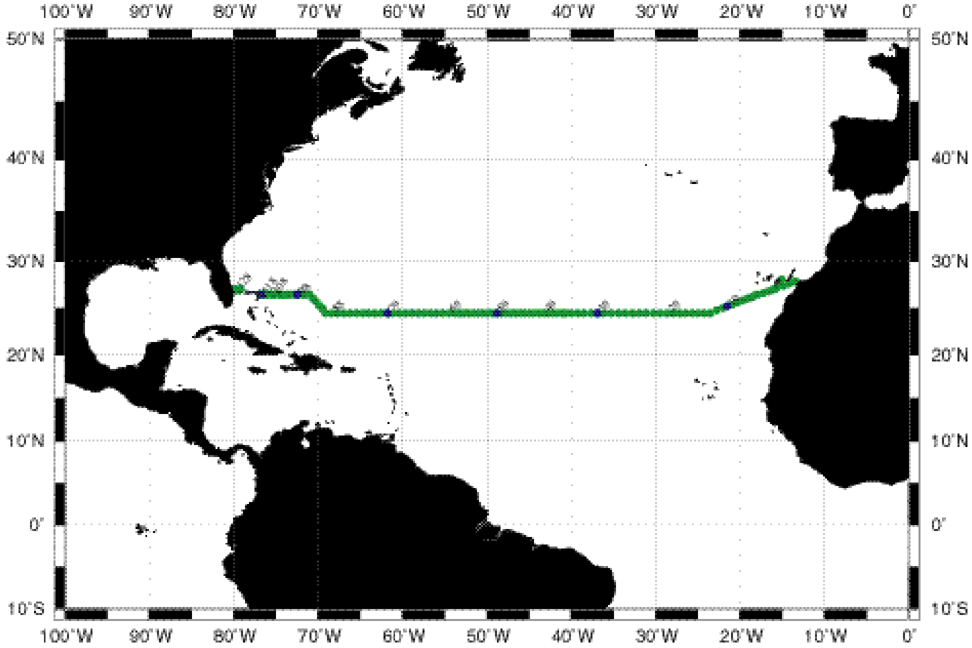
A. Cruise Narrative: AR01



A.1. Highlights

WHP Cruise Summary Information

WOCE section designation	**AR01**
Expedition designation (EXPOCODE)	**31RBOACES24N_2**
Chief Scientist(s) and their affiliation	**Kitack Lee AOML/CIMAS***
Dates	1998.JAN.23 - 1998.FEB.24
Ship	Ronald H. Brown
Ports of call	Las Palmas, Canary Islands to Miami, Florida
Number of stations	130
Geographic boundaries of the stