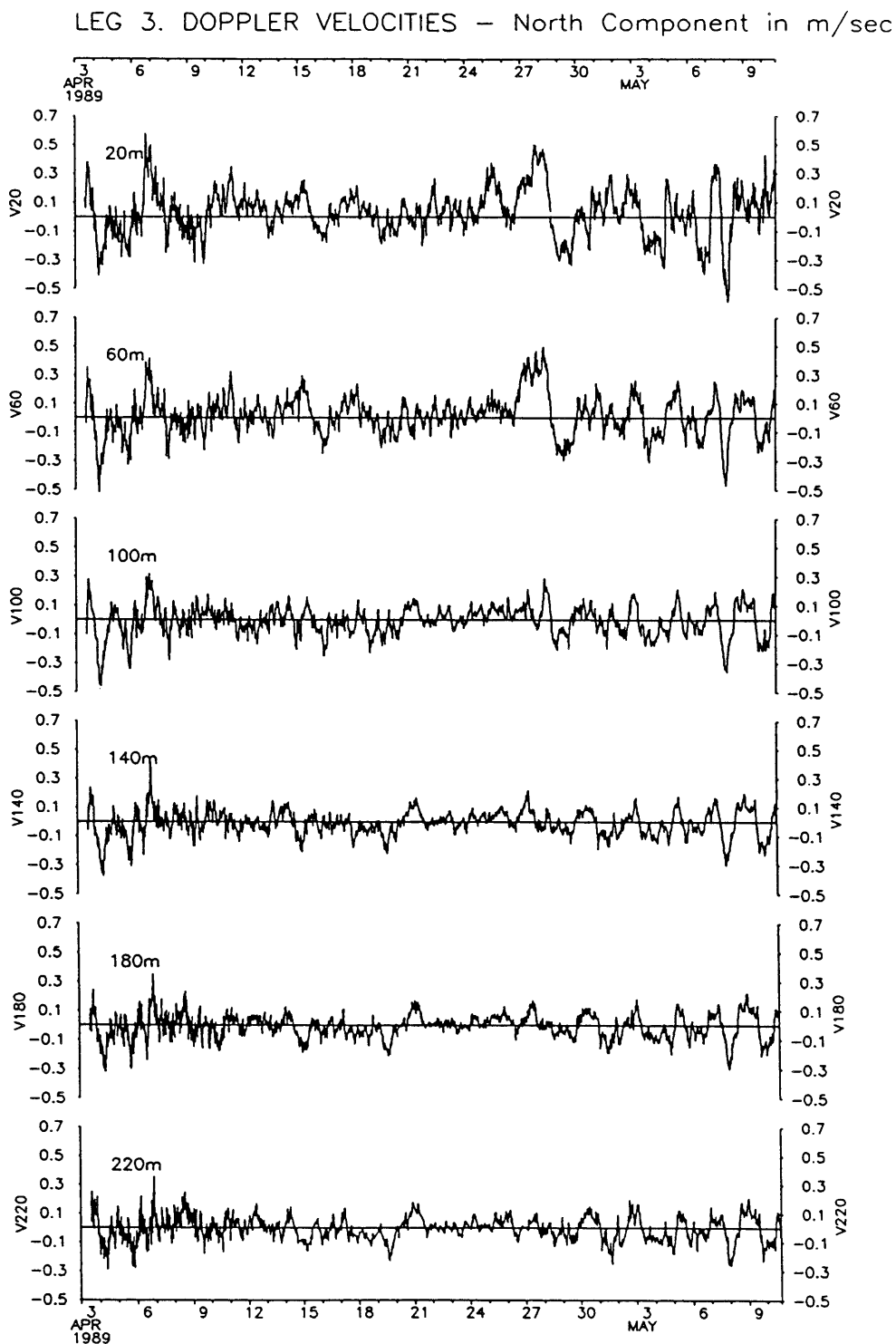

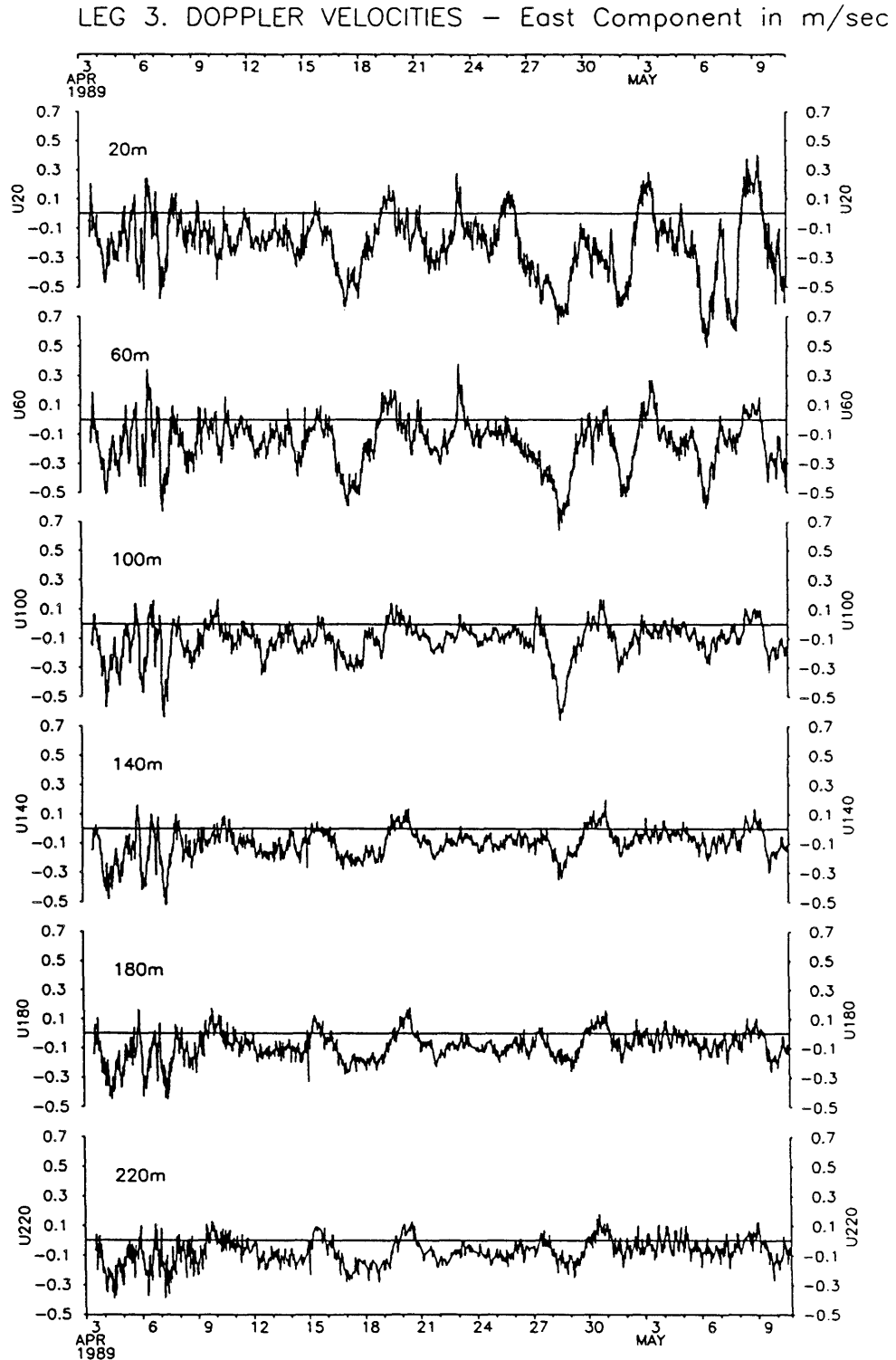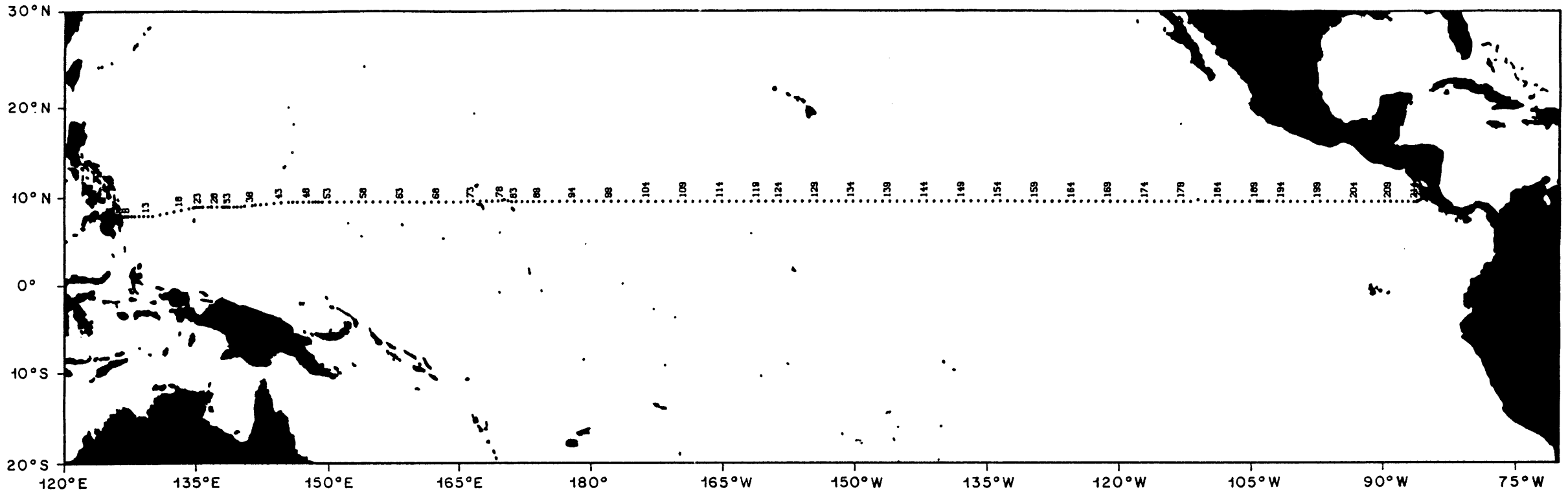LEG 3. DOPPLER VELOCITIES — North Component in m/sec

Figure 5a-7: Time series of east velocities measured by the ADCP at depths of 20, 60, 100, 140, 180 and 220m for leg 3.
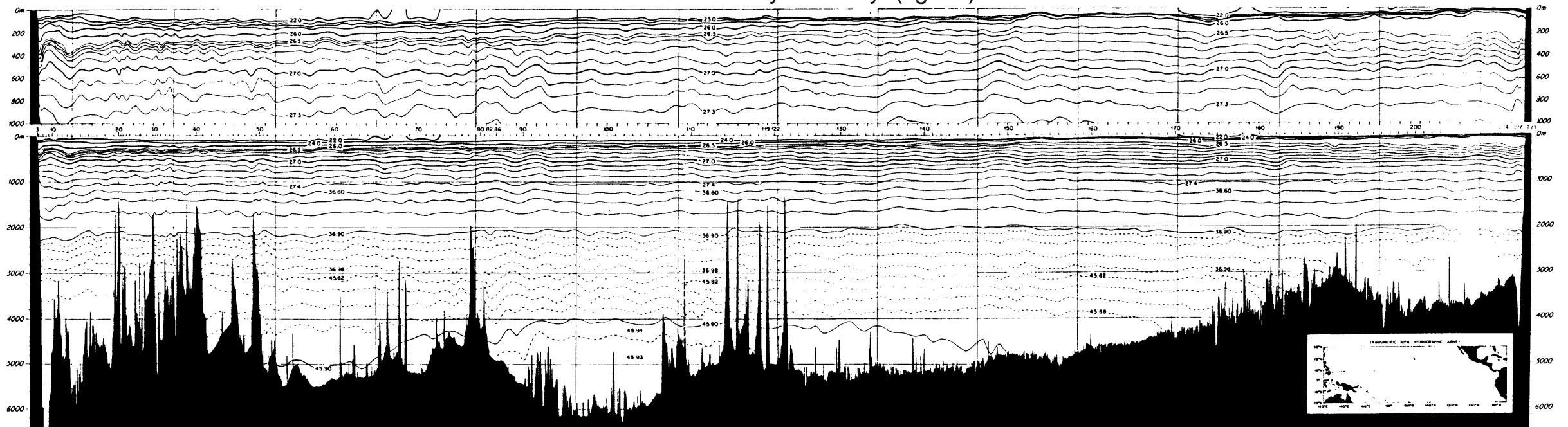

LEG 3. DOPPLER VELOCITIES — East Component in m/sec
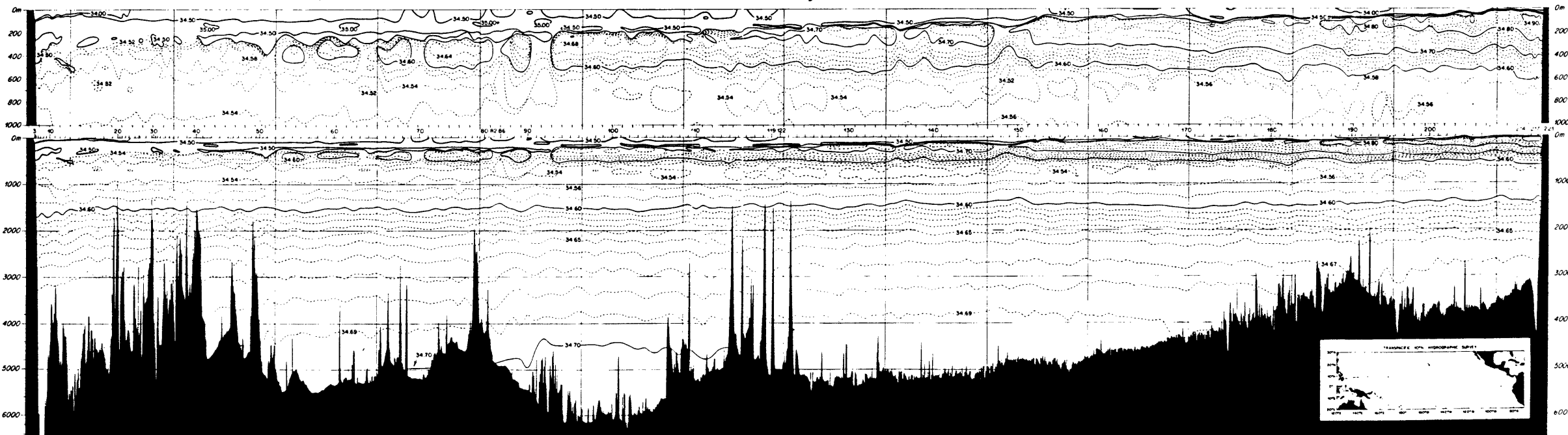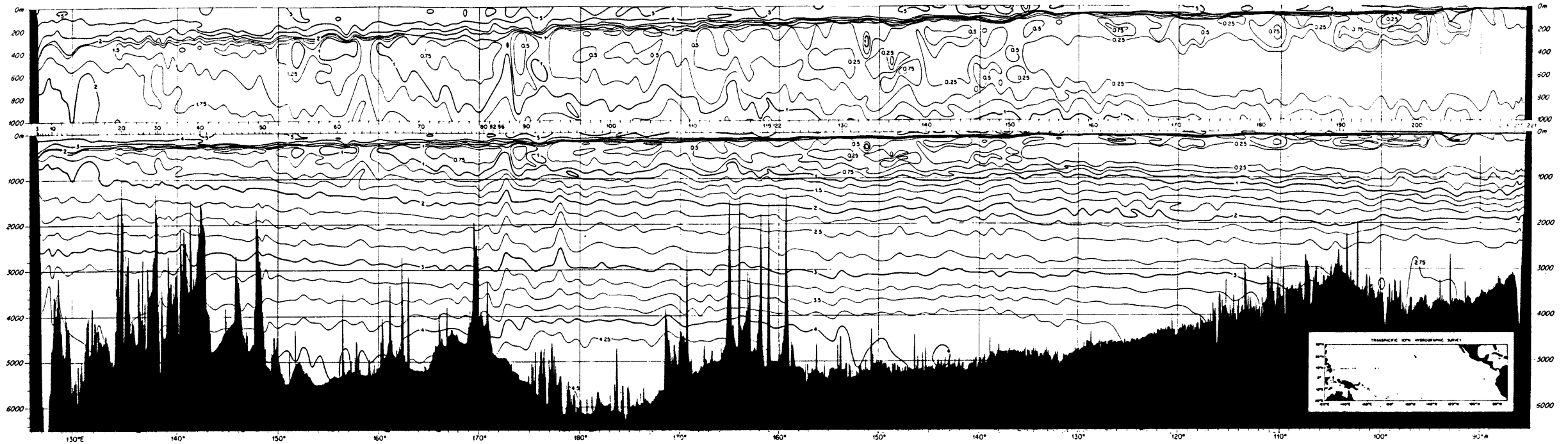
Plate 1

Station Positions

Potential Density Anomaly (kg/m3)

Plate 2

Potential Temperature (°C)

Salinity

Plate 3

Oxygen (ml/l)

Silica (µmol/l)

Plate 4

Nitrate (µmol/l)
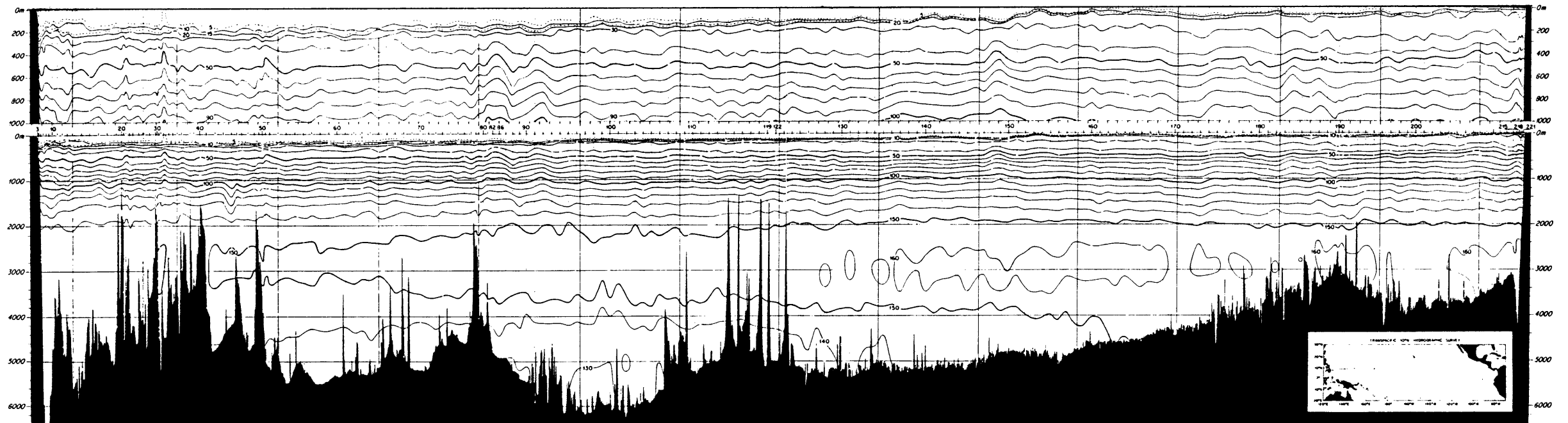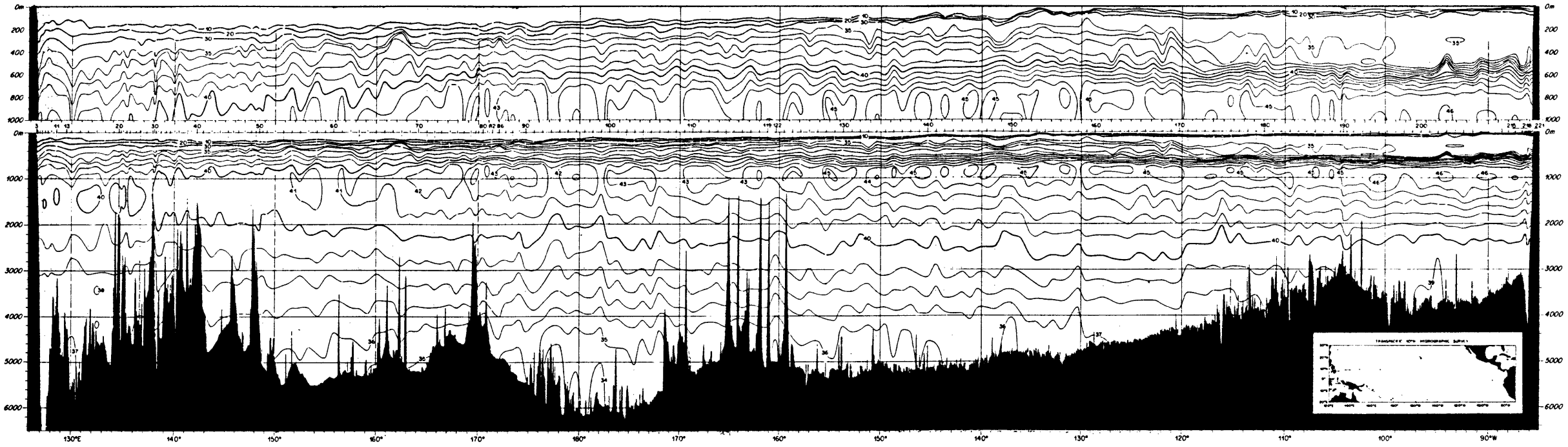
Phosphate (µmol/l)
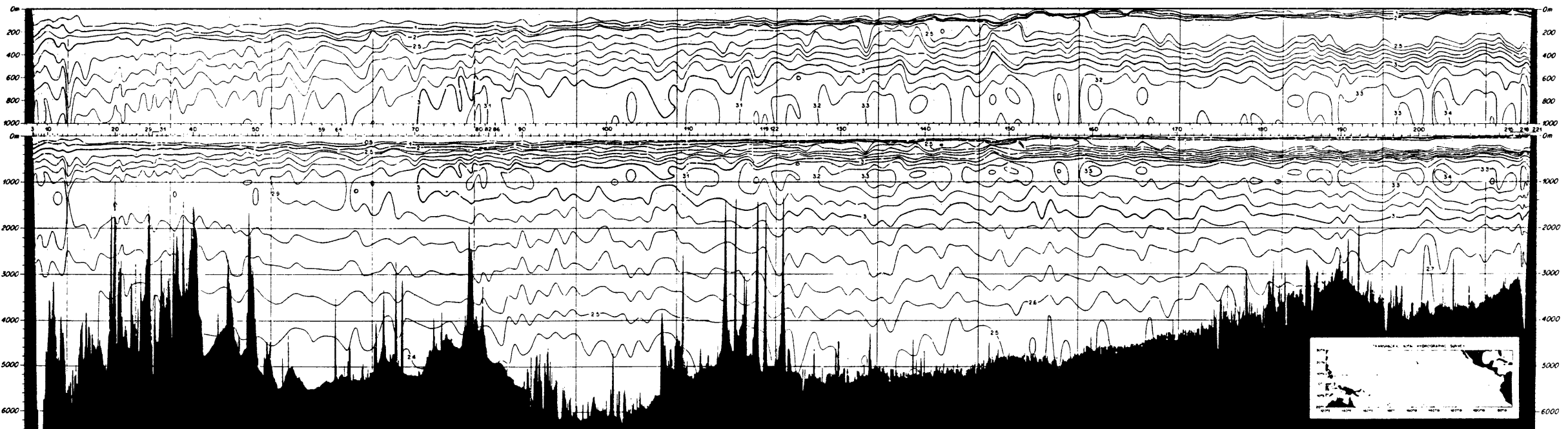
5b. PRECISION AND ACCURACY OF WATER SAMPLE SALINITY AND OXYGEN MEASUREMENTS
(G.P. Knapp, M.C. Stalcup and R.J. Stanley)

A complete description of the dissolved oxygen and salinity measurement techniques used during this cruise is presented by Knapp et al. (1989). As described in this report, samples are collected for the analysis of dissolved oxygen and salinity from each of the 24 ten-liter Niskin (SIO) bottles tripped on the upcast of each CTD station. The vertical distribution of these samples was a compromise between the need to obtain deep samples for the calibration of the CTD conductivity and oxygen sensors and the requirement to define the characteristics of the water masses by the distributions of the various measured parameters.

Several analyses were performed on the water retrieved from each rosette bottle. Analysis samples were drawn from the rosette bottles in the sequence recommended by the World Ocean Circulation Experiment (WOCE) Hydrographic Program: CFC, Helium-Tritium, oxygen, nutrients, salinity. Several tests were performed during the cruise to assess possible degradation of oxygen samples collected from the overflow of the copper tubes used to collect the Helium-Tritium samples. No change was observed in oxygen samples collected in this manner. Each oxygen bottle was rinsed twice with sample water and then carefully filled to avoid aeration. Approximately 200 ml of the sample was permitted to overflow the bottle. One ml each of the MnCl2 and NaI-NaOH reagents was immediately added to the seawater, and the sample bottle was capped and shaken vigorously. The salinity sample bottles and caps were rinsed three times with sample water before filling. An air space of approximately 8 cc was left in the bottle to allow for the expansion of cold samples. When all of the oxygen and salinity samples had been collected, they were placed in the constant temperature portable lab to equilibrate thermally and await analysis. About an hour after the oxygen samples were collected, they were shaken a second time to ensure complete oxidation of the precipitant.

Just before the oxygen samples were to be titrated, one ml of H2SO4 was added to each sample, followed by a second vigorous shaking to dissolve the precipitate and release iodine proportional to the dissolved oxygen originally in the sample. A 50 ml aliquot of the iodine solution from each bottle was titrated with 0.01 N sodium thiosulphate using an automated amperometric, dead-stop method controlled by a Metrohm Titroprocessor. The normality of the thiosulphate was determined regularly by comparison with a biiodate standard solution which has a normality of exactly 0.0100. The reagent blank value was also determined periodically.

SALINITY

Analysis of the salinity samples was not conducted until samples achieved laboratory temperature, generally about 3-4 hours after collection. Before each salinity bottle was opened it was thoroughly shaken to remove gradients. Both the filling tube and the sealing cork on the salinometer were carefully dried before each sample was measured to avoid contamination from the previous sample. The rate at which the air pump fills the conductivity cell with seawater is adjusted to ensure that the sample reaches bath temperature before the conductivity ratio is measured. The Guildline Autosal Model 8400-A salinometer was standardized with IAPSO Standard Sea Water (SSW) Batch P-97, and the zero reference and heater lamps were checked daily.

The salinometer manufacturer claims a precision of 0.0002 and an accuracy of 0.003 when the instrument is operated at a temperature within +4 C and -2 C of ambient. They also note that, when measurements are made in a laboratory in which the temperature is constant (+/-1 C) and maintained about 1-2 C below that of the salinometer water bath, the accuracy is better than 0.001. All of the salinity measurements made during this cruise were made within a temperature controlled (+/-1 C) portable laboratory maintained about 2 C below that of the salinometer water bath (set to 24 C) .

Mantyla (1987) has found that the conductivity ratio of some batches of standard water appears to change as they age. The batch used during this cruise (P-97) is dated 3/3/1983 and, because of concern over the aging problem identified by Mantyla, has been routinely compared with fresher batches for the past several years. These comparisons show that the conductivity ratio of P-97 has not changed since it was bottled. He also notes that P-97 is slightly fresher than the PSS78 KCl standard. Based on his work a correction of +0.0008 has been applied to all of the salinities measured during this cruise.

Table 5b-1 shows the results of salinity measurements made during the cruise from 43 duplicate samples collected at different stations from each of two 10 liter Niskin bottles tripped at the same depth. The standard deviation of the differences in salinity measured from these samples is 0.0010.

Figure 5b-1a shows water sample salinities interpolated at potential temperatures of 1.0 , 1.2 , 1.4 , 1.6 , 1.8 and 2.0 C plotted versus longitude. A least squares line has been fitted to the data at each temperature. The salinity increases toward the east at an average rate of about 0.00014 per degree of longitude at all but the coldest temperature. The standard deviation and the coefficients of variation of the differences between these lines and the data are presented in Table 5b-2. The values plotted in Figure 5b-1a and the differences presented in this table include the effects of linear interpolations between observations above and below each potential temperature, the effects of oceanic variability, and errors introduced during the sampling and analysis of the salinity samples. In

order to assess the accuracy of the salinity measurements better, data were selected from a region where the (oceanic) variability was low. In both Figures 5b-1a and 5b-1b the measurements made between 110 W and 150 W at potential temperatures of 1.6 deg and 1.8deg show reduced variability. These data are presented in Figures 5b-1f and 5b-1g where least squares lines have been fitted to the data at each potential temperature. Although the non-random character of the small scale variability in this figure might suggest that the variability was due to systematic measurement errors, the 16 daily standardizations of the salino-meter during this part of the cruise revealed no measurable drift. In addition the salinometer "standby" number was recorded at each station. This reading indicates whether the standardize control setting has been changed or if the electronics have drifted during the course of the measurements. The standard deviation of this value during this part of the cruise is equivalent to a change in salinity of 0.00017. Thus the non-random changes in the salinities shown in Figure 5b-1f are most likely the result of small and somewhat regular variations in the deep salinity along the cruise track. The standard deviation of the differences between these salinity data and a least squares line is 0.0010. This value includes the variation due to oceanic variability and errors introduced during the interpolation procedure as well as problems with sampling and analysis. We interpret these data to indicate that the accuracy of the salinities measured during Moana Wave 89-3 is probably better than +/-0.001.

OXYGEN

All of the dissolved oxygen samples measured during this cruise were analysed with an automated Winkler titration system described by Knapp et.al (1989). On two separate occasions 13 duplicate dissolved oxygen samples were collected from a single 10 liter Niskin bottle and titrated to assess the precision of the dissolved oxygen measurements. The standard deviations of the two tests were 0.005 and 0.007 ml/l and indicates the precision of the oxygen measurements is about 0.1%. Table 5b-1 shows the results from the measurement of replicate samples collected from separate Niskin bottles tripped at the same depth at 21 different stations and indicates a precision of 0.015 ml/l or about 0.2%. Figure 5b-1b shows dissolved oxygen values interpolated at potential temperatures of 1.0 1.2 , 1.4 , 1.6 , 1.8 and 2.0 C at each of the stations with a least squares fit to the data at each temperature. Table 5b-2 presents the standard deviations and coefficients of variation for the differences between the interpolated oxygen data and the least squares lines. Figure 5b-1g is for the same stations shown in Figure 5b-1f and depicts oxygen values interpolated at potential temperatures of 1.6 and 1.8 C together with least squares lines fit to the data between 150 W and 110 W, in a region of reduced oceanic variability. The standard deviation of the differences between these lines and the data at potential temperatures of 1.6 and 1.8 C is 0.8 and 0.019 and 0.028 ml/l respectively. Using the same assumptions regarding oceanic variability that were made for the salinity measurements, these data indicate that the accuracy of the oxygen measurements made during this cruise is likely better than 1%.

FIGURE CAPTIONS SECTION 5b

Figures 5b-1a to 5b-1e.
Salinity, oxygen, silica, nitrate and phosphate values were interpolated at six potential temperatures for all of the stations occupied during Moana Wave 89-3. The square symbols are at theta = 1.0 C, the asterisks are at 1.2 C, the diamonds are 1.4 C, the stars are at 1.6 C, the pluses are at 1.8 C and triangles are at 2.0 C. Least-squares lines, fit to the data versus longitude on each potential temperature surface, show the east-west trend of the variables. To avoid over-plotting the data, only the three deepest surfaces are shown in the nutrient plots.

Figures 5b-1f and 5b-1g.
Salinity and oxygen values interpolated at potential temperatures of 1.6 and 1.8 C from data collected between 148 W and 110 W where the oceanic variability is low. These data were selected to assess the accuracy of the salinity and oxygen measurements made during this cruise. The standard deviations and coefficients of variation of the differences between a least-squares linear fit to the data are shown in Table 5b-2.

Figure 5b-1a:
Salinity values interpolated at six potential temperatures for all of the stations occupied during Moana Wave 89-3. The square symbols are at theta = 1.0 C, the asterisks are at 1.2 C, the diamonds are 1.4 C, the stars are at 1.6 C, the pluses are at 1.8 C, and triangles are at 2.0 C.

Figure 5b-1b:
Oxygen values interpolated at six potential temperatures for all of the stations occupied during Moana Wave 89-3. The square symbols are at theta = 1.0 C, the asterisks are at 1.2 C, the diamonds are 1.4 C, the stars are at 1.6 C, the pluses are at 1.8 C and triangles are at 2.0 C.

Figure 5b-1c:
Silica values interpolated at three potential temperatures for all of the stations occupied during Moana Wave 89-3. The square symbols are at theta = 1.0 C, the asterisks are at 1.2 C, the diamonds are 1.4 C.

Figure 5b-1d:
Nitrate values interpolated at three potential temperatures for all of the stations occupied during Moana Wave 89-3. The square symbols are at theta = 1.0 C, the asterisks are at 1.2 C, the diamonds are 1.4 C.

Figure 5b-1e:
Phosphate values interpolated at three potential temperatures for all of the stations occupied during Moana Wave 89-3. The square symbols are at theta = 1.0 C, the asterisks are at 1.2 C, the diamonds are 1.4 C.

Figure 5b-1f:
Salinity values interpolated at potential temperatures of 1.6 and 1.8 C from data collected between 148 W and 110 W where the oceanic variability is low.

Figure 5b-1g:
Oxygen values interpolated at potential temperatures of 1.6 and 1.8 C from data collected between 148 W and 110 W where the oceanic variability is low.

TABLES SECTION 5b

Table 5b-1. Samples were collected from two 10 liter Niskin bottles which were tripped at the same depth at 21 stations. The differences between the salinity and oxygen measurements made on these duplicate samples are shown. The standard deviation of the salinity and oxygen differences are respectively, 0.0010 PSU and 0.015 ml/l.

Sta #	**Differences** Bottle #	Salt PSS78	Oxy. ml/l	Sta #	**Differences** Bottle #	Salt PSS78	Oxy ml/l
36	4,5	0.001	0.01	64	6,7	0.001	0.02
38	4,5	0.001	0.01	64	11,12	0.000	0.02
47	4,5	0.000	0.03	65	7,8	0.000	0.00
50	1,2	0.000	0.01	65	9,10	0.002	0.01
50	4,5	0.001	0.02	65	18,19	0.000	0.02
51	4,5	0.000	0.02	66	16,17	0.002	0.01
52	1,2	0.001	0.01	66	18,19	0.001	0.01
52	4,5	0.000	0.00	66	20,21	0.002	0.06
53	2,3	0.001	0.00	67	18,19	0.000	0.04
53	4,5	0.000	0.01	67	21,22	0.001	0.01
54	1,2	0.000	0.02	68	16,17	0.002	0.00
58	4,5	0.000	0.00	69	14,15	0.000	0.01
58	8,9	0.003	0.00	69	16,17	0.003	0.01
59	4,5	0.002	0.00	69	18,19	0.002	0.02
59	8,9	0.000	0.02	69	20,21	0.001	0.05
61	13,14	0.000	0.02	70	15,16	0.002	0.01
62	7,8	0.001	0.00	70	17,18	0.003	0.01
62	9,10	0.000	0.00	70	19,20	0.000	0.02
62	11,12	0.000	0.01	70	22,23	0.001	0.06
62	17,18	0.000	0.01	71	14,15	0.002	0.00
63	13-14	0.000	0.03	71	20,21	0.000	0.04
63	19,20	0.003	0.02				

Table 5b-2. Pressure, salinity, oxygen and nutrient values were interpolated at six potential temperatures for all of the stations. A least squares fit was made to the data on each potential temperature surface and the differences were calculated. These differences were used to determine the standard deviation and the coefficient of variation (standard deviation / average * 100) for each variable. The two sub-tables labeled "Stations between 110 W and 150 W" were calculated as described above and show the standard deviations and coefficients of variation at theta equals 1.6 and 1.8 C. The data used in these calculations are shown in Figures 5b-1f and 1g and were selected from a region where the oceanic variability appears to be low in order to assess better the accuracy of the salinity and oxygen measurements made during this cruise.

STANDARD DEVIATION OF WATER SAMPLE DATA

	Theta C	Pts	Press db	Salnty	Oxygen ml/l	Silcat uM/1	Phspht uM/1	Nitrat uM/1
MW	1.0	65	202	0.0017	0.039	1.2841	0.0292	0.2687
MW	1.2	133	111	0.0014	0.034	1.6349	0.0353	0.2787
MW	1.4	171	71	0.0015	0.039	1.7089	0.0339	0.3062
MW	1.6	193	114	0.0017	0.044	1.8516	0.0337	0.3427
MW	1.8	206	53	0.0016	0.046	1.5895	0.0338	0.3720
MW	2.0	207	65	0.0015	0.052	1.4664	0.0353	0.4065

Stations between 110 W and 150 W

MW	1.6	43	34	0.0010	0.019
MW	1.8	43	40	0.0010	0.028

COEFFICIENT OF VARIATION OF WATER SAMPLE DATA

	Theta	Pts	Press	Salnty	Oxygen	Silcat	Phspht	Nitrat
MW	1.0	65	4.613	0.005	0.968	0.916	1.179	0.749
MW	1.2	133	3.000	0.004	0.976	1.080	1.361	0.743
MW	1.4	171	2.295	0.004	1.256	1.104	1.264	0.793
MW	1.6	193	4.192	0.005	1.566	1.193	1.225	0.871
MW	1.8	206	2.276	0.005	1.792	1.040	1.204	0.931
MW	2.0	207	3.126	0.004	2.162	0.983	1.238	1.005

Stations between 110 W and 150 W

MW	1.6	43	1.27	0.002	0.708
MW	1.8	43	1.72	0.003	1.147

Figure 5b-1a: Salinity values interpolated at six potential temperatures for all of the stations occupied during <u>Moana Wave</u> 89-3. The square symbols are at theta = 1.0°C, the asterisks are at 1.2°C, the diamonds are 1.4°C, the stars are at 1.6°C, the pluses are at 1.8°C, and triangles are at 2.0 °C.
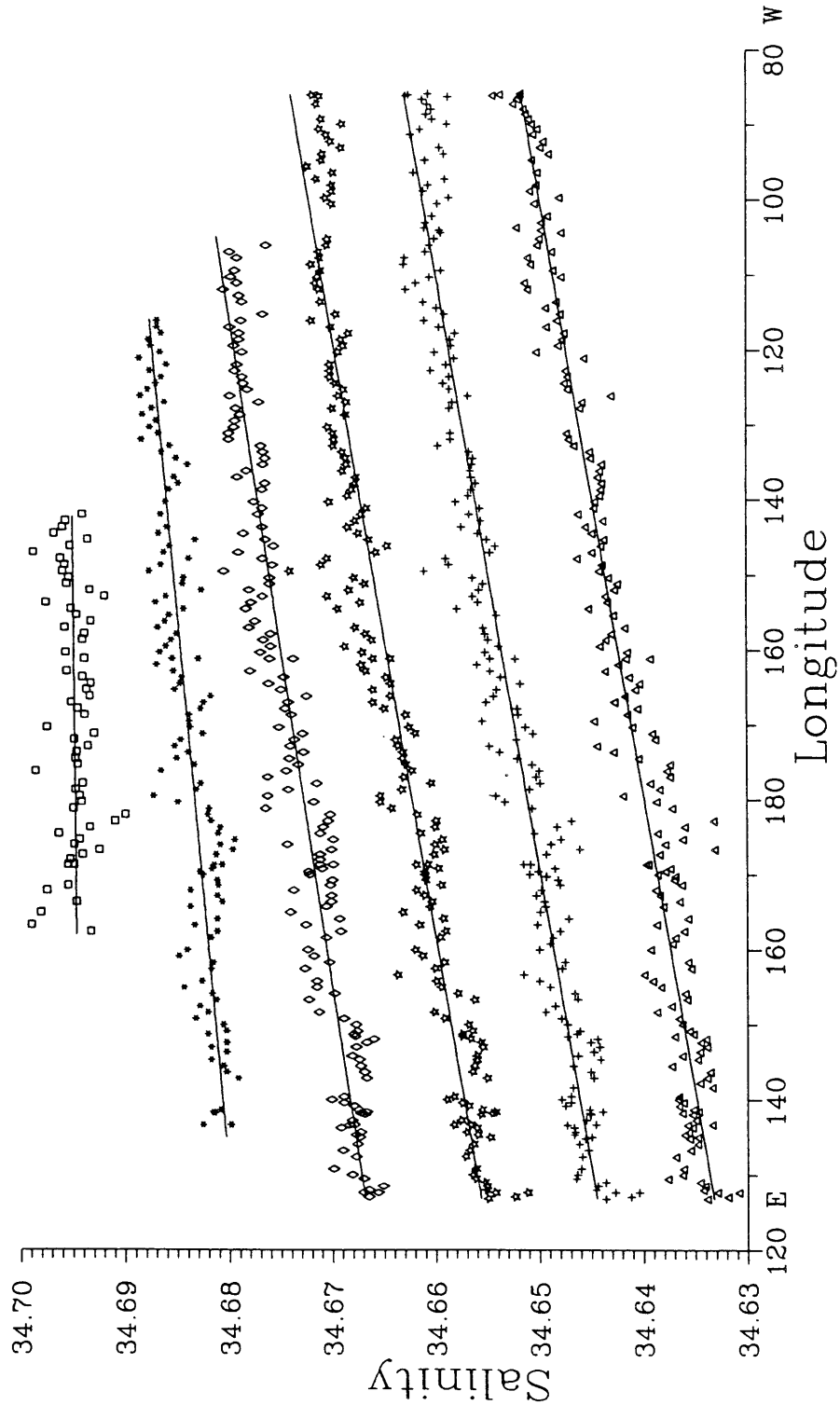
Figure 5b-1b: Oxygen values interpolated at six potential temperatures for all of the stations occupied during <u>Moana Wave</u> 89-3. The square symbols are at theta = 1.0°C, the asterisks are at 1.2°C, the diamonds are 1.4°C, the stars are at 1.6°C, the pluses are at 1.8°C and triangles are at 2.0 °C.

Figure 5b-1c: Silica values interpolated at three potential temperatures for all of the stations occupied during <u>Moana Wave</u> 89-3. The square symbols are at theta = 1.0°C, the asterisks are at 1.2°C, the diamonds are 1.4°C.

Figure 5b-1d: Nitrate values interpolated at three potential temperatures for all of the stations occupied during <u>Moana Wave</u> 89-3. The square symbols are at theta = 1.0°C, the asterisks are at 1.2°C, the diamonds are 1.4°C.
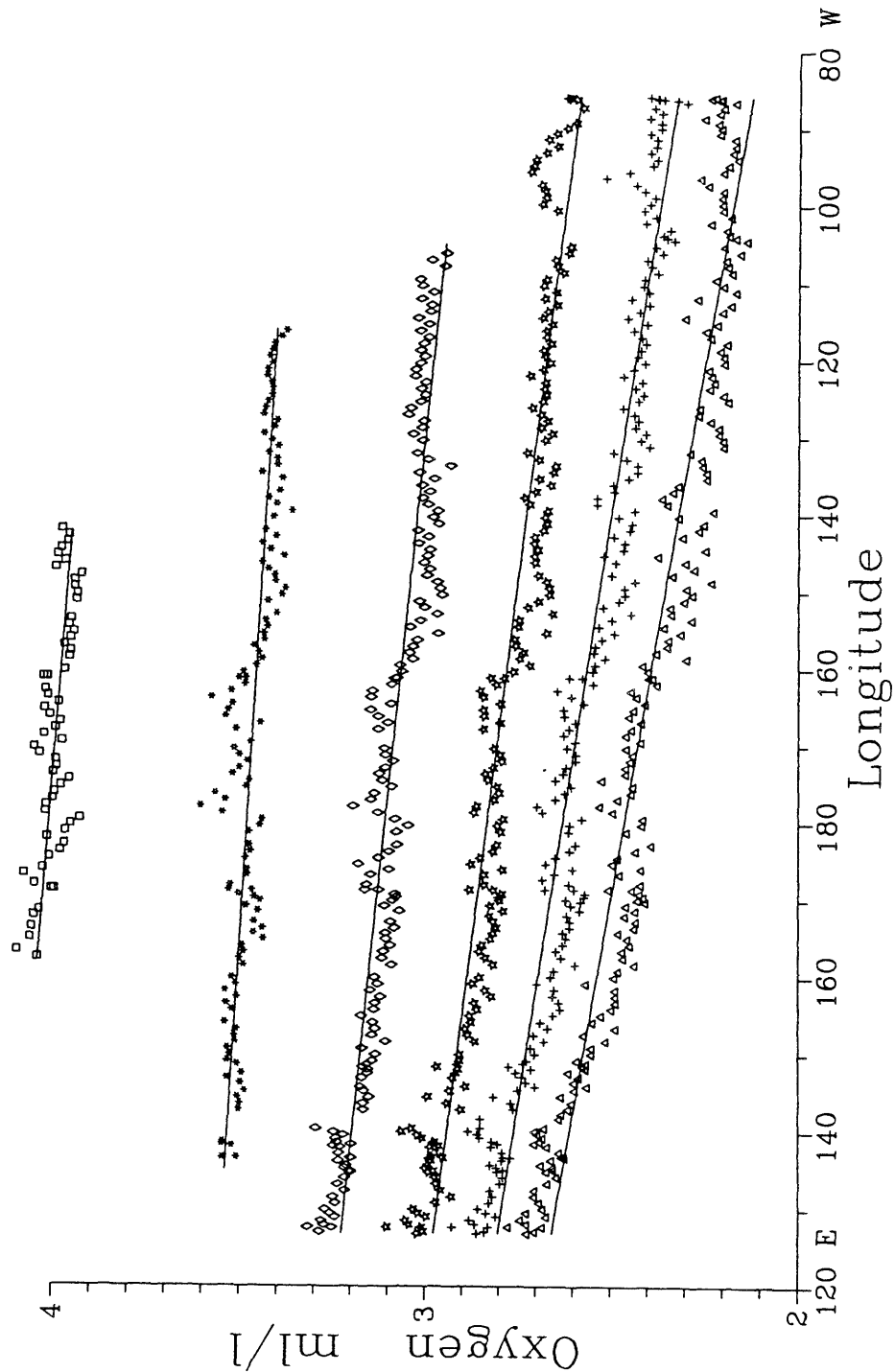
Figure 5b-1e: Phosphate values interpolated at three potential temperatures for all of the stations occupied during Moana Wave 89-3. The square symbols are at theta = 1.0°C, the asterisks are at 1.2°C, the diamonds are 1.4°C.

Figure 5b-1f: Salinity values interpolated at potential
temperatures of 1.6° and 1.8°C from data collected between 148° and
110°W where the oceanic varibility is low.

Figure 5b-1g: Oxygen values interpolated at potential temperatures of 1.6° and 1.8°C from data collected between 148° and 110°W where the oceanic varibility is low.

5c.   CTD MEASUREMENTS
          (C. MacMurray and J. Toole)

The NBIS CTD/O2 instrument is equipped with sensors to measure pressure, and sea water temperature, conductivity and dissolved oxygen concentration. The ultimate accuracy of the reduced data set hinges on the calibration of these sensors. Both laboratory measurements and water sample data obtained at sea are used to determine the sensor calibrations. General information on CTD calibration methodolo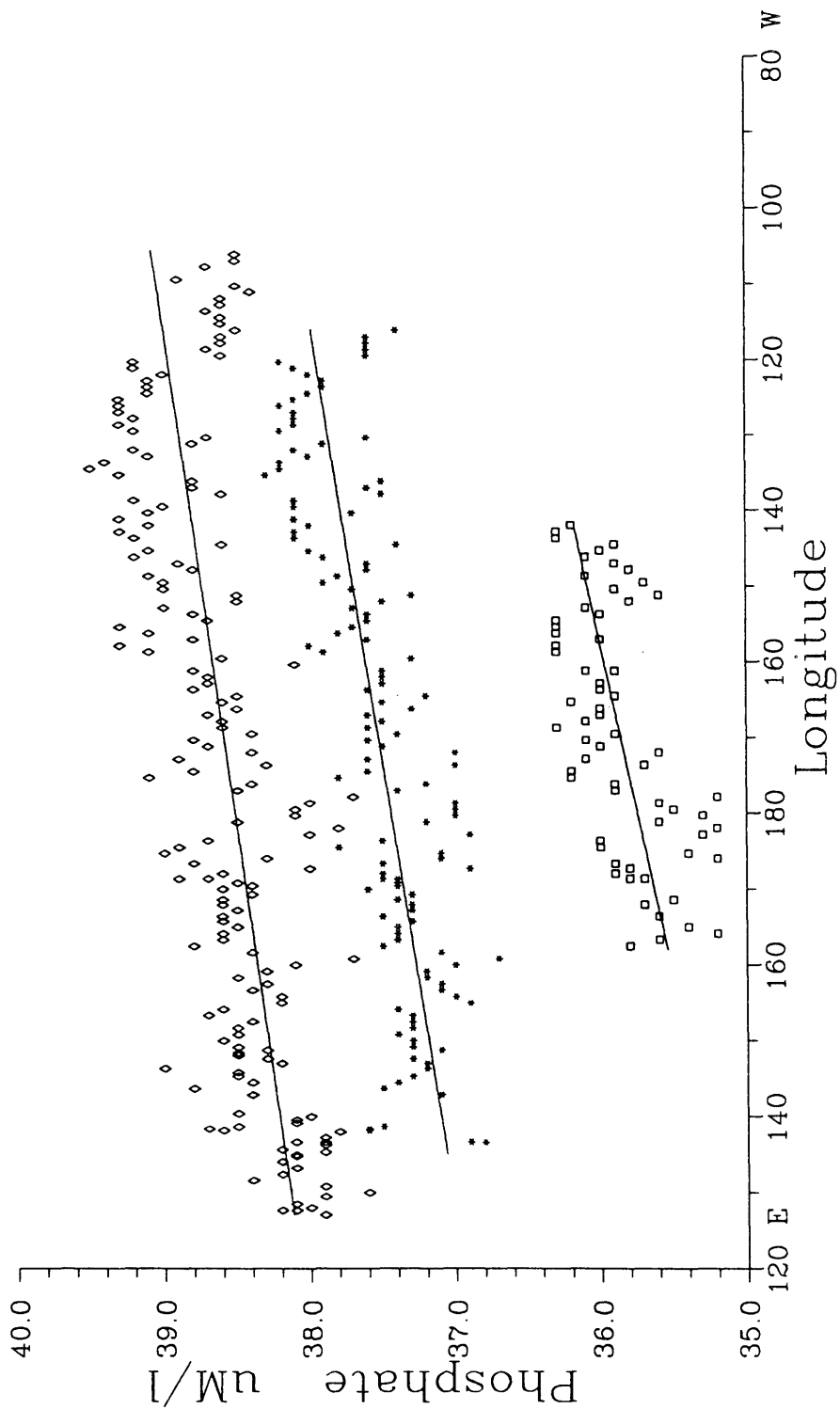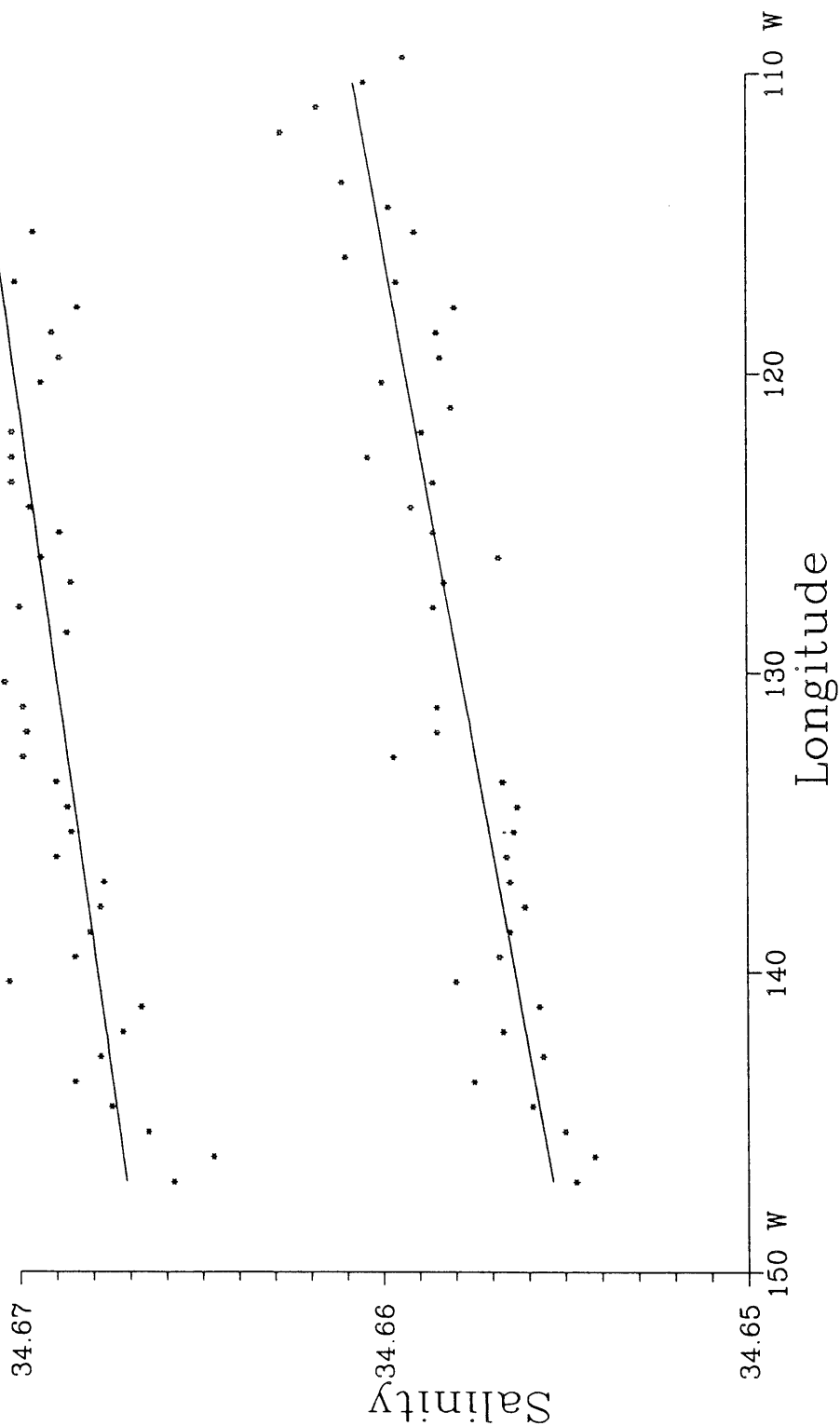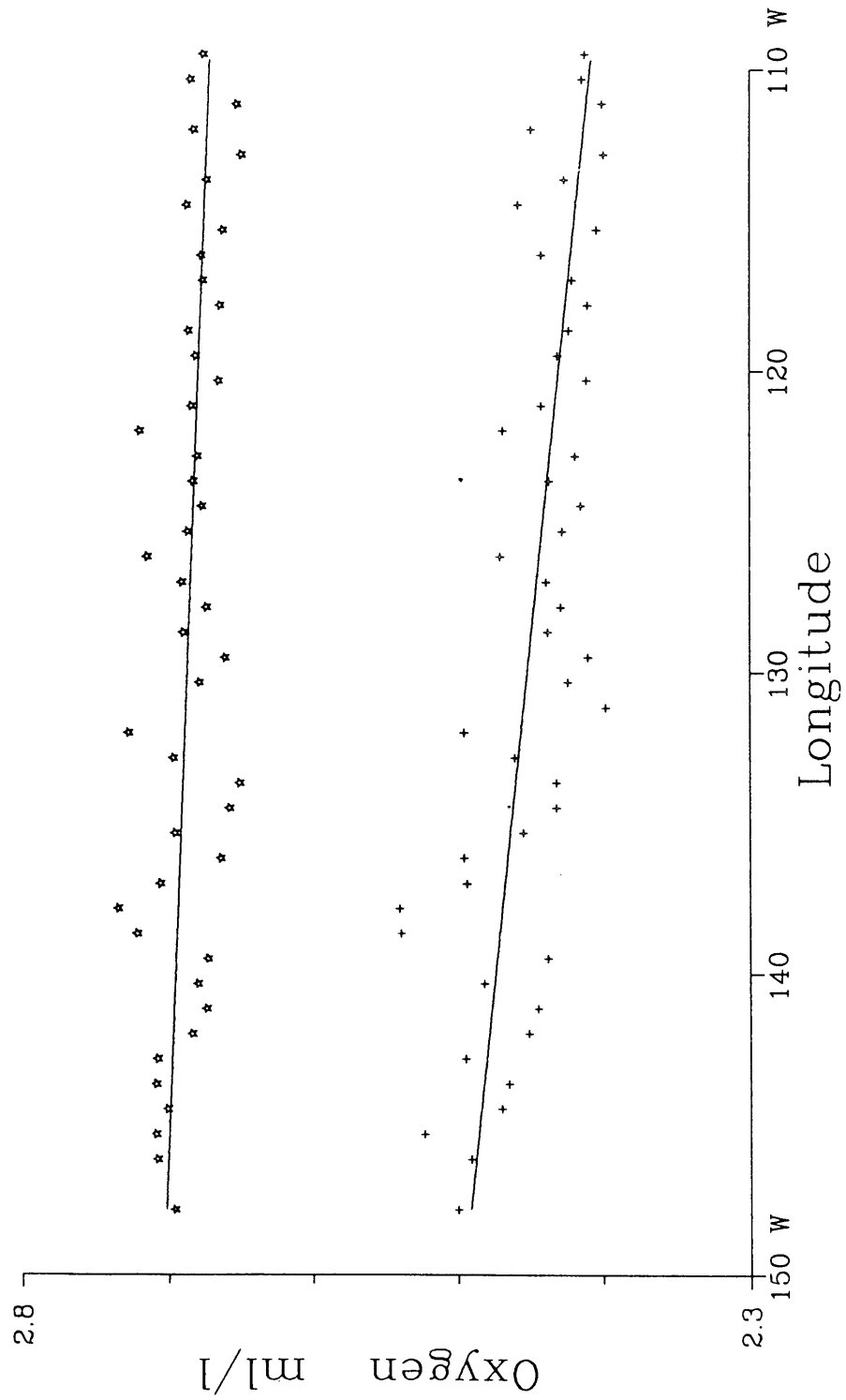gy and data processing procedures can be found in the reports of Fofonoff, Hayes, and Millard (1974) and Millard and Galbraith (1982).

Temperature and pressure data
Laboratory calibrations, performed before and after the 10 N cruise, provide the sole correction information for the CTD pressure and temperature sensors. Note that temperature and pressure calibrations are used to scale the data profiles as well as the CTD component of the rosette water sample data files. Laboratory temperature calibrations of CTD #9 at the WHOI calibration facility before and after the cruise showed a change of .0004 at 0 C and .0026 at 24 C (instrument reported colder in time). Pre- to post-cruise differences were even less for CTD #81, .0003 at 0 C and .0014 at 24 C (instrument reported colder at 24 C in post-cruise calibration but warmer at 0 C). Due to tight shipping schedules, there was not much time to perform a careful check of CTD #10 prior to leg 3. The pre-cruise calibration for CTD #10 was hurried, and we do not give it much credibility. Nevertheless, the observed pre-to-post cruise temperature shift at 0 C was only on the order of one half a millidegree. Based on these results, we believe the relative accuracy of the temperatures reported here, on the IPTS-68 temperature scale, is on the order of 2 m C. As absolute accuracy of the temperature data involves calibration and stability of the laboratory transfer standard and the homogeneity of the calibration bath, the 10 N absolute temperature data is probably uncertain by 3-4 m C.

No electronic adjustments were made to the temperature sensor interface boards during laboratory calibrations in order to preserve a long standing history on the stability of these sensors. Instead, corrections, determined by polynomial least-squares fits to the laboratory calibration data, were applied to the data. Temperature calibrations consisted of quadratic fits to 8-11 temperature points ranging between 0 and 30 C in reference to a platinum thermometer standard, Figure 5c-1. The following temperature correction algorithms were used in the reduction of CTD downcast and water sample rosette data collected on the 10 N transpacific cruise.

CTD#8 $T = .593955E\text{-}2 + (.499779E\text{-}3)*T_{raw} + (.343056E\text{-}11)*T2_{raw}$
          (Post-cruise) where T_{raw} is the raw counts of the temperature channel. For CTD #8, a time lag correction of 0.250 seconds between C and T sensors (deduced during the cruise) was also made.

CTD#9   T = .953261E-2 + (.499906E-3) * Traw + (.104558E-11) * T2raw
(Pre-cruise) Data from CTD #9 were corrected for a time-lag of .15
seconds.

CTD#10 T = .784017E-3 + (.499702E-3) * Traw + (.432617E-11) * T2raw
(Post-cruise) Data from CTD #10 were corrected for a time-lag of .25
seconds.

Pressure calibrations were done using a dead-weight tester; data were sampled at 1000 psi intervals with both increasing and decreasing pressure between 0 and 10000 psi. Data reduction employed a cubic calibration algorithm determined from a least-squares-fit to these data, Figure 5c-2. The pressure bias term applied to each CTD cast was determined by the pre-lowering deck unit pressure reading (du). The following downcast (0-6000 db range) pressure calibration algorithm was applied to the CTD #9 profiles.

CTD#9   P = - (du) + (.998880E-1) Praw + (.113246E-7) P2raw - (.169297E-12) P3raw
(Pre-cruise) where Praw is the raw counts of the pressure channel.

Final pressure data obtained with CTD #8 and CTD #10 contain empirical corrections which were applied to rectify a discrepancy between water sample and CTD derived salinity data. This correction is explained more fully below in the discussion of conductivity calibration. The downcast pressure calibration algorithm applied to CTD #8 data was:

CTD#8   P = - (du) + (.100459) Praw - (.147732E-7) P2raw + (.118881E-12) P3raw
(Post-cruise plus empirical correction)

The downcast calibration algorithm for instrument #10 pressure data was:

CTD#10   P = - (du) + (.983410E-1) Praw + (.628596E-7) P2raw - (.633079E-12) 3raw
(Post-cruise plus empirical correction)

In similar fashion, cubic calibration curves were constructed from the decreasing pressure (upcast) laboratory calibration data. A weighted combination of the pre-cruise downcast and upcast pressure calibrations were then applied to the CTD component of the rosette water sample data. The effect of this scaling is to force the down and up pressure calibration curves to be continuous at the bottom of the cast; the algorithm is:

$$P = (1-W) * Pup + W * Pdn$$

with Pup and Pdn being the results of the upcast and downcast calibration algorithms. The Pup calibration algorithms for each instrument are:

CTD9   Pup = -.299188EI + (.999125E-1) Praw + (.146870E-7) P2raw - (.197944E-12) P3raw
(Pre-cruise)

CTD8   Pup = .869254EO+ (.992531E-1)Praw + (.327062E-7) P2raw (.335345E-12) P3raw
(Post-cruise)

CTD10   Pup = -.218008E0 + (.990681E-1) Praw + (.251184E-7) P2raw (.164667E-12) P3raw
(Post-cruise)

The weighting, W, is given by:

$$W = \exp \frac{(P - Pbottom)}{300 \text{ db}}$$

Pbottom is the maximum pressure of the cast. The scale depth of 300 db was established from laboratory calibration data in which the CTD was cycled from 0 to 5000 psi.

Conductivity data
Linear conductivity calibration algorithms, derived from pre-cruise laboratory data, were used to generate CTD data acquisition display plots. The algorithms employed were:

CTD #8:   C = -.166747E-1 + (.100159E-2) * Craw * [1+A*(T-TO)+B*(P-PO)]
CTD #9:   C = .396792E-2 + (.999569E-3) * Craw * [1+A*(T-TO)+B*(P-PO)]
CTD #10:   C = -.286030E-2 + (.100004E-2) * Craw * [1+A*(T-TO)+B*(P-PO)]

where:
      Craw is the raw counts of the conductivity channel;
      A is   the temperature correction coefficient (-.65E-5 C-1)
      B is   the coefficient of cell contraction with pressure (1.5E-8 db-1)
      T is   scaled temperature
      T0 is 2.8 C
      P is   scaled pressure
      P0 is 3000 db

Final conductivity calibrations were derived from a least-squares regression of CTD and water sample conductivity data to determine the slope and bias terms in the above algorithms (Millard and Galbraith, 1982). As CTD #9 was employed for the bulk of the stations on the 10 N cruise, its conductivity calibration was addressed first. The regression routine for estimating conductivity bias and slope adjustments was initially run over all CTD #9 water sample data using the nominal A and B cell deformation coefficients in the above equation. Time series plots of water sample - CTD conductivity differences were then constructed to

identify station subgroups in which the CTD conductivity cell appeared stable in time, or drifted linearly in time. Expanded-scale potential temperature/salinity plots were also used to confirm the groupings. Careful examination of the deep-water temperature/salinity information revealed a subtle salinity departure (order .001) of the CTD trace from the water sample data. This discrepancy was minimized by setting the coefficient of cell deformation with pressure (B in the equation) to zero (as was done for a previously analyzed data set collected with CTD #9 by Cook et al., 1991). We have no explanation for why CTD #9's conductivity data is nonstandard. Table 5c-1 presents the coefficients of the CTD #9 conductivity correction algorithm used to produce the final data.

Derivation of conductivity calibration algorithms for data acquired with CTD instruments 8 and 10 proved significantly more difficult. Correction algorithms, defined from regressions between upcast CTD measurements and water sample observations, when applied to downcast CTD data resulted in CTD salinity data that was inconsistent with the water sample salinity observations. CTD and water sample salinity data diverged with increasing temperature on potential temperature-salinity diagrams; the discrepancy was greatest at the salinity minimum level around potential temperature 6.0 C where CTD-bottle salinity differences were on order .005-.0067. The error was ultimately traced to residual hysteresis in the pressure data (see below). The magnitude of the salinity error associated with this problem was quantified by estimating the salinity differences between CTD downcast and upcast at selected temperature surfaces. If the ocean temperature/salinity relationship was steady in the time interval between down and up, there should be no difference in the two CTD salinity values. Figure 5c-3 shows that there were measurable salinity differences between the down- and upcasts.

After much thought, it was concluded that the salinity error was caused by error in the pressure data. The nominal sensitivity of the derived salinity on pressure is 0.001 per 2.5 db (Fofonoff and Millard, 1983). The observed salinity errors are indicative of pressure errors of order 10-15 db. However, the static pressure calibrations, performed at the WHOI Calibration Facility in 1989, are believed accurate to .1% or 6 decibars (G. Bond, personal communication, 1991). The standard NBIS CTD pressure sensor can be sensitive to thermal transients of this magnitude when the time response of the pressure gauge and its associated thermistor collar (Brown and Morrison, 1978) are mismatched. Laboratory thermal shock tests, performed after the cruise, revealed pressure errors in the correct sense to explain the 10 N salinity error.

We derived empirical pressure correction algorithms to account for the pressure sensor error. The algorithm applied to the downcast data consisted of an adjustment to the laboratory derived cubic correction equation discussed above. The adjustment varied linearly with decreasing pressure (as suggested by the salinity difference data of Figure 5c-3) from zero adjustment at 5000 db to order 10 db adjustment at 1000 db. At shallower levels the pressure adjustment

returned smoothly to zero value at the surface. The adjusted correction algorithms are reported above. No adjustment was made to the upcast data as it was argued that, apart from the upper few hundred meters of the water column, the CTD experiences no strong thermal transients, and so should accurately report its pressure.

Determination of the coefficients in the conductivity correction algorithm for CTD #8 and #10 data then proceeded straightforwardly as for CTD #9 data. Conductivity was fit over all stations for each of these instruments. No subgrouping or drifting was apparent. Table 5c-1 presents the bias and slope values used to produce the final data.

Uncertainty in the final CTD salinity data may be measured by differences between CTD and water sample salinity data. Absolute CTD salinity accuracy of course hinges on the accuracy of the water sample data (see the preceding section). Two measures of CTD/water-sample consistency were prepared (Figures 5c-4 and 5c-5, lower panels). The time series plot of salinity differences as a function of station number shows the final data to be uniformly calibrated. The histogram of the salinity differences for the full data set is Gaussian with zero mean as would be expected from random measurement error; the standard deviation of the population is .00177 in the deep water (pressure greater than 2500 db). The distribution of potential density anomaly along 10 N is presented in Plate 1 together with the location of each station. The distribution of potential temperature (C) and salinity along the section is shown in Plate 2.

Oxygen data
Coefficients in the CTD oxygen sensor calibration algorithm were derived from in situ water sample oxygen data following Owens and Millard (1985). The algorithm is:

Oxm = [A * (Oc + B dOc/dt) + C] Oxsat (T, S) e D   [T + E * (To-T) + F * P

Where

 Oc is the measured oxygen current

 To is the measured oxygen temperature

 Oxsat(T,S) is the oxygen saturation according to Weiss (1970)

 A is the oxygen current slope;

 B is the oxygen sensor lag;

 C is the oxygen current bias;

 D, E, and F represent adjustments for the oxygen sensor's Teflon membrane permeability sensitivity to temperature and pressure.

CTD oxygen sensors were replaced several times during the cruise when it appeared that the data were degrading. Table 5c-2 reports the sensor history for the cruise.

The process of calibrating the data began by subdividing the stations into groups which appeared to have homogeneous calibration characteristics. A multiple regression technique was then used to define the coefficients in the above equation. Note that the regression is between downcast CTD oxygen sensor data and water sample observations obtained on the upcast. (This is because erroneous CTD oxygen data are obtained when the underwater package is stopped to close a rosette bottle. As well, the oxygen sensor typically exhibits excessive up-down hysteresis.)

Oxygen sensor characteristics changed markedly in time on the 10 N cruise. Regression groups were typically small, and frequently consisted of single stations. Because of the extremely low oxygen values found in the Pacific Ocean, some of the oxygen fitting routines did not give satisfactory results; the algorithm occasionally returned values below zero. These areas, generally in the shallow thermocline, were interpolated over. Some fits also needed to be weighted either more heavily at the surface or bottom to obtain reasonable fits, while other stations required large lags in order to get the CTD to match the water sample data at the thermocline. We have no explanation for the lack of sensor stability or its occasional nonstandard behavior. The following details the algorithm coefficients used to generate the final data:

As was the case for the salinity data, a measure of CTD derived oxygen data uncertainty is given by comparison with the water sample data (Figures 5c-4 and 5c-5, upper panels), but the absolute accuracy depends directly on the water sample accuracy. The population of oxygen difference data has a standard deviation of .03 ml/l in the deep water (pressure greater than 2500 db), with a mean indistinguishable from zero. The distribution of dissolved oxygen (ml/1) along 10 N is shown in Plate 3.

Figure 5c-1: Temperature calibrations with 8-11 temperature points ranging between 0° and 30°C in reference to a platinum thermometer standard.
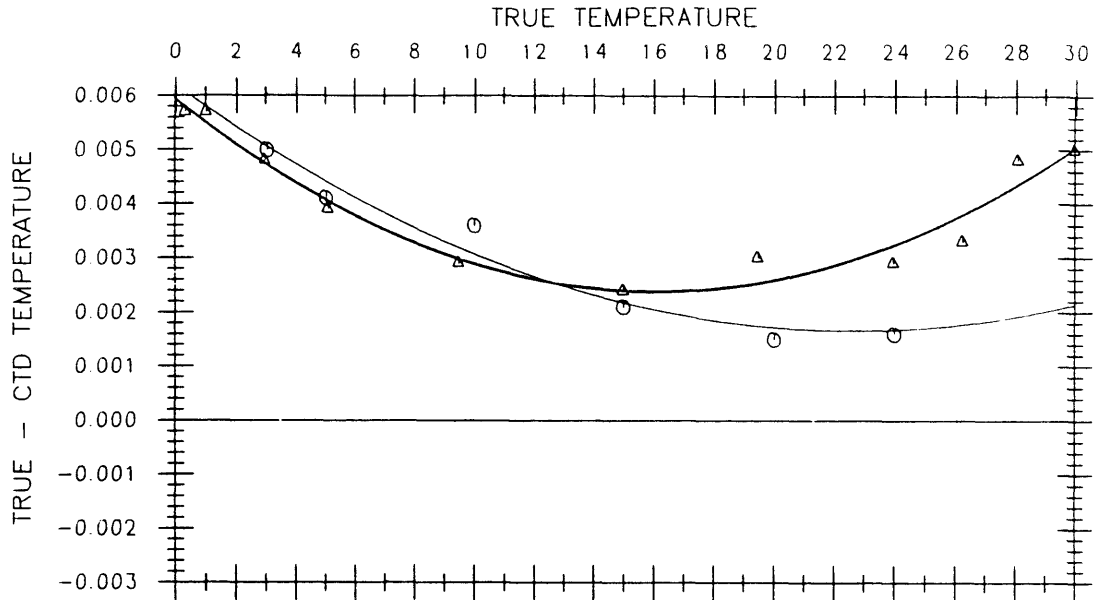
CTD8 cals dec88 jun89
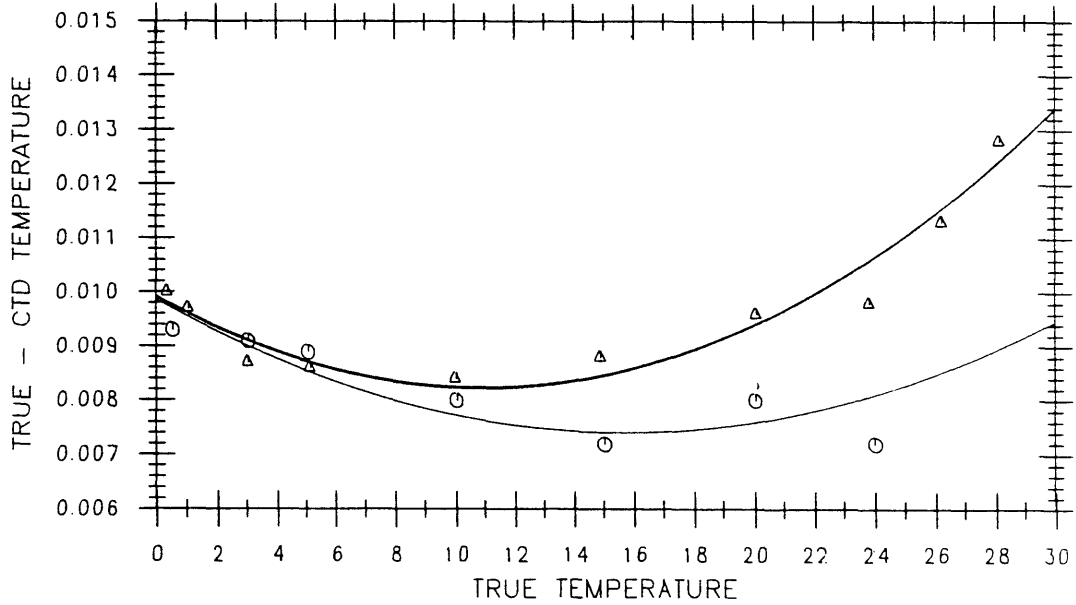
CTD9 cals dec88 jun89

Figure 5c-2: Pressure calibrations employed a cubic calibration algorithm determined from a least squares fit.

CTD8,9,10 pre and post mw893 pressure cals

Figure 5c-3: Salinity differences between the down- and upcasts *vs* pressure.

Figure 5c-4: The time series of salinity differences as a function of station number shows the final data to be uniformly calibrated.

MOANA WAVE — OBSERVATIONS BELOW 2500 DB

Figure 5c-5: Histograms showing the water sample minus CTD differences for oxygen and salinity at pressures greater than 2500 db.

OBS DEEPER THAN 2500 DB

FIGURE CAPTIONS SECTION 5c

Figure 5c-1: Temperature calibrations with 8-11 temperature points ranging between 0 and 30 C in reference to a platinum thermometer standard.
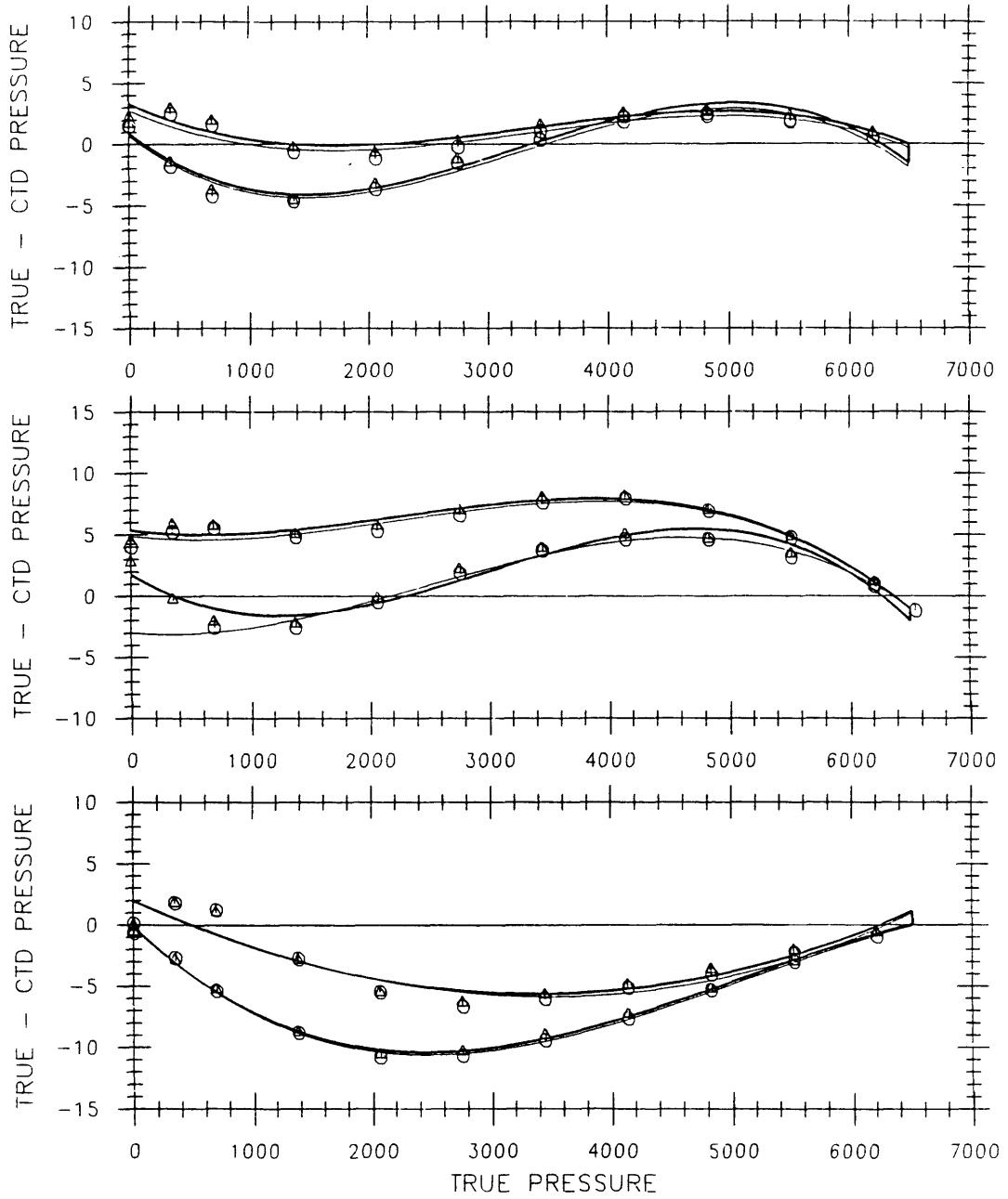
Figure 5c-2: Pressure calibrations employed a cubic calibration algorithm determined from a least squares fit.

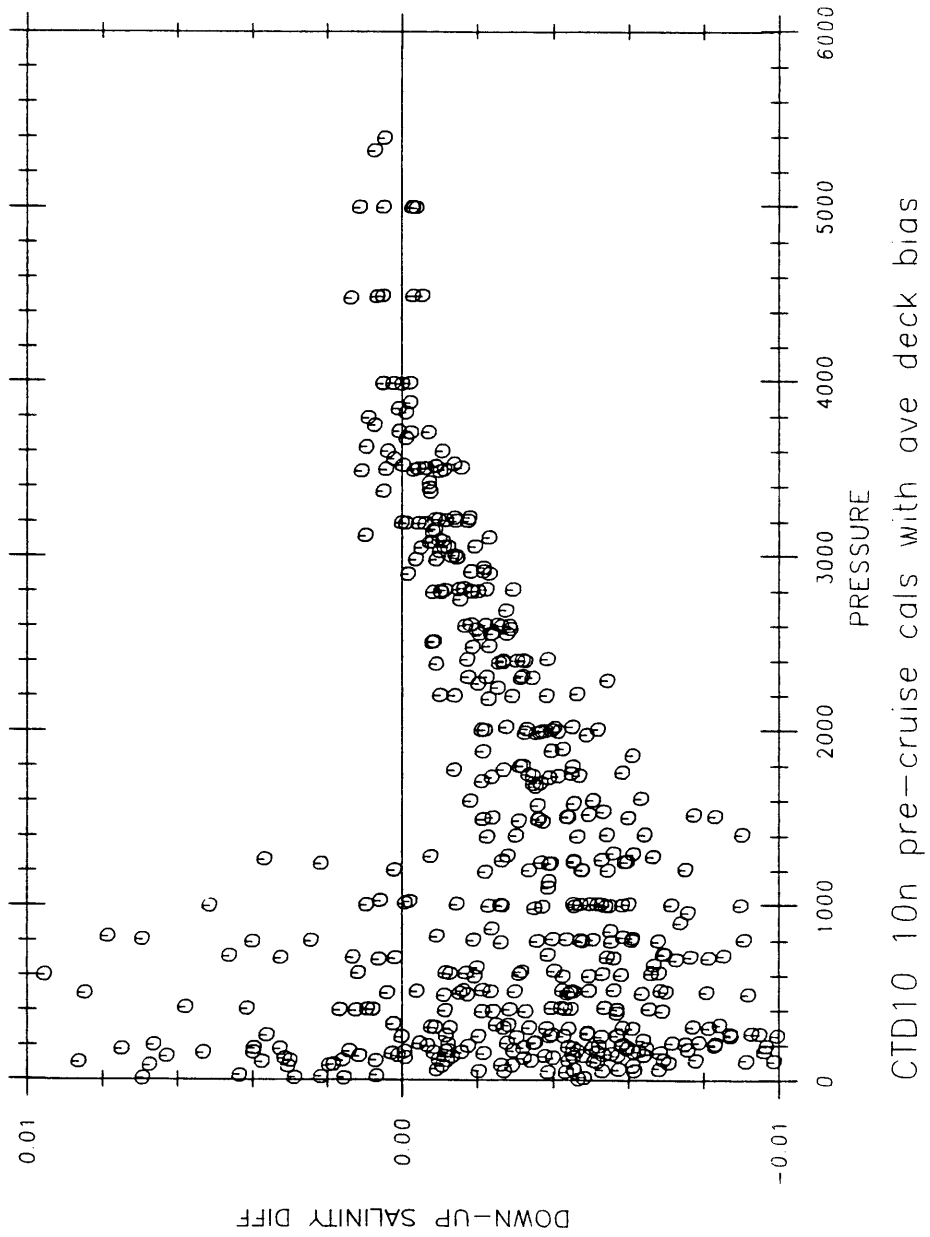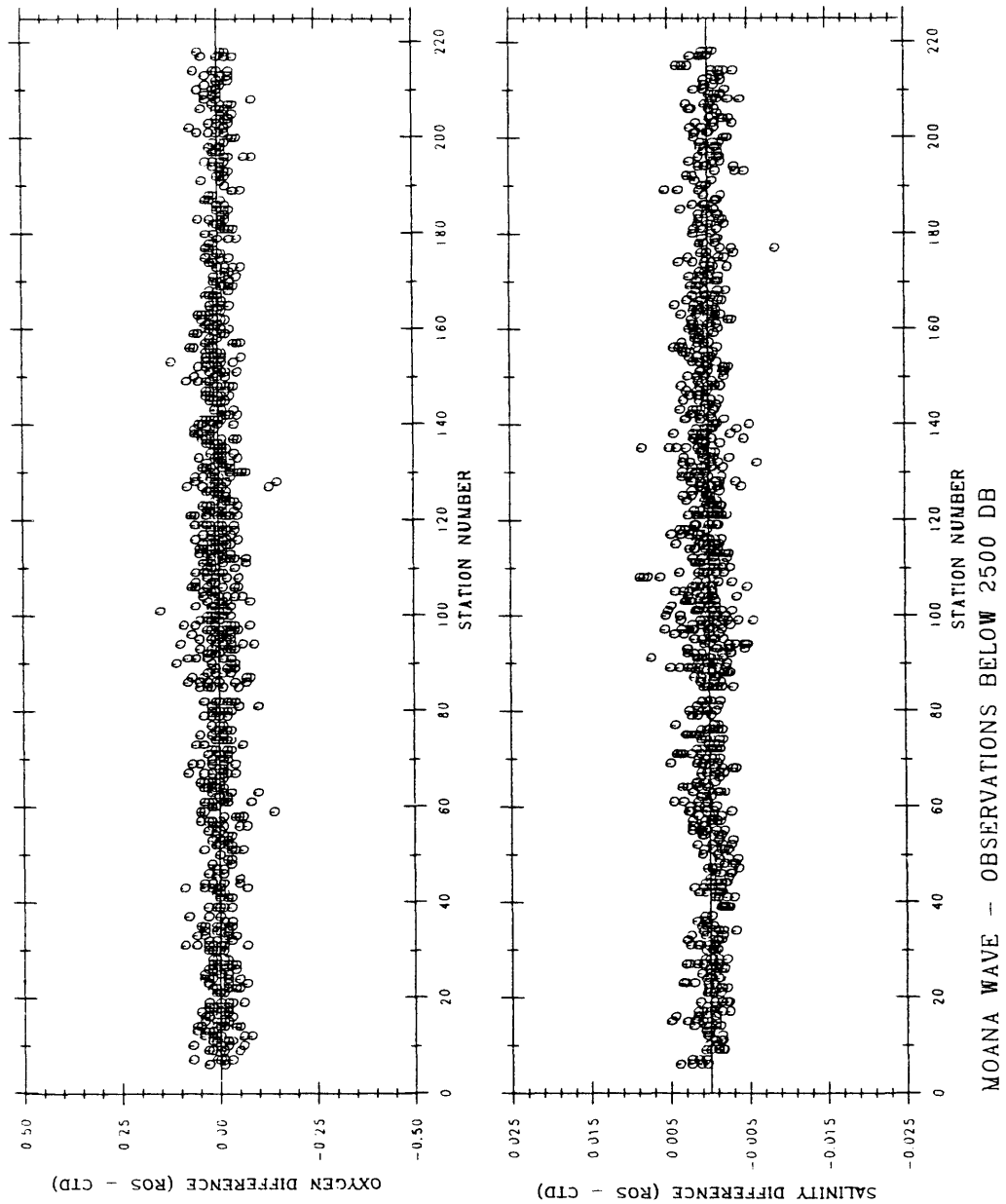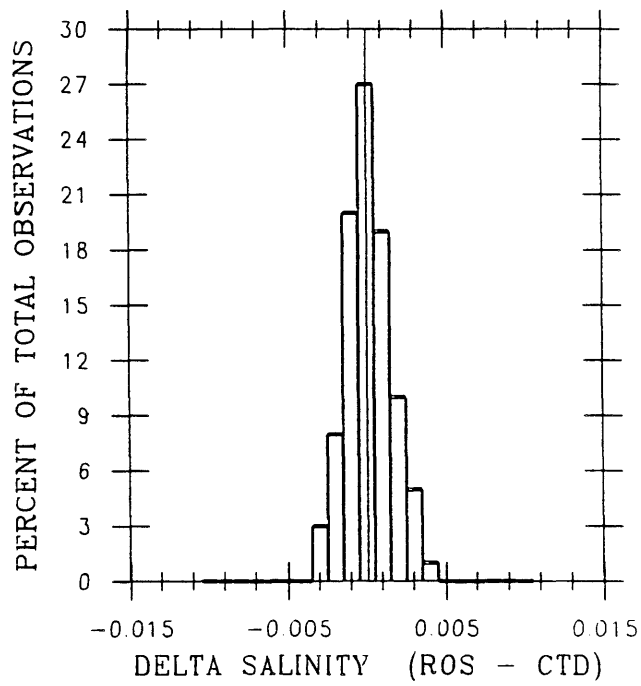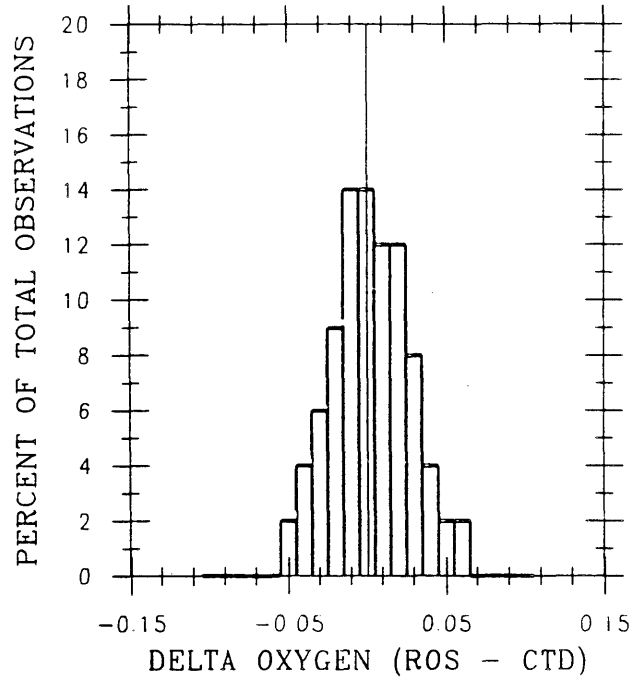Figure 5c-3: Salinity differences between the down- and upcasts vs. pressure.

Figure 5c-4: The time series of salinity differences as a function of station number shows the final data to be uniformly calibrated.

Figure 5c-5: Histograms showing the water sample minus CTD differences for oxygen and salinity at pressures greater than 2500 db.

TABLES SECTION 5C

Table 5c-1. Bias and slope coefficients of the conductivity correction algorithm applied to the 10N CTD data.

Sta #	Ctd	Bias	Slope	Sta #	Ctd	Bias	Slope
3-7,9-15	8	-.26691994E-1	.10018587E-2	159		.16260127E-1	.99907210E-3
16		-.26691994E-1	.10018866E-2	160		.16260127E-1	.99907932E-3
17-26		-.26691994E-1	.10018587E-2	161		.16260127E-1	.99908653E-3
27-33	9	.16260127E-1	.99890810E-3	162		.16260127E-1	.99909374E-3
34-73		.16260127E-1	.99890250E-3	163		.16260127E-1	.99910095E-3
74		.16260127E-1	.99890904E-3	164		.16260127E-1	.99910816E-3
75		.16260127E-1	.99891558E-3	165		.16260127E-1	.99911538E-3
76		.16260127E-1	.99892212E-3	166		.16260127E-1	.99912259E-3
77		.16260127E-1	.99892866E-3	167		.16260127E-1	.99912980E-3
78		.16260127E-1	.99893520E-3	168		.16260127E-1	.99917699E-3
79		.16260127E-1	.99894174E-3	169		.16260127E-1	.99918409E-3
80		.16260127E-1	.99894828E-3	170		.16260127E-1	.99919143E-3
81		.16260127E-1	.99895482E-3	171		.16260127E-1	.99915865E-3
82		.16260127E-1	.99896136E-3	172		.16260127E-1	.99916586E-3
85-93		.16260127E-1	.99892646E-3	173		.16260127E-1	.99917307E-3
94-103		.16260127E-1	.99895662E-3	174		.16260127E-1	.99926356E-3
104-119		.1260127E-1	.99898404E-3	175		.16260127E-1	.99920249E-3
121-122		.16260127E-1	.99890250E-3	176		.16260127E-1	.99925299E-3
123-135		.16260127E-1	.99892002E-3	177		.16260127E-1	.99954766E-3
137		.16260127E-1	.99890250E-3	178		.16260127E-1	.99924243E-3
138-142		.16260127E-1	.99892002E-3	179		.16260127E-1	.99923715E-3
143		.16260127E-1	.99895671E-3	180		.16260127E-1	.99923186E-3
144		.16260127E-1	.99896392E-3	181		.16260127E-1	.99922658E-3
145		.16260127E-1	.99897114E-3	182		.16260127E-1	.99922130E-3

Sta #	Ctd	Bias	Slope	Sta #	Ctd	Bias	Slope
146		.16260127E-1	.99897835E-3	183		.16260127E-1	.99921602E-3
147		.16260127E-1	.99898556E-3	184		.16260127E-1	.99921073E-3
148		.16260127E-1	.99899277E-3	185		.16260127E-1	.99920545E-3
149		.16260127E-1	.99899998E-3	186		.16260127E-1	.99920017E-3
150		.16260127E-1	.99900720E-3	187		.16260127E-1	.99919489E-3
151		.16260127E-1	.99901441E-3	188		.16260127E-1	.99918960E-3
152		.16260127E-1	.99902162E-3	189		.16260127E-1	.99918432E-3
153		.16260127E-1	.99902883E-3	190		.16260127E-1	.99923485E-3
154		.16260127E-1	.99903604E-3	191		.16260127E-1	.99917376E-3
155		.16260127E-1	.99904326E-3	192		.16260127E-1	.99916847E-3
156		.16260127E-1	.99905047E-3	193		.16260127E-1	.99925103E-3
157		.16260127E-1	.99905768E-3	194		.16260127E-1	.99915791E-3
158		.16260127E-1	.99906489E-3	195		.16260127E-1	.99915263E-3
				136 10		.56433148E-3	.99991328E-3
				196-214		.56433148E-3	.99991328E-3
				217-221		.56433148E-3	.99991328E-3

Table 5c-2: Summary of oxygen sensors employed on the 10 N cruise. Sensors on each instrument were assigned sequential letter codes (A, B, C,

STA	3-7	CTD	#8	Oxygen sensor A
STA	9-26	CTD	#8	Oxygen sensor B
STA	27-82	CTD	#9	Oxygen sensor A
STA	85-195	CTD	#9	Oxygen sensor B
STA	136,196-221	CTD	#10	Oxygen sensor A

Table 5c-3: Summary of dissolved oxygen algorithm coefficients used to reduce the 10 N transpacific CTD/02 data.

Sta	BIAS	SLOPE	PCOR	TCOR	WT	LAG
3-7	-0.019	0.927	0.1502E-03	-0.3491E-01	0.6734E+00	0.6239E+01
9	-0.067	1.012	0.1953E-03	-0.3645E-01	0.6934E+00	0.4202E+01
10	0.040	0.761	0.1546E-03	-0.3003E-01	0.6064E+00	0.4092E+01
11-14	-0.003	0.920	0.1614E-03	-0.3008E-01	0.9130E+00	0.8000E+01
15-16	-0.021	0.992	0.1701E-03	-0.3328E-01	0.8260E+00	0.6773E+00
17	0.011	0.918	0.1601E-03	-0.3008E-01	0.8698E+00	0.8004E+01
18-20	-0.075	1.139	0.1902E-03	-0.3575E-01	0.7879E+00	0.8000E+01
21	-0.008	0.975	0.1616E-03	-0.3081E-01	0.9660E+00	0.8000E+01
22-25	0.016	0.861	0.1746E-03	-0.2542E-01	0.8607E+00	0.8000E+01
26	-0.064	1.186	0.1661E-03	-0.3779E-01	0.6705E+00	0.7987E+01
27	-0.029	0.977	0.1366E-03	-0.3627E-01	0.1000E+01	0.8000E+01
28	-0.027	1.025	0.1410E-03	-0.3424E-01	0.8475E+00	0.8005E+01
29-32	0.016	0.906	0.1398E-03	-0.2847E-01	0.8195E+00	0.8465E+01
33	0.017	0.878	0.1419E-03	-0.2841E-01	0.7404E+00	0.8000E+01
34	0.010	0.945	0.1460E-03	-0.2914E-01	0.8875E+00	0.8032E+01
35	0.022	0.878	0.1432E-03	-0.2818E-01	0.1084E+01	0.8000E+01
36-38	-0.006	1.015	0.1404E-03	-0.3223E-01	0.8163E+00	0.8000E+01

Sta	BIAS	SLOPE	PCOR	TCOR	WT	LAG
39-40	-0.019	1.078	0.1414E-03	-0.3472E-01	0.8125E+00	0.4732E+01
41-45	-0.008	1.053	0.1400E-03	-0.3081E-01	0.7990E+00	0.8000E+01
46	-0.016	1.068	0.1385E-03	-0.3106E-01	0.7669E+00	0.8000E+01
47	-0.020	1.095	0.1344E-03	-0.3052E-01	0.9005E+00	0.8000E+01
48	-0.044	1.211	0.1211E-03	-0.3506E-01	0.7500E+00	0.8000E+01
49-50	-0.030	1.158	0.1312E-03	-0.3135E-01	0.7656E+00	0.8000E+01
51	-0.031	1.200	0.1275E-03	-0.3168E-01	0.8362E+00	0.8000E+01
52-53	-0.015	1.114	0.1261E-03	-0.2993E-01	0.7671E+00	0.6683E+01
54	0.013	0.997	0.1277E-03	-0.2507E-01	0.7500E+00	0.8000E+01
55-56	-0.010	1.041	0.1287E-03	-0.2480E-01	0.7500E+00	0.8000E+01
57-59	-0.006	1.077	0.1200E-03	-0.2796E-01	0.7500E+00	0.8000E+01
60-61	-0.011	1.138	0.1159E-03	-0.2430E-01	0.7500E+00	0.8000E+01
62	-0.015	1.082	0.1188E-03	-0.2668E-01	0.8367E+00	0.8000E+01
63-65	0.020	0.982	0.1203E-03	-0.1993E-01	0.7535E+00	0.8000E+01
66	0.009	1.126	0.1100E-03	-0.2127E-01	0.7500E+00	0.8000E+01
67	0.001	1.205	0.9421E-04	-0.2266E-01	0.7500E+00	0.8000E+01
68	-0.019	1.213	0.1062E-03	-0.2563E-01	0.7500E+00	0.8000E+01
69	-0.008	1.183	0.1150E-03	-0.2433E-01	0.7500E+00	0.8000E+01
70	0.000	1.249	0.1002E-03	-0.2385E-01	0.7500E+00	0.8000E+01
71	-0.007	1.195	0.1095E-03	-0.2029E-01	0.7500E+00	0.8000E+01
72	-0.032	1.468	0.9045E-04	-0.2794E-01	0.1000E+01	0.8000E+01
73	0.009	1.165	0.1187E-03	-0.1765E-01	0.7500E+00	0.8000E+01
74-75	0.005	1.225	0.1040E-03	-0.1996E-01	0.7500E+00	0.8000E+01
76-77	-0.016	1.440	0.8805E-04	-0.2043E-01	0.1000E+01	0.3800E+02
78	-0.028	1.814	0.1441E-04	-0.2508E-01	0.1000E+01	0.3800E+02
79-81	-0.010	1.447	0.8550E-04	-0.2034E-01	0.1000E+01	0.3800E+02
82	0.036	1.005	0.1199E-03	-0.9294E-02	0.4175E+01	0.3800E+02
85	-0.001	1.053	0.1285E-03	-0.3295E-01	0.9741E+00	0.8000E+01
86	0.020	0.862	0.1639E-03	-0.2574E-01	0.1000E+01	0.8000E+01
87	0.077	0.737	0.1639E-03	-0.1835E-01	0.7500E+00	0.8000E+01
88-90	0.010	1.106	0.1427E-03	-0.3276E-01	0.8171E+00	0.8000E+01
91-93	-0.020	1.216	0.1486E-03	-0.3459E-01	0.9586E+00	0.8000E+01
94	0.028	1.226	0.1221E-03	-0.3618E-01	0.7500E+00	0.8000E+01
95	-0.003	1.214	0.1396E-03	-0.3794E-01	0.7500E+00	0.8000E+01
96	-0.007	1.142	0.1554E-03	-0.3303E-01	0.4886E+00	0.8000E+01
97	-0.020	1.247	0.1447E-03	-0.3545E-01	0.7009E+00	0.8000E+01
98-99	-0.002	1.205	0.1410E-03	-0.3388E-01	0.7500E+00	0.8000E+01
100-101	-0.003	1.153	0.1451E-03	-0.3265E-01	0.1099E+01	0.8000E+01
102	-0.018	1.228	0.1413E-03	-0.3490E-01	0.1090E+01	0.8000E+01
103	0.011	1.069	0.1454E-03	-0.3122E-01	0.6922E+00	0.8000E+01
104-105	0.006	1.084	0.1469E-03	-0.2924E-01	0.1083E+01	0.8000E+01
106-111	0.016	1.042	0.1505E-03	-0.2958E-01	0.9851E+00	0.8000E+01
112-119	0.007	1.075	0.1505E-03	-0.3011E-01	0.7500E+00	0.8000E+01
121	-0.008	1.042	0.1583E-03	-0.3113E-01	0.4796E+00	0.8000E+01
122	-0.014	1.164	0.1377E-03	-0.3485E-01	0.9135E+00	0.8000E+01
123	0.012	1.098	0.1338E-03	-0.3309E-01	0.3371E+00	0.8000E+01
124-129	-0.008	1.167	0.1389E-03	-0.3486E-01	0.8682E+00	0.8000E+01
130	-0.021	1.252	0.1326E-03	-0.3596E-01	0.5423E+00	0.8000E+01

Sta	BIAS	SLOPE	PCOR	TCOR	WT	LAG
131-134	-0.006	1.156	0.1368E-03	-0.3473E-01	0.8463E+00	0.8000E+01
135	-0.009	1.174	0.1382E-03	-0.3414E-01	0.7500E+00	0.8000E+01
136	-0.049	0.980	0.1394E-03	-0.3635E-01	0.7500E+00	0.8000E+01
137-143	-0.009	1.174	0.1382E-03	-0.3414E-01	0.7500E+00	0.8000E+01
144-145	-0.005	1.132	0.1387E-03	-0.3229E-01	0.7500E+00	0.8000E+01
146-155	-0.002	1.114	0.1418E-03	-0.3162E-01	0.6225E+00	0.8000E+01
156-173	0.002	1.082	0.1404E-03	-0.3029E-01	0.1033E+01	0.8000E+01
174-186	-0.002	1.093	0.1397E-03	-0.3149E-01	0.7500E+00	0.8000E+01
187-195	-0.001	1.067	0.1398E-03	-0.2974E-01	0.1000E+01	0.8000E+01
196	-0.012	0.906	0.1389E-03	-0.4545E-01	0.7500E+00	0.1200E+02
197-203	-0.019	0.920	0.1417E-03	-0.3027E-01	0.7500E+00	0.1200E+02
204-211	-0.020	0.953	0.1375E-03	-0.3168E-01	0.7500E+00	0.1200E+02
212-214	-0.024	1.025	0.1203E-03	-0.3683E-01	0.1000E+01	0.1200E+02
217	-0.078	1.066	0.1482E-03	-0.4942E-01	0.1000E+01	0.1200E+02
218	-0.041	1.000	0.1384E-03	-0.3451E-01	0.1000E+01	0.1200E+02
219-221	-0.044	1.163	0.7750E-04	-0.3959E-01	0.1000E+01	0.1200E+02

5d. NUTRIENT PRECISION AND ACCURACY DURING MOANA WAVE 89-3
(L.I. Gordon and J.C. Jennings, Jr.)

Nutrient analyses were performed by a team of analysts from Oregon State University, using an Alpkem Corp., Rapid Flow Analyzer, Model RFA?300. The methods for silicic acid, nitrate plus nitrite, and nitrite were those given in the Alpkem manual (Alpkem Corp., 1987). The method for phosphate was an adaptation of our hydrazine reduction method for the AutoAnalyzer -II (Atlas et al., 1971). The adaptation consisted of scaling reagent concentrations and pump tube sizes to duplicate final concentrations of reagents in the sample stream used with our AutoAnalyzer -II phosphate method. We had tested all of these methods as implemented on the RFA-300 by comparison with an AutoAnalyzer -II simultaneously running our existing AutoAnalyzer -II methods. The results were equal or better in all cases, with respect to accuracy, precision, linearity and interferences.

Sampling for nutrients followed that for the tracer gases, Helium, Tritium, CFCs, and dissolved oxygen on average 30-45 minutes after the casts were on deck. Samples were drawn into 30cc high-density polyethylene, narrow mouth, screw-capped bottles. Then they were immediately introduced into the RFA sampler by pouring into 4 cc polystyrene cups which fit the RFA sampler tray. Both the 30 cc bottles and 4 cc cups were rinsed three times with approximately one third their volume prior to filling. Analyses routinely were begun within twenty minutes after the 30 cc bottles were filled and completed within an additional hour and a half. When the RFA malfunctioned at three stations, delays of up to one and a half hours after casts arrived on deck were experienced. If the delay were anticipated to be more than one half hour, the samples were refrigerated. Samples were refrigerated and stored up to one hour on stations 3, 23 and 181.

During the work we monitored short-term precision by analyzing replicate samples taken from the same Niskin bottle and by taking replicate samples from Niskin bottles tripped at the same depth. We also compared results from similar depths on the same station. The results are shown in Table 5d-1.

To check accuracy we compared our results with historical data from the region. There is not much historical data, however. We used GEOSECS and Western Pacific Ocean Circulation Study (WEPOCS) data for comparison but the WEPOCS study area was too far south to be definitive. The present data set agrees with the old within our accuracy estimated from identified sources of error and estimates of their magnitude, i.e., silicic acid, 2%; nitrate plus nitrite, 1%; and nitrite, 0.1 micromoles per liter. The fractional values are relative to the highest concentrations found in the regional water columns. Our deep phosphate concentrations may be up to about 0.07 micromolar higher on average than the GEOSECS data. We have no recorded laboratory notebook entries that could explain the difference. The distribution of silicic acid (umol/1) along 10 N is shown in Plate 3 and the distribution of nitrate and phosphate along the section is shown in Plate 4.

Table 5d-1:
Precision results from cruise Moana Wave 89-3. Entries are one standard deviation of a single analysis computed by pooling variances. Units are micromoles per liter throughout. To convert the nutrient values to micromoles/kg, use the potential densities of the seawater samples computed for the salinity of the sample and for 23 C, the mean laboratory temperature at the time of measurement of the nutrients. (This is the temperature at which the volume of the sample captured by the nutrient analyzer is fixed.) The nutrient lab temperature varied by a maximum of +/-3 C during the cruise. Therefore this parameter introduces a small, non-random error of 0.08% or less into the nutrient concentrations. Case I describes replicates taken from different Niskin bottles tripped at the same depth; case II, replicates from the same Niskin bottles; and case III, samples from closely adjacent depths. "DF" gives the number of degrees of freedom for each case.

Case	Phosphate	Nitrate + Nitrite	Silicic Acid	Nitrite	DF
Leg 1					
I	0.013	0.07	0.22	0.001	53
II	.008	.08	.35	.002	49
Leg 2					
II	.010	.08	.17	.008	36
III	.006	.12	.09	.00	4
Leg 3					
II	.014	.05	.24	.003	97
III	.007	.05	.13	.002	34

Table 5d-2.
Average nutrient laboratory temperatures measured for each station's analyses during the 10 N transpacific section. These temperatures are used to convert the units from umol/1 to umol/kg.

Nutrient Lab temperature summary, 10 N Pacific

Sta	Date	Time	Temp	Sta	Date	Time	Temp	Sta	Date	Time	Temp
1	07 Feb 89	1430	23.7	75	02 Mar 89	2331	22.1	149	19 Apr 89	1940	22.5
2	-	-	22.8	76	03 Mar 89	0625	22.8	15	20 Apr 89	0440	22.0
3	10 Feb 89	0045	22.0	77	03 Mar 89	1325	24.8	151	20 Apr 89	1230	22.0
4	10 Feb 89	0045	22.0	78	03 Mar 89	1920	24.4	152	20 Apr 89	2120	21.6
5	10 Feb 89	0250	22.8	79	03 Mar 89	2245	24.5	153	21 Apr 89	0530	22.0
6	10 Feb 89	-	22.0	80	03 Mar 89	0505	25.0	154	21 Apr 89	1445	22.2
7	10 Feb 89	1406	24.0	81	04 Mar 89	1020	25.0	155	21 Apr 89	2410	21.3
8	10 Feb 89	2045	25.0	82	-	1700	24.4	156	22 Apr 89	0900	22.0
9	11 Feb 89	0830	24.4	83	04 Mar 89	2150	20.5	157	22 Apr 89	1715	22.4
10	-	1015	23.8	84	-	0352	22.0	158	-	-	22.3
11	11 Feb 89	1600	25.0	85	-	0715	21.0	159	-	1020	22.2
12	11 Feb 89	2230	25.0	86	-	1515	21.0	160	23 Apr 89	1830	22.8
13	12 Feb 89	0425	24.0	87	-	2350	23.0	161	23 Apr 89	0330	22.0
14	12 Feb 89	-	25.0	88	10 Mar 89	0705	22.5	162	24 Apr 89	1225	22.1
15	12 Feb 89	2005	25.5	89	10 Mar 89	1500	24.0	163	24 Apr 89	2140	21.1
16	13 Feb 89	0340	24.8	90	-	2215	23.0	164	25 Apr 89	0615	20.6
17	13 Feb 89	1025	25.5	91	-	0730	22.7	165	25 Apr 89	1310	22.4
18	-	-	25.5	92	-	1550	22.5	166	25 Apr 89	2030	22.0
19	14 Feb 89	0145	25.5	93	11 Mar 89	0025	22.2	167	26 Apr 89	0420	21.8
20	14 Feb 89	0730	25.5	94	12 Mar 89	0940	22.0	168	26 Apr 89	1150	22.5
21	14 Feb 89	1225	25.5	95	-	-	22.0	169	26 Apr 89	2005	20.9
22	14 Feb 89	1643	25.9	96	13 Mar 89	0308	22.0	170	27 Apr 89	0430	21.0
23	-	2250	26.4	97	13 Mar 89	1215	22.0	171	27 Apr 89	1200	22.6
24	-	-	26.4	98	13 Mar 89	2150	22.0	172	27 Apr 89	2000	22.2
25	15 Feb 89	1115	27.0	99	-	0745	22.5	173	28 Apr 89	0340	22.0
26	15 Feb 89	1830	27.2	100	-	1715	21.8	174	28 Apr 89	1127	22.8
27	15 Feb 89	-	27.0	101	15 Mar 89	0225	21.2	175	28 Apr 89	1940	21.9
28	16 Feb 89	0640	26.0	102	15 Mar 89	1335	23.0	176	29 Apr 89	0400	22.0
29	16 Feb 89	1220	25.0	103	15 Mar 89	2220	21.7	177	29 Apr 89	1100	22.3
30	16 Feb 89	1645	23.5	104	16 Mar 89	0725	22.7	178	29 Apr 89	1738	21.8
31	16 Feb 89	2155	22.5	105	16 Mar 89	1645	23.7	179	30 Apr 89	0055	22.5
32	-	0050	22.7	106	17 Mar 89	0118	22.5	180	30 Apr 89	0750	22.7
33	17 Feb 89	0630	22.7	107	17 Mar 89	1035	22.0	181	30 Apr 89	1540	21.5
34	17 Feb 89	1220	23.0	108	17 Mar 89	1830	23.0	182	30 Apr 89	2350	22.0
35	17 Feb 89	1740	23.5	109	-	-	23.0	183	01 May 89	0700	22.0
36	17 Feb 89	2235	22.3	110	18 Mar 89	1045	23.0	184	01 May 89	1358	21.1
37	18 Feb 89	0432	22.5	111	18 Mar 89	1844	24.0	185	01 May 89	2125	22.0
38	18 Feb 89	1205	22.7	112	19 Mar 89	0325	23.3	186	02 May 89	0500	22.0
39	18 Feb 89	1624	22.7	113	19 Mar 89	1127	23.0	187	02 May 89	1131	22.6
40	18 Feb 89	-	22.7	114	19 Mar 89	1950	23.5	188	02 May 89	1818	21.5
41		0430	22.7	115	20 Mar 89	-	23.5	189	03 May 89	0040	21.5
42	19 Feb 89	1500	22.7	116	20 Mar 89	1140	23.5	190	03 May 89	0420	21.5
43	19 Feb 89	2245	22.0	117	20 Mar 89	1720	23.5	191	03 May 89	0800	22.3
44	20 Feb 89	0815	21.8	118	-	0255	22.0	192	03 May 89	1330	22.8

Sta	Date	Time	Temp	Sta	Date	Time	Temp	Sta	Date	Time	Temp
45	20 Feb 89	1240	23.0	119	21 Mar 89	1145	22.0	193	03 May 89	2110	22.3
46	20 Feb 89	-	22.9	120	9 Apr 89	0630	21.9	194	04 May 89	0420	22.0
47	21 Feb 89	0140	22.9	121	09 Apr 89	1105	23.2	195	04 May 89	1034	22.4
48	21 Feb 89	0925	22.8	122	09 Apr 89	1940	23.1	196	04 May 89	1720	21.9
49	21 Feb 89	1455	23.3	123	10 Apr 89	0350	23.3	197	05 May 89	0025	20.9
50	21 Feb 89	1925	23.0	124	10 Apr 89	1158	25.3	198	05 May 89	0705	20.4
51	22 Feb 89	-	23.0	125	10 Apr 89	2125	25.0	199	05 May 89	1415	20.8
52	-	0750	22.8	126	11 Apr 89	0700	24.1	200	05 May 89	2135	21.0
53	22 Feb 89	1620	23.5	127	11 Apr 89	1540	25.5	201	06 May 89	0600	20.7
54	22 Feb 89	-	23.3	128	11 Apr 89	-	22.6	202	06 May 89	1335	22.8
55	23 Feb 89	1035	23.2	129	12 Apr 89	1020	22.9	203	06 May 89	2110	21.0
56	23 Feb 89	1955	24.0	130	12 Apr 89	1850	23.0	204	07 May 89	0410	20.5
57	24 Feb 89	0420	23.2	131	-	0315	20.7	205	07 May 89	1135	22.0
58	24 Feb 89	1320	25.0	132	13 Apr 89	1310	22.9	206	07 May 89	2000	21.5
59	24 Feb 89	-	24.5	133	13 Apr 89	2210	21.9	207	08 May 89	0320	20.2
60	25 Feb 89	0845	24.0	134	14 Apr 89	0930	21.9	208	08 May 89	0900	20.5
61	25 Feb 89	1905	23.4	135	14 Apr 89	1740	22.6	209	08 May 89	1430	21.9
62	26 Feb 89	0425	23.5	136	15 Apr 89	0215	21.5	210	08 May 89	2000	20.7
63	26 Feb 89	1505	24.3	137	15 Apr 89	1030	21.5	211	09 May 89	0150	20.3
64	26 Feb 89	0045	24.7	138	15 Apr 89	1900	21.8	212	09 May 89	-	20.3
65	27 Feb 89	1120	23.0	139	16 Apr 89	0315	21.3	213	09 May 89	1315	20.9
66	27 Feb 89	2025	22.0	140	16 Apr 89	1130	22.8	214	09 May 89	1635	21.0
67	28 Feb 89	0550	22.3	141	16 Apr 89	2010	22.0	215	09 May 89	1945	20.5
68	28 Feb 89	1425	22.3	142	17 Apr 89	0600	21.7	216	-	-	20.3
69	28 Feb 89	2355	23.7	143	17 Apr 89	1435	21.2	217	-	-	20.3
70	01 Mar 89	-	23.7	144	17 Apr 89	0029	21.8	218	10 May 89	0500	20.
71	01 Mar 89	1750	23.7	145	18 Apr 89	1020	21.7	219	10 May 89	0717	20.4
72	02 Mar 89	0130	23.0	146	18 Apr 89	1935	21.9	220	10 May 89	0912	20.8
73	02 Mar 89	0905	23.5	147	19 Apr 89	0320	22.0	221	10 May 89	1039	21.7
74	-	1558	23.0	148	19 Apr 89	1125	22.7				

5e. CHLOROFLUOROCARBONS MEASURED DURING MOANA WAVE CRUISE 89-3
(R. Weiss and R. Van Woy)

Concentrations of the dissolved atmospheric chloro- fluorocarbons (CFCs) F-11 (trichlorofluoromethane) and F-12 (dichlorodifluoromethane) were measured by shipboard electron-capture gas chromatography, according to the methods described by Bullister and Weiss (1988). The CFC measurements were carried out as a collaboration between the Scripps Institution of Oceanography (R. F. Weiss), the University of Miami (R. A. Fine), and the Woods Hole Oceanographic Institution (J. L. Bullister). The Scripps group provided the CFC analytical system, and carried out the shorebased data processing and initial quality control. A total of 3001 water samples were measured for CFCs, of which 241 were replicates.

The CFC analytical system functioned well, although there were CFC contamination problems of an unprecedented severity on this expedition. Nearly

all of the analytical equipment, including the 10-liter Niskin bottles used for the majority of the hydrographic work, were sent to Majuro in a shipping container which was severely contaminated with CFCs, probably originating from packing foams used for other equipment in the container. The CFC measurement system was badly contaminated, although we were able to get the system reasonably clean after a few stations (there was also some F-12 contamination from refrigeration leaks aboard ship which had to be repaired). However, the most serious problem was the contamination of the Niskin sampling bottles, apparently by the absorption and subsequent desorption of F-11 and F-12 by the PVC material of the bottles themselves. Despite every effort to clean the bottles and to expose them to uncontaminated air aboard ship, the contamination for F-11 persisted for nearly all of the expedition, and the contamination for F-12 persisted for most of the first leg.

These difficulties caused serious losses for the deeper low-level measurements, especially in the beginning of the expedition, and added a tremendous amount of work to data processing. This problem was exacerbated by the practice of identifying each Niskin bottle only by its position on the sampling rosette, rather than assigning each physical bottle a number regardless of position on the rosette, as has been done on many other expeditions. Bottle positions were frequently changed during the expedition, including rotations of position and substitutions of spare bottles, in an attempt to find the bottles with the lowest blanks and in an effort to assess the blanks of each of the bottles by using them to sample CFC-free deep waters at some of the stations. Fortunately the changes were recorded by the CFC analysts, and with this information a map of actual bottle number versus rosette position at each station was constructed.

This map was first used in an attempt to construct a blank history for each bottle, but it was found that there was insufficient information to determine a blank level for each bottle throughout the expedition. It was possible, however, to construct a composite history for each type of bottle used. There were four different bottle types used on this expedition. The most highly contaminated were the 10-liter Niskin provided by the WHOI CTD group which were used for the vast majority of the sampling. Also used were a few 2.4-liter custom sampling bottles designed by J. Bullister, and one 10-liter bottle designed by B. Thomas of the Scripps Oceanographic Data Facility group. All of these bottles were shipped to the expedition in the same container, and had similar problems of varying degree. For the final leg of the expedition, several uncontaminated 10-liter bottles from the University of Miami were air freighted to the ship. These had significantly lower blank levels.

Sample blank histories for each type of bottle were determined by plotting the measured CFC concentrations as a function of potential density to identify a potential density at which we would safely conclude that there was no longer a decreasing CFC trend with increasing potential density. Waters at greater densities were considered to be effectively CFC-free. We selected waters with

sigma-theta values of 27.5 or greater, which is consistent with the density regime of CFC-free waters found on the 47 N and 24 N trans-Pacific sections in 1985 (Warner, 1988). For each type of bottle, the resulting blanks were fitted to a simple first-order exponential decay as a function of time for each of the three legs:

$$C = ae^{-bT}$$

where T is time in days, C is the blank concentration in picomoles/kg, and a and b are the fitted constants. The results of this fit are listed below for each of the three legs and for each bottle type:

Table 5e-1: F-11 Sample Blank Fit Results

	Leg 1		Leg 2		Leg 3	
Bottle Type	a	b	a	b	a	b
WHOI 10 1	0.0474	0.0387	0.0222	0.0306	0.0094	0.0266
Bullister 2.4 1	0.0252	0.0108	0.0260	0.1121	0.0058	0.0206
Scripps 10 1	0.0474	0.0387				
Miami 10 1					0.0041	0.0350

Table 5e-1: Continued.

F-12 Sample Blank Fit Results

	Leg 1		Leg 2		Leg 3	
Bottle Type	a	b	a	b	a	b
WHOI 10 1	0.0186	0.0787	0.0050	0.0	0.0050	0.0
Bullister 2.4 1	0.0120	0.0587	0.0040	0.0	0.0040	0.0
Scripps 10 1	0.0186	0.0787				
Miami 10 1					0.0058	0.0592

The precision (+/- one s.d.) of the CFC measurements, as determined from replicate analyses, is normally about 1% or about 0.005 pmol/kg, whichever is greater, for both CFCs. However, the uncertainties introduced by the large and variable blank values for F-11 during most of the expedition, and for F-12 during the first leg, increased the error in low-level CFC measurements in the early part of the expedition to about 0.05 picomoles/kg for F-11, and to about 0.02 picomoles/kg for F-12. The estimated accuracy of the calibrations is about 1.3% for F-11 and 0.5% for F-12. The results of individual replicate analyses are listed in Table 5e-1, and their mean values are reported in the main bottle data listings,

annotated with a 161 in the Quality word. All results are reported on the SIO 1986 calibration scale.

It is important to emphasize that the data have been edited to remove serious 'flyers' and contaminated samples, and to correct gross numerical errors. However, all of the data have not yet been subjected to the level of scrutiny associated with careful interpretive work. Readers are therefore requested to contact the Scripps CFC group for any revisions in the data which may post-date this report, and to draw to our attention any suspected inconsistencies.

The following flags appear in the Quality word in the data listings:

        6   = mean of replicate measurements
        7   = manual peak integration
        8   = irregular digital integration

Final CFC Data Quality Evaluation (DQE) Comments on tps10 (P04).
(David Wisegarver)
Dec 2000

Based on the data quality evaluation, this data set meets the relaxed WOCE standard (3% or 0.015 pmol/kg overall precision) for CFCs. Detailed comments on the DQE process have been sent to the PI and to the WHPO.

The CFC concentrations have been adjusted to the SIO98 calibration Scale (Prinn et al. 2000) so that all of the Pacific WOCE CFC data will be on a common calibration scale.

For further information, comments or questions, please, contact the CFC PI for this section (J. Bullister, johnb@pmel.noaa.gov, R. Weiss, rfw@gaslab.ucsd.edu, R. Fine, rana@rsmas.miami.edu) or David Wisegarver (wise@pmel.noaa.gov).

More information may be available at www.pmel.noaa.gov/cfc.

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The information below was provided by the CFC PI for this section.
(None available at time of most recent update)

5f. MEASUREMENT OF HELIUM ISOTOPES AND TRITIUM AT 10 N
(W.J. Jenkins)

Tritium and helium sampling was done with a maximum station separation of 5 longitude in the interior, and 3 near the ends of the section. Tritium samples were obtained from the Niskin water samplers in pretreated and argon filled flint glass bottles with polyseal caps. Each bottle was nearly filled and returned to the shorebased laboratory for subsequent degassing and Me regrowth analysis. Helium samples on the first two legs were taken in crimped copper tubes for shorebased extraction. For the third leg, helium samples were taken in stainless steel cylinders and extracted on board. Helium extraction and tritium degassing techniques are similar to those described elsewhere (Jenkins, 1981). Both tritium and helium measurements were (and are being) made on a dual collecting, statically operated magnetic sector mass spectrometer. For mass spectrometric procedures, see Lott and Jenkins, 1984.

A total of 655 samples were taken, of which 373 helium analyses and 101 tritium analyses have been performed. All samples have been extracted or degassed, and completion of analyses is anticipated within the next six months of the time of writing (August, 1991). Not all the data are yet available, in particular tritium has not been analyzed due to the mandatory incubation period, but sufficient exists to show some interesting, if qualitative, results. Figure 5f-1 shows the section of Me (expressed as the helium isotope ratio anomaly in permil) along 10 N viewed from the south (west on the left). Data points are indicated on the diagram by vertical crosses, and it should be noted that additional data (samples have been extracted but not yet analyzed) will fill in the details primarily in the western half of the section (and also at the extreme eastern end). The lower panel is the full depth section, showing the deep, primordial Me plume emanating westward from the East Pacific Rise. It is analogous to the corresponding plume observed at 15 S (Lupton and Craig, 1981), presumably driven by beta-plume dynamics (Stommel, 1982), and is a signature of hydrothermal effluent at the ridge. A cross section of this plume can be clearly seen in the meridional GEOSECS sections at approximately 120 and 180 W (GEOSECS, 1987). Two "bullseyes" appear north and south of the equator at those latitudes. The maximum value in this plume, slightly more than 400?, is somewhat less than its southern counterpart. Below the plume, the incoming, Me impoverished bottom water can be seen. Careful analysis of the 10 N data indicates the "cleanest" water is entering near the dateline, and apparently recirculating southward between 120 and 160 W (Johnson, 1990).

In the shallow water (upper panel of Figure 5f-1) one sees a minimum Me at a depth of about 400 m, overlain by a maximum at a depth of 200-300 m. This shallow maximum is produced by the in situ decay of Me, a feature also observed in the Atlantic thermocline (e.g. see Jenkins, 1988). The important question is to what extent is this "tritiugenic Me signal" contaminated by primordial Me. The presence of the minimum below implies that it should be

possible to separate the two signals. Noting that the deep silica and Me distributions look qualitatively alike, one is tempted to use silica as an analog of primordial 3He (cf. Broecker, 1980). Although the ultimate sources of these tracers are different, it can be argued that the upward mixing or upwelling of primordial Me should be accompanied by deep silica. Figure 5f-2 (upper panel) is a plot of (3He) vs. silica, highlighting the incoming bottom water (the downward hook on the RHS of the graph), the primordial plume (the spike above it), and the tritiugenic Me maximum at the low silica end. The region between the deep water plume and the tritiugenic hump is strikingly linear (lower panel in Figure 5f-2), so that one anticipates using the linear relation as a predictor of the component of primordial Me in shallower waters. A significant fraction of the Me variance about the line can be accounted for by an additional correlation with AOU (the range of AOU across the section at these density horizons is 50-100 uM/kg) due to a small component of in situ dissolution.

This refinement is currently being investigated.

Using the silica correction, one can then construct the "corrected" Me section, shown vs. ? in the upper panel of Figure 5f-3. The lower panel is the tritium distribution, also in T.U. for the same section. The lower panel shows the tritium data available to date for the same section (analyses are currently underway).

The relationship between the two tracers is consistent with observations in the North Atlantic thermocline: the tritiugenic Me maximum is below the tritium maximum, embedded in the top of the "tritium-cline". As expected, the corrected Me approaches "zero" (atmospheric equilibrium value, near -17T in the deep water. This gives us confidence that the primordial Me subtraction scheme is correct at least to first order. One can then attempt to compute tritium-helium ages, shown in Figure 5f-4 (upper panel), which can be combined with AOU measurements to obtain oxygen utilization rates (lower panel of Figure 5f-4). Figure 5f-4 Tritium-3He age in years (upper panel) and Oxygen Utilization Rates (in uM/kg/y, lower panel) for the 10 N section. The reader should be cautioned that the data are preliminary in addition to being rather incomplete, and that the correction scheme, although promising, requires refinement. Nonetheless, the features seen in Figures 5f-3 and 5f-4 are interesting. The tritium maximum centered on ? = 24-25 lies at the base of the salinity maximum associated with the penetration of subtropical common water into the tropics. The tritium-3He age associated with this feature clocks the time scale of this circulation, i.e. the time lapse since this water was at the sea surface in the subtropics, as approximately 8-10 years. Fine et al. (1987) estimated an upper limit of 14 years to this exchange time scale, and the higher precision obtained by tritium-3He dating refines their estimate. It is notable that although the salinity and tritium extrema associated with this feature are not seen east of about 160 W, the tritium-3He age does not increase on this isopycnal beyond the watermass's eastward extent. The data are unfortunately sparse at present, awaiting the completion of analyses. A final note regarding interpretation of the tritium-3He

age is a reminder that ages much beyond 15-20 years must be interpreted within the framework of a model, since these ages will be strongly affected by mixing (see Jenkins, 1987, 1988), and that even for the shorter time-frames, some caution should be exercised.

The oxygen utilization rate pattern is interesting (Figure 5f-4, lower panel). The values are low near the surface due to competition of photosynthesis vs. oxidation, reach maximum below the euphotic zone, and then decrease with depth. Intensity of consumption is greater on the eastern boundary, consistent with higher productivity there. Further, the scale height associated with the OUR decrease with depth is shorter on the eastern end, although on the whole it is comparable to that observed in the Atlantic (e.g., cf. Jenkins, 1987). A crude integration of the section OURs yields an estimated new production of order 2 mole(C)m-2y-1 with a slightly higher value ? 2.5 mole(C)m-2y-1) on the eastern side. The difference between the oxygen deficient zone and the interior is not greater due to the compensatory change in scale height. One observation is that although the region of intense oxygen deficiency is characterized by higher productivity; it is in fact largely due to poor ventilation.

The estimates of new production obtained here are significantly larger than those made by "conventional" estimates. Chavez and Barber (1987), for example, estimate rates of order 0.5 to 1.0 mole(C)m-2y-1 in the equatorial regions, with values approaching 2 to 2.5 mole(C)m-2y-1 off the coast of Peru. Overall, the productivity values computed for this section are similar to, but less than, those observed in the Atlantic. Evidence is beginning to accumulate that the Pacific is biologically less productive (in the sense of new production) than the Atlantic.

Finally, I show the tritium section (Figure 5f-5, upper panel), but this time vs. depth with a contour interval of 0.025 TU, a value still more than 5 times detection limit. Here one sees the equatorward penetration of intermediate waters at a depth of about 800 m on the extreme western side of the section. An extremely interesting diagnostic of source regions for this water is the tritium-freon ratio: due to the inherent hemispheric asymmetry in the distribution of tritium, the tritium-freon ratio of southern waters is much lower than northern waters. This analysis will be done in the future. A section of tritium/freon ratio should prove useful in assessing the relative components of southern and northern waters.

FIGURE CAPTIONS SECTION 5f

Figure 5f-1: Me sections along 10 N in the Pacific (west to the left) expressed in terms of helium isotope ratio anomaly in permil. Vertical crosses indicate data points. Lower panel is the full depth section, upper panel is the upper 1000 m only.

Figure 5f-2: Me (in permil) vs. silica (u/Kg) correlations for 10 N in the Pacific.

Figure 5f-1: ^{3}He sections along 10°N in the Pacific (west to the left) expressed in terms of helium iosotope ratio anomaly in permil. Vertical crosses indicate data points. Lower panel is the full depth section, upper panel is the upper 1000 m only.
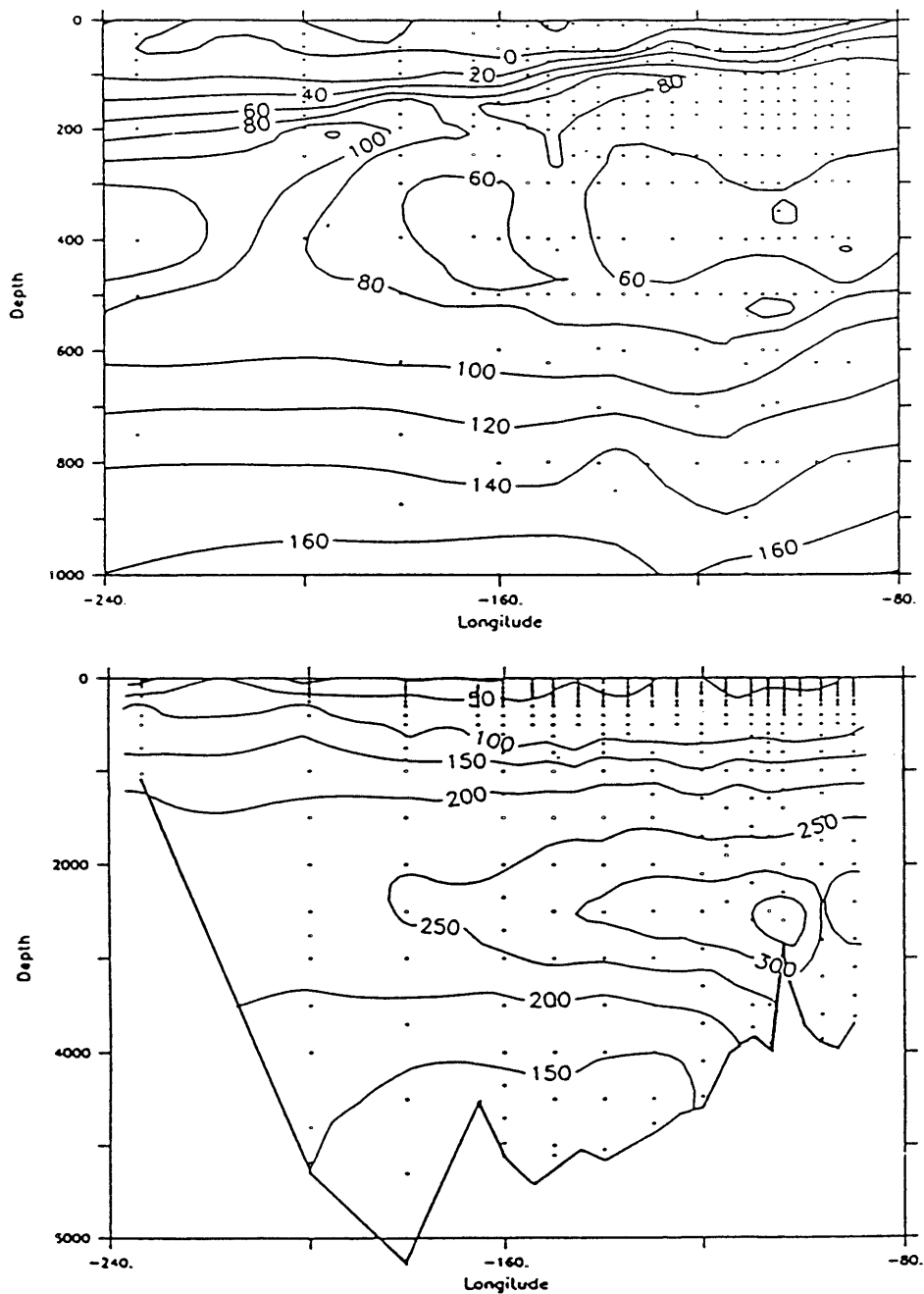
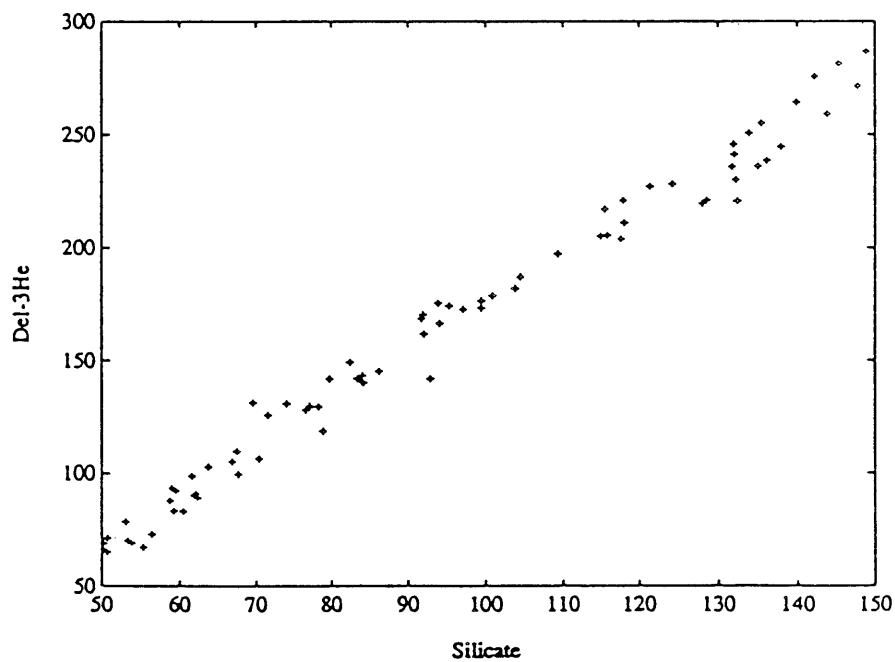Figure 5f-2: ^{3}He (in permil) vs silica (μ/Kg) correlations for 10°N in the Pacific.

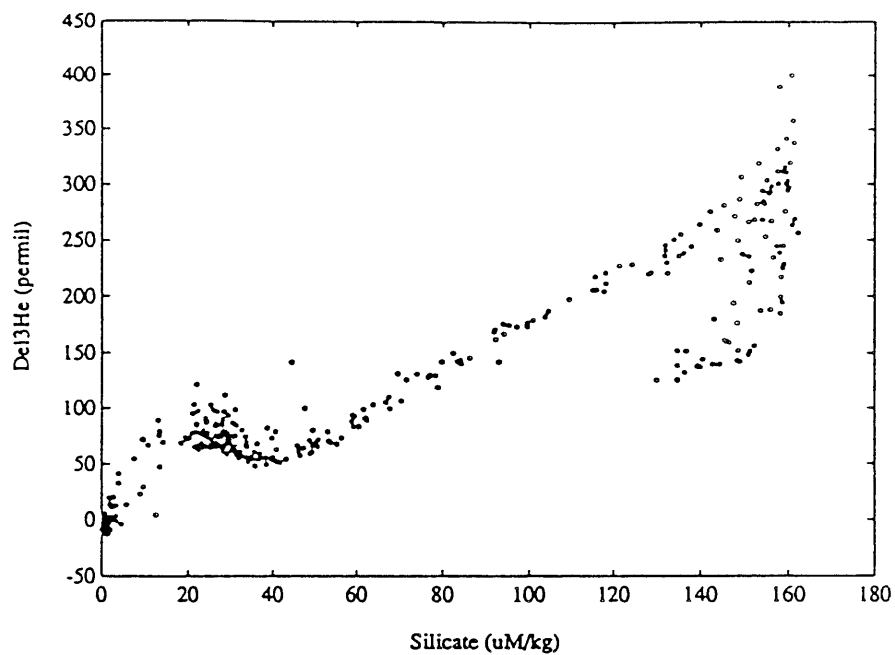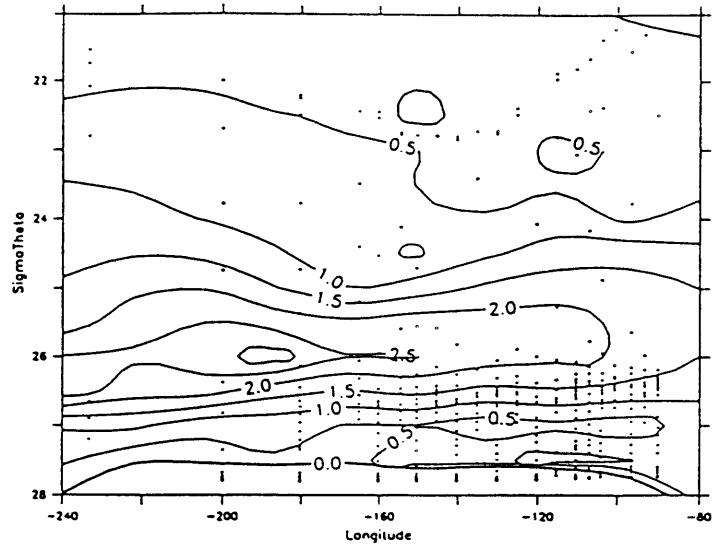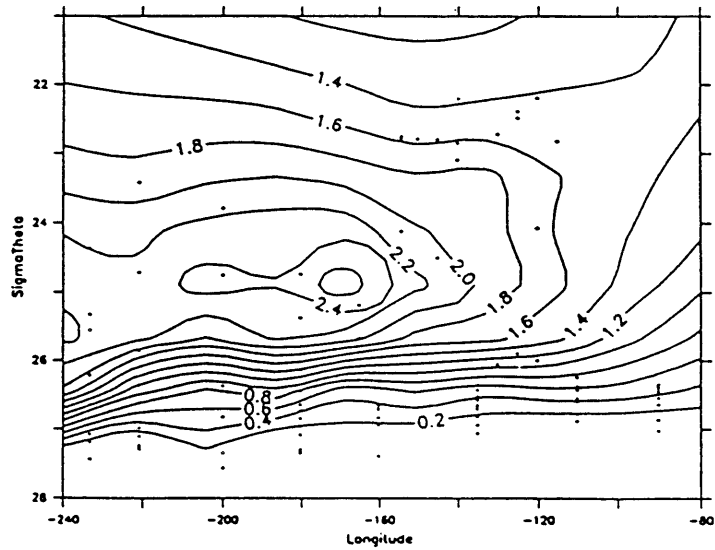Figure 5f-3: ^{3}He section expressed in T.U. (upper panel) corrected for primordial ^{3}He using silica. The lower panel is the tritium distribution, also in T.U. for the same section.

Corrected 3He on TPS

Tritium on TPS

Figure 5f-4: Tritium-^{3}He age in years (upper panel) and Oxygen Utilization Rates (in $\mu M/kg/y$, lower panel) for the 10°N section.
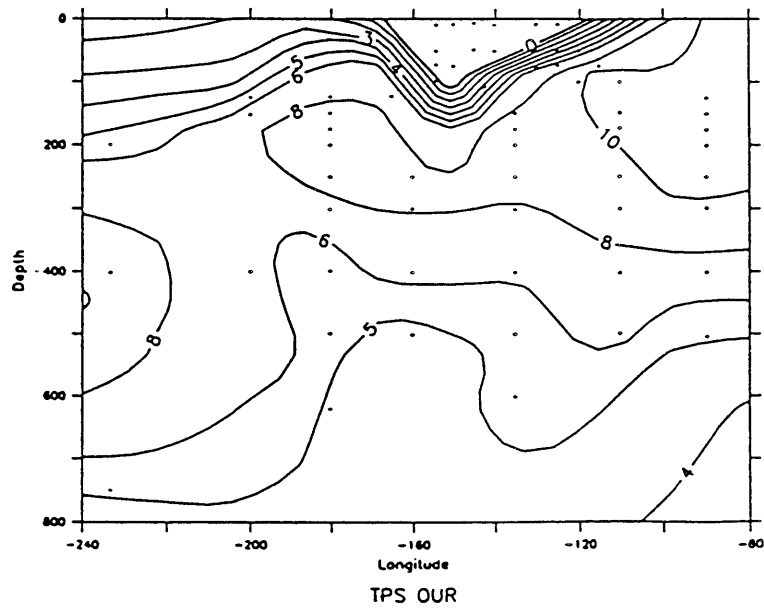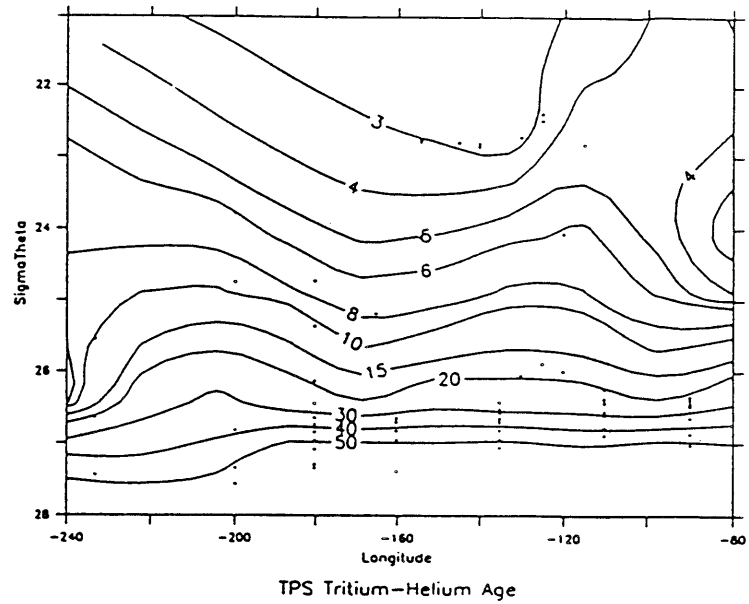
TPS Tritium—Helium Age

TPS OUR

Figure 5f-5: Tritium for the 10°N section. Note the contour intervals change from 0.025 to 0.10 to 0.50 TU.

Figure 5f-3: Me section expressed in T.U. (upper panel) corrected for primordial Me using silica. The lower panel is the tritium distribution, also in T.U. for the same section.

Figure 5f-4: Tritium-3He age in years (upper panel) and Oxygen Utilization Rates (in uM/kg/y, lower panel) for the 10 N section.

Figure 5f-5: Tritium for the 10 N section. Note the contour intervals change from 0.025 to 0.10 to 0.50 TU.

6. ACKNOWLEDGEMENTS

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APPENDIX A

List of Scientific Participants, their responsibility during the cruise and Institutional affiliation.

MW 89-3 (Leg 1) Palau to Majuro, Feb. 6 - Mar. 9, 1989

Name	Responsibility	Affiliation
John Toole	Chief Scientist	WHOI
Esther Brady	Scientist	WHOI
Jeffrey Kinder	CTD Hardware	WHOI
Carol MacMurray	CTD Software	WHOI
Margaret Francis	CTD Software	WHOI
Marvel Stalcup	Salts/Oxygens	WHOI
John Bullister	CFCs	WHOI
Christopher Johnston	CFCs	WHOI
Scot Birdwhistell	Tritium/Helium	WHOI
Joseph Jennings	Nutrients	OSU
Stanley Moore	Nutrients	OSU
Donald Cook	Watch Stander	WHOI
Kurt Polzin	Watch Stander	WHOI

MW 89-4 (Leg 2) Majuro to Hawaii, March 9-24, 1989

Name	Responsibility	Affiliation
Esther Brady	Chief Scientist	WHOI
Harry Bryden	Scientist	WHOI
Jeffrey Kinder	CTD Hardware	WHOI
Carol MacMurray	CTD Software	WHOI
Robert Stanley	Salts/Oxygens	WHOI
Christopher Johnston	CFCs	WHOI
Scot Birdwhistell	Tritium/Helium	WHOI
Stanley Moore	Nutrients	OSU
Nurit Cress	Nutrients	OSU
Ruth Gorski	Watch Stander	WHOI
Gregory Johnson	Watch Stander	WHOI
Rebecca Schudlich	Watch Stander	WHOI
David Wellwood	Watch Stander	WHOI

MW 89-6 (Leg 3) Hawaii to Costa Rica, Apr. 2 - May 10, 1989

Name	Responsibility	Affiliation
Harry Bryden	Chief Scientist	WHOI
Esther Brady	Scientist	WHOI
Jeffrey Kinder	CTD Hardware	WHOI
Carol MacMurray	CTD Software	WHOI
George Knapp	Salts/Oxygens	WHOI
Joseph Jennings	Nutrients	OSU
James Krest	Nutrients	OSU
Kathy Tedesco	CFCs	SIO
Kevin Sullivan	CFCs	RSMAS/UM
William Jenkins	Tritium/Helium	WHOI
Carol Alessi	Watch Stander	WHOI
Barbara Gaffron	Watch Stander	WHOI
Sophie Wacongne	Watch Stander	ORSTOM, Brest
Theresa Turner	Watch Stander	WHOI
Timothy Stockdale	Watch Stander	Oxford Univ.

APPENDIX B

Plate 1 (upper): The location of each of the CTD stations occupied during R/V Moana Wave cruise #89-3, -4, -6 is shown by the dots along 10 N. The depth to the bottom, measured during the cruise, is shown in each of the sections.

Plate 1 (lower): The distribution of potential density anomaly (kg/m3) is shown in the upper 1000 m relative to 0 db. Below 1000 m the potential density is relative to 4000 db.

Plate 2 (upper): The distribution of CTD potential temperature (C) measured along the 10 N section.

Plate 2 (lower): The distribution of CTD salinity measured along the 10 N section.

Plate 3 (upper): The distribution of CTD oxygen (ml/1) measured along the 10 N section.

Plate 3 (lower): The distribution of water sample silica (umol/1) measured along the 10 N section.

Plate 4 (upper): The distribution of water sample nitrate (umol/1) measured along the 10 N section.

Plate 4 (lower): The distribution of water sample phosphate (umol/1) measured along the 10 N section.

APPENDIX C

Station listings for the 10 N transpacific hydrographic section are presented following this description of the fields in each station listing. The Fortran algorithms employed in the generation of these listings are documented in UNESCO Tech. Report 44 "Algorithms for computation of fundamental properties of seawater" by N. P. Fofonoff and R. C. Millard (1983).

The header of each station listing contains the time and position at the bottom of the cast. Positions are determined from satellite navigation or by dead reckoning from the last satellite fix. The speed of sound is an average value computed over the full station depth. The water depth is from an echo sounder, corrected for the speed of sound (Carter, 1980).

The first block of data is calibrated CTD data and calculated variables. Starting at the left, the station variables are categorized in four groups as follows. The observed variables: temperature, salinity, and oxygen are vertically filtered values at the pressure level indicated. The standard Woods Hole Oceanographic Institution 2 dbar pressure-averaged CTD data are centered on odd pressure intervals (1,3,5,7,...) while the adopted pressure listing levels are at even pressure values. The 2 dbar temperature, salinity, and oxygen data were smoothed with a binomial filter and then linearly interpolated as required to the standard levels. The potential temperature, potential density anomaly, and potential density anomaly referenced to 2000 and 4000 dbars that follow in the listings were computed using the Fortran algorithms of UNESCO Tech. Report 44. The dynamic height and potential energy are integral quantities from the surface to the pressure interval indicated. These assume that the value of the specific volume anomaly of the first level of the 2 dbar CTD data profile can be extrapolated to the sea surface. A trapezoidal integration method was employed. The next quantities: potential temperature and salinity gradients, potential vorticity, and Brunt-Vaisala frequency, involve the calculation of vertical gradients. Gradient quantities were estimated from a centered linear least squares fit calculated over half of the neighboring listing intervals. The calculated depth involves a dynamic height correction and a latitude dependent gravity correction.

The second block of data consists of both observed and calculated variables at actual bottle levels: Botl. No. is the position on the rosette of the Niskin bottle. Next listed are CTD pressure and temperature, calculated potential temperature, potential density anomaly, and potential density anomaly referenced to 2000 and 4000 dbars and CTD salinity (all, as described above). Listed next are the measured bottle salinity, oxygen, silica, phosphate, nitrate, nitrite, CFC-11, CFC-12, and calculated depth. Finally, a quality word is included, associated with the listed variables that are marked with a double asterisk.

Appendix C: Continued.

The columns of the station listing (first block) are:

PRES   DBAR   Pressure (P) level in decibars.

TMP   C   Temperature (T) in degrees Celsius calibrated
                on the 1968 International Temperature scale
                (IPTS 1968).

SALT   Salinity (S) computed from conductivity (C),
                temperature and pressure measured by the CTD
                sensor according to the 1978 practical salinity
                scale. (Fofonoff and Millard, 1983).
                C(35,15,O) = 42.914 mmho/cm.

OXYG   ML/L   Oxygen in milliliters per liter measured by
                the CTD sensor. The partial pressure of oxygen
                is computed from the polarographic electrode
                measurements using an algorithm described by
                Owens and Millard (1985).

PTMP   C   Potential temperature in degrees Celsius
                computed by integrating the adiabatic lapse
                rate after Bryden (1973) (see Fofonoff and
                Millard, 1983). The reference level, Pr, for
                the calculation is 0.0 decibars. (S,T,P,Pr).

SIG-TH kg/m3   Potential density anomaly in kilograms/m3.
                Obtained by computing the density anomaly
                at 0 pressure replacing the in situ tempera-
                ture with potential temperature referenced
                to 0 dbars.

SIG-2   kg/m3   Potential density anomaly referenced to
                2000 dbars in kilograms/m3. Obtained by
                computing the density anomaly at 2000 dbars
                replacing the in situ temperature with
                potential temperature referenced to 2000 dbars.

SIG-4   kg/m3   Potential density anomaly referenced to
                4000 dbars in killograms/m3. Obtained by
                computing the density anomaly at 4000 dbars
                replacing the in situ temperature with
                potential temperature referenced to 4000 dbars.

Appendix C: Continued.

DYN-HT   Dyn m   Dynamic height in units of dynamic meters (10 Joules/kg) is the integral with pressure of specific volume anomaly (Fofonoff, 1962).

PE   10-5J m2   Potential energy anomaly in 10-5 Joules/m2 is the integral with pressure of the specific volume anomaly multiplied by pressure (Fofonoff, 1962) .

GRD-PT   10-3C DB   Potential temperature gradient in units of millidegrees Celsius per decibar. Estimated from the least squares temperature gradient over half the surrounding pressure intervals minus the center pressure adiabatic lapse rate.

GRD-S   10-3 DB   Salinity gradient per decibar. Estimated from the least squares salinity gradient over half the surrounding pressure intervals.

POT-V   10-12 (M S)   Planetary potential vorticity times 10-12 per meter-second.

B-V   CPH   Brunt-Vaisala frequency in cycles per hour. This is the natural frequency of oscillation of a water parcel when vertically displaced from a rest position assuming no exchanges of heat or salt with surroundings. This calculation uses the adibatic leveling of steric anomaly (Fofonoff, 1985; Millard, Owens, and Fofonoff,1990).

DEPTH   m   The depth of the pressure interval including the local gravity and dynamic height (see DYN-HT definition) corrections (Fofonoff and Millard, 1983).

The columns of the station listing (second block) are:

BOTL NO   Bottle number represents the firing position of the Niskin bottle on the rosette.

PRES   DBAR   Pressure (P) level in decibars.

CTDTMP   C   Temperature (T) in degrees Celsius calibrated on the 1968 International Temperature scale (IPTS 1968)

THETA   C   Potential temperature in degrees Celsius computed by integrating the adiabatic lapse rate after Bryden (1973) (see Fofonoff and Millard, 1983). The reference level, Pr, for the calculation is 0.0 decibars.

SIG-TH   kg/m3   Potential density anomaly in kilograms/m3. Obtained by computing the density anomaly at 0 pressure replacing the in situ tempera-ture with potential temperature referenced to 0 dbars.

SIG-2   kg/m3   Potential density anomaly referenced to 2000 dbars in kilograms/m3. Obtained by computing the density anomaly at 2000 dbars replacing the in situ temperature with potential temperature referenced to 2000 dbars.

SIG-4   kg/m3   Potential density anomaly referenced to 4000 dbars in kilograms/m3. Obtained by computing the density anomaly at 4000 dbars replacing the in situ temperature with potential temperature referenced to 4000 dbars.

CTDSAL   Salinity (S) computed from conductivity (C), temperature and pressure measured by the CTD sensor according to the 1978 practical salinity scale (Fofonoff and Millard, 1983).
$C(35,15,O) = 42.914$ mmho/cm.

SALNTY   Water sample salinities measured with a Guildline Autosal 8400A, using PSS-78 con-version tables. Values are corrected by +.0008, for SSW Batch P-97 offset (Mantyla, 1987).

OXYGEN   ml/l*   Water sample dissolved oxygen measurements in milliliters per liter as described by Knapp, et al. (1989).

SILCAT   uM/l*   Water sample silicate measurements in micro-moles per liter as described in the section on nutrients.

PHSPHT   uM/l*   Water sample phosphate measurements in micro-moles per liter as described in the section on nutrients.

NITRAT   uM/l*   Water sample nitrate measurements in micro-moles per liter as described in the section on nutrients.

NITRIT   uM/l*   Water sample nitrite measurements in micro-
moles per liter as described in the section on
nutrients.

CFC-11   pM/kg   Water sample chlorofluorcarbon (Freon-11)
measurements made in pico-moles per kilogram
as described in the section on CFCs.

CFC-12   pM/kg   Water sample chlorofluorcarbon (Freon-12)
measurements made in pico-moles per kilogram
as described in the section on CFCs.

DEPTH   m   The depth of the pressure interval including
the local gravity and dynamic height (see
DYN-HT definition) corrections (Fofonoff and
Millard, 1983).

QUALT1   A series of alphanumeric characters, one for
each variable marked with a double asterisk,
to indicate the quality of each measurement.

Quality Indicators
1 = Sample for this measurement was drawn but results of analysis not yet
received.
2 = Acceptable measurement.
3 = Questionable measurement.
4 = Bad measurement.
5 = Not Reported.
6 = Mean of replicate measurements.
7 = Manual chromatographic peak integration.
8 = Irregular digital chromatographic peak integration.
9 = Sample not drawn for this measurement at this bottle.
A,B,C.....Investigator specific descriptors.

*   To convert ml/l of dissolved oxygen to uM/kg, multiply oxygen ml/l by
44.660 (1000/molar volume of oxygen at STP (Weiss, 1981) and divide
the result by the density of the sea water at the time the sample was
pickled. If the temperature at this time is not known, the potential
temperature may be used to calculate the density. To convert nutrients in
uM/1 to uM/kg divide by the density of the seawater sample at the time the
sample is analyzed.

Data Processing History

Date	Contact	Data Type	Data Status Summary
5/28/92	Joyce	NITRAT	Values appear to be high
	letter sent to A. Mantyla: As I was preparing the 15 and P4 pre-WOCE data to send you, I noticed problems with the nitrate values, with a sharp 9 mole/l increase in values at all depths after station 25. Upon further examination, it appears that when separating nitrate and nitrite from the data, the nitrite values were subtracted from the total (N03+NO2) even when there were no nitrite values (assigned -9 in the data). Subtracting a -9 would increase nitrate values by the right amount. The data appearing in the hard cover report suffer from this problem; the present file does not. I do not know why there were no nitrites after station 25; the nutrient report by Gordon and Jennings doesn't say anything about problems. I will ask Bryden when he returns from P6 later this week. Perhaps you know something? I have also included a floppy disk with the second year of HOTS data; I expect the third year sometime later this month. Of course, I don't expect you to start right in with the DQE work, especially since we haven't sent any money yet!		
6/17/92	Bryden	NITRAT	Some values are high; Appears to be a
	computer glich: Regarding your recent query about high nitrate values on some stations on the 10°N transpacific hydrographic section, I have looked into the issues and conclude that some of the nitrate values printed in the 10°N data report are high by 9 mole/l. As you pointed out in your 28 May letter to Arnold Mantyla these erroneously high values are due to a glich in the computer software that generated the data report tables. In particular, when there is no printed nitrite value, the software subtracted a -9 (used internally to indicate no nitrite reading) from the total nitrate + nitrite value to derive a nitrate value 9 mole/l higher than the nitrate + nitrite value.		

I believe that the printed nitrate values are 9 mole/l too high for the following stations in the 10°N data report:

9	Bottle 1
26-39	
41-42	
43	Bottle 7
44-57	
71	
72	Bottles 5-10
73-74	
76	
97	Bottle 10
134-135	
163	
212	Bottles 21-24
213	

Please note that the problem is not continuous after station 25 as your letter to Mantyla, suggested. The problem stations and bottles axe easy to spot because they consist of all bottles for which nitrate concentration is printed but no nitrite concentration is printed.

Because there is essentially no nitrite concentration below 125 m depth for nearly all of the 10°N section, reasonable nitrate values can be derived for most of these

	problem stations by subtracting 9 mole/l from the printed nitrate values, that is effectively to equate nitrite + nitrate concentration with nitrate concentration. More careful consideration is needed only in the upper 125 m over the entire section and between 250 m and 450 m depths on stations 212-213 where there may indeed be some nitrite present. Otherwise, I would conclude that nitrate concentrations for these problem stations could be accurately derived from the values printed in the data report.		
	Because the nutrient analysis directly measures two primary quantities, nitrate + nitrite concentration and nitrite concentration, and then derives nitrate concentration by taking the difference between the primary quantities, it may be sensible to archive and present the primary quantities in WHP data reports. The less appealing alternative seems to be that when there is no nitrite measurement the nitrate concentration cannot be presented, even though there is a valid measurement of nitrate + nitrite concentration that almost always represents accurately the nitrate concentration.		
	Thank you for pointing out the problem with the nitrate concentrations printed in the data report.		
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.		
3/26/99	Ross	SUM	Data Update see note:
	This is Andy Ross speaking.... I'm working with Lou Gordon on the GODS Pacific project. No doubt you'll be hearing more from me.		
	In regard to the "P10 - Nitrate" note Lou sent to you the other day - the data listed under the "NITRATE" column is in fact the total of "Nitrate AND Nitrite" or N+N. You are correct in stating that to obtain NITRATE only, you must subract out the corresponding NITRITE value. Again, the units of µmol/Kg are correct for all nutrients.		
	To clarify, I obtained the P10 data (p10hy.txt) from the WOCE website that your PACIFIC data listing website linked - http://whpo.ucsd.edu/data/onetime/pacific/p10/index.htm.		
	After downloading and checking cruise TPS10 (WOCE p04ehy.txt, p04chy.txt,p04why.txt) from the WOCE website, I've determined the same situation to be true. The data listed under the "NITRATE" column is actually NITRATE and NITRITE combined. The units of µmol/Kg are correct for all the nutrients in the WOCE files.		
4/5/99	Diggs	CTD	Web Updated; ctd data now OnLine
4/19/00	Bartolacci DELC14	Website Updated	
	P4C/E/W Changed to indicate no samples collected.		

5/23/00	Key	BTL/SUM	Update Needed See note:
	1 in the sum file(s): No entry for station 8 or 215 (data exists in hyd files) Entry for station 77 out of order (data in hyd file in correct order) 2 in the sum AND hyd files: No entry for stations 1,2,84 or 216. Station and data entries existed for these in older versions of the files (32MW893-i.yyy) Data records for 119 bottles now "missing".		
7/24/00	Salameh	CFCs	Update Needed; See note:

There are two problems with the TPS10 CFC data. The first has to do with contaminated bottles. Nearly all of the analytical equipment, including the WHOI 10-liter Niskin bottles used for the majority of the hydrographic work, were sent to Majuro in a shipping container which was severely contaminated with CFCs, probably originating from packing foams used for other equipment in the container.

There were 4 types of bottles used during this cruise, each with a different initial CFC blank, and each cleaning up at a different (about exponential) rate. Ricky and I did our best to fit the blanks for each bottle type to an exponential as a function fo time. To give you some idea, the initial blanks (in pmol/kg) at the start of each leg for each bottle type were:

Leg1	**CFC-11**	**CFC-12**
10 liter WHOI Niskin	0.047	0.019
2.4 liter Niskin	0.025	0.012
10 liter SIO Barron	0.047	0.019

Leg2	**CFC-11**	**CFC-12**
10 liter WHOI Niskin	0.022	0.005
2.4 liter Niskin	0.026	0.004

Leg3	**CFC-11**	**CFC-12**
10 liter WHOI Niskin	0.009	0.005
2.4 liter Niskin	0.006	0.004
10 liter Miami Niskin	0.004	0.006

When determining these blanks we also had the problem that CFC-free water was not sampled for all bottle types at all times, so some guess work was involved. As I write this, Ray reminds me that we have already written a detailed report on this. I have attached this as PostScript file "text.ps" if you would like all the details.

The second problem I discovered recently when comparing the WHPO database with our CFC database, as part of the WOCE synthesis. For TPS10 leg3, I found a few values where the two databases do not match, and also quite a few samples where the WHPO file shows CFC values of 0.0 where we report no value.

These were clearly merging problems at the old WHPO at WHOI. I have attached the list of mis-matches and a correct version of the tps10 leg3 CFC data. I will send the corrected data to the WHPO next week (see below).

Please note that all the SIO TPS data (TPS10, 24 and 47) are still on the SIO 1986 standard scale. All the other SIO data at the WHPO are on the SIO 1993 standard scale. Early next week I will update the WHPO database with SIO 1993 values for the TPS cruises (the conversion from SIO 1986 to SIO 1993 requires dividing CFC-12 values by 0.9874 and CFC-11 values by 1.0251). If you would like, I will email you a copy of these data when I send them to the WHPO.

10/23/00	Toole	DOC	Update Needed
	complete e. version requested by J. Swift. Paper version on hand at WHPO		
11/30/00	Toole	DOC	As far as I know, there are no electronic
	versions of any figures from this report.		
12/8/00	Huynh	DOC	Website Updated; pdf, txt versions online
5/8/01	Talley	NITRIT	Update Needed; bad quality 1 flags
	The quality flags for nitrite (NITRIT) on station 40 must all be set to "bad" - I see that bad flags on adjacent stations are "5"'s. If you want, I can plot the section for you with and without these data - they are clearly impossible (uniformly 0.13 throughout most of water column - there isn't any way anywhere in the world that you would find such uniformity to such great depth). Should I just go ahead and do this and send you the edited file with a date stamp on it?		
5/10/01	Diggs	NITRIT	Update Needed; Lynne's comments will be
	QUALT2 flags. The P04 section needs more work than you have time for, but we did want you to give your flags as QUALT2 (rather than QUALT1) flags. I guess we can work out the details on this soon.		
6/22/01	Uribe	CTD/BTL	Website Updated; CSV File Added
	CTD and Bottle files in exchange format have been put online.		
6/29/01	Wisegarver	CFCs	DQE Complete
	precision outside original WOCE standards; meets "relaxed" stnds		
	The precision of the CFC-11 and CFC-12 measurements fell outside of the original WOCE standards of 1% or 0.005 pmol/kg with an estimated precision of 1.3% or 0.006 for CFC-11 and an estimated precision of 1.9% or 0.002 pmol/kg for CFC-12. Estimates of precision were based on the median value of percent deviation for mean concentrations > 0.5 pmol/kg and median standard deviation for mean concentrations less than or equal to 0.5 pmol/kg.		
	Due to bottle contamination experienced during the initial phase of the project, the calculated deep CFC concentrations were variable, in stpite of efforts to correct for the problem. The standard deviation of samples in the deep, presumable zero CFC concentration water was 0.01 for CFC-11 and 0.007 for CFC-12 during leg 1, but was reduced to 0.04 and 0.003 for CFC-11 and CFC-12 respectively by leg 3. This lever of scatter can be seen throughout the water column.		
	Based on the precision of the replicate samples and the scatter due to bottle contamination, this data set does not meet the original WOCE quality standards [1.3% or 0.006 for CFC-11 and 1.9% or 0.002 pmol/kg for CFC-12], but does fall within the relaxed standards of 3% or 0.015 pmol/kg.		
8/21/01	Bartolacci	CFCs	Submitted; CFCs need to be merged into BTL
	file. I have placed the new file containing updated CFC values for ALL P04 cruises in the subdirectory called original/20010709_CFC_WISEGARVER_P04 located in the parent P04 directory. These data are in need of merging into the individual P04 bottle files currently online.		

8/27/01	Muus	CTD/BTL/SUM Update Needed
	Station present in BTl that is not in SUM, correction needed, see note:	
	PO4W has Station 8 rosette data on web SEA file (20010326WHPOSIOKJU) but not in web SUMMARY file (20010326WHPOSIOKJU)	
	This is a Pre-WOCE cruise, TPS-10N, R/V Moana Wave, Palau, Feb 6, to Majuro, Mar 4, 1989. EXPOCODE 32MW803_1. Chief Scientist: John Toole (WHOI) On board CFCs: John Bullister (WHOI) CFC Documentation: R. Weiss/R. Van Woy	
	Station 8, Cast 1 SEA file has 24 bottles with oxygen, nutrients, and 5 levels of CFCs. No Station 8 data in revised CFC file from Wisegarver, May 2001.	
	The Chief Scientist's report in the .DOC file leaves out Station 8 in all CTD correction tables but the Nutrient lab temperature table contains Station 8.	
	The "Cruise Overview" section mentions 2 test casts, Station 3 as the first real station at 125m bottom depth, and then a CTD instrument change at Station 27. I could find no other mention of Station 8. Sta. 8 appears to be a Philippine Trench station, 6501.3db max sample depth, per SUMMARY file positions for Stations 7 and 9. The WHOI Technical Report (WHOI-91-32) has Station 7 on Page 76 and Station 9 on Page 77 but no data for Station 8. Plate 1 (Station Position Plots) does show Station 8 at the same latitude as the adjacent stations.	
	The WOCE Exchange File: BOTTLE,20001101WHPSIOJJW #code : jjward hyd_to_exchange.pl V1.0 #original files copied from HTML directory: 2000.8.10 #original HYD file: p04why.txt Thu Aug 10 13:43:30 2000 #original SUM file: p04wsu.txt.tmp Wed Nov 1 11:45:13 2000	
	32MW893_1, P04W, 7, 1, 1, 1, 2,19890209,2255, 8.0017, 127.0833, 5985, 5927.1 32MW893_1, P04W, 8, 1, 24, 24,2,19890209,-999, 8.0017, 127.3033, -999, 5.7 32MW893_1, P04W, 8, 1, 1, 1, 2,19890209,-999, 8.0017, 127.3033, -999, 6501.3 32MW893_1, P04W, 9, 1, 24, 24,2,19890210,1335, 8.0017, 127.6650, 5793, 9.5	
	has SUM file "p04wsu.txt.tmp". Do not know if JJW had a real position or just interpolated one to make the exchange conversion work.	
	Is this worth a message to Toole and Weiss/Bullister/Wisegarver or should we delete Station 8.	
8/29/01	Muus	BTL/SUM CFCs merged into BTL file, SUM file updated
	Notes on P04C CFC merging Aug 29, 2001. D. Muus	
	1. New CFC-11 and CFC-12 from: /usr/export/html-public/data/onetime/pacific/p04/original 20010709_CFC_WISEGARVER_P04/20010709.165933_WISEGARVER_P04_tp s10_CFC_DQE.dat merged into web SEA files as of Aug 21, 2001: P04C (20010327WHPOSIOKJU)	
	One file contained new CFC data for all three legs. No SEA file QUALT2 words so added QUALT2 identical to QUALT1 prior to merging.	

	New CFC data file appears to have SAMPNO and BTLNBR swapped with respect to .SEA file data. Checked that .SEA file SAMPNO same as CFC file "btlnbr" with respect to Sta#, Cast# and CTDPRS.		
	2. SUMMARY file (20010326WHPOSIOKJU) has "INT" (interpolated?) as NAV entry numerous times. "INT" not a NAV code per WOCE Manual. EVENT CODE is BO, EN, BE rather than normal sequence of BE, BO, EN. All three position and time entries for each station are identical since this is a Pre-WOCE cruise. Left SUMMARY file unchanged.		
	3. Exchange file checked using Java Ocean Atlas.		
8/31/01	Muus	BTL/SUM	CFCs merged into BTL file; SUM file updated
	1. New CFC-11 and CFC-12 from John Bullister, PMEL anonymous ftp site on Aug 31, 2001: wocecfc/freon/pacific/FINALDQE/RELAXED/tps10_CFC_DQE.dat merged into web SEA file as of Aug 21, 2001: P04W (20010326WHPOSIOKJU) The first revised CFC file received this summer was missing Station 8 because it was not in the SUMMARY file: /usr/export/html-public/data/onetime/pacific/p04/original		
	20010709_CFC_WISEGARVER_P04/20010709.165933_WISEGARVER_P04_tps10_CFC_DQE.dat One file contained new CFC data for all three legs. No SEA file QUALT2 words so added QUALT2 identical to QUALT1 prior to merging. New CFC data file appears to have SAMPNO and BTLNBR swapped with respect to .SEA file data. Checked that .SEA file SAMPNO same as CFC file "btlnbr" by comparing to Sta#, Cast# and CTDPRS.		
	2. SUMMARY file (20010326WHPOSIOKJU) has "INT" (interpolated?) as NAV entry numerous times. "INT" not a NAV code per WOCE Manual. EVENT CODE is BO, EN, BE rather than normal sequence of BE, BO, EN. All three position and time entries for each station are identical since this is a Pre-WOCE cruise. No Station 8 in SUMMARY file although .SEA file contains Station 8, Cast 1 with 24 bottles (see Item 3 below). Added Station 8 data to SUMMARY file per John Toole info received Aug 28, 2001. Left rest of SUMMARY unchanged.		
	3. Station 8, Cast 1 in Mar 26, 2001 .SEA file has 24 bottles with oxygen, nutrients, and 5 levels of CFCs. Message from Chief Scientist, John Toole, Aug 28, 2001, says Station 8 not used because CTD sensor guards left on making the CTD temperature suspect and the CTD salinities useless. He said bottle data can be used and noted air vents open on bottles 14, 19 and 22. Changed all CTDSAL quality codes from 2 to 4 (bad measurement). Changed BTLNBR quality codes for bottles 14, 19 & 22 from 2 to 3 (leaking). Changed CTDPRS for Station 8 to final calibrated pressures supplied by John Toole.		
	4. Exchange file checked using Java Ocean Atlas.		

9/4/01	Muus	BTL/SUM	CFCs merged into BTL; SUMfile updated

1. New CFC-11 and CFC-12 from John Bullister, PMEL anonymous ftp site on Sept 4, 2001:
   wocecfc/freon/pacific/FINALDQE/RELAXED/tps10_CFC_DQE.dat
   merged into web SEA file as of Aug 21, 2001: P04E (20010326WHPOSIOKJU)
   The first revised CFC file received this summer was missing Station 215 because it was not in the SUMMARY file:
   /usr/export/html-public/data/onetime/pacific/p04/original

   20010709_CFC_WISEGARVER_P04/20010709.165933_WISEGARVER _P04_tps10_CFC_DQE.dat

   One file contained new CFC data for all three legs.
   No SEA file QUALT2 words so added QUALT2 identical to QUALT1 prior to merging.
   New CFC data file appears to have SAMPNO and BTLNBR swapped with respect to .SEA file data. Checked that .SEA file SAMPNO same as CFC file "btlnbr" compared with Sta#, Cast# and CTDPRS.

2. SUMMARY file (20010326WHPOSIOKJU) has "INT" (interpolated?) as NAV entry numerous times. "INT" not a NAV code per WOCE Manual.
   EVENT CODE is BO, EN, BE rather than normal sequence of BE, BO, EN. All three position and time entries for each station are identical since this is a Pre-WOCE cruise.
   No Station 215 in SUMMARY file although .SEA file contains Station 215, Cast 1 with 24 bottles (see Item 3 below).

3. Station 215, Cast 1 in Mar 26, 2001 .SEA file has 24 bottles with oxygen, nutrients, and 14 levels of CFCs.
   .DOC overview states: "Stations 215-217 were made in deep water at the same geo- graphical position, 9.6 N and 86.2 W, to compare the data from the three CTDs used during this cruise."
   .DOC ctd corrections have no info for Stations 215 or 216, only 217. No bottle or ctd data in WHOI Technical Report WHOI-91-32 for Stations 215 or 216. Station 217 SEA file has bottle salinities and oxygens but no nutrients or CFCs. Do not know what, if any, CTD corrections applied to Station 215 CTDPRS, CTDTMP or CTDSAL. Ctd data look reasonable compared to Station 217 at approximately the same location.

   In order to provide users with nutrients and CFCs for this location I have added Station 215 to the SUMMARY file with a comment about the uncertain status of the ctd data. Also changed quality codes for CTDSAL from "2" to "3" as an added caution for users.

   Changed parameter numbers for 217 from "1-8" to "1-2".
   Used parameter numbers "1-8" for 215.
   Used intended position and estimated time and date for 215.

4. Exchange file checked using Java Ocean Atlas.

9/7/01	Bartolacci	BTL/SUM	Website Updated CFCs merged into BTL,
	new file online, updates SUM file online. I have replaced the previously online bottle file for P04W with the bottle file containing newly merged CFCs. Data updates were sent by D. Wisegarver and merged by D. Muus. New updated sumfile was also created by D. Muus. all previous files have been moved to original subdirectory. and have been renamed. All references have been updated to reflect this change. Notes regarding merging will be sent to meta data manager under separate email.		
9/7/01	Bartolacci	BTL/SUM	Website Updated CFCs merged into BTL
	file, new file online. SUMfile updated and online. I have replaced the previously online bottle file for P04E with the bottle file containing newly merged CFCs. Data updates were sent by D. Wisegarver and merged by D. Muus. New updated sumfile was also created by D. Muus. all previous files have been moved to original subdirectory and have been renamed. All references have been updated to reflect this change. Notes regarding merging will be sent to meta data manager under separate email.		
9/7/01	Bartolacci	BTL	Website Updated CFCs merged into BTL,
	new file online. I have replaced the previously online bottle file for P04C with the bottle file containing newly merged CFCs. Data updates were sent by D. Wisegar-ver and merged by D. Muus. all previous files have been moved to original subdirectory and have been renamed. All references have been updated to reflect this change. Notes regarding merging will be sent to meta data manager under separate email.		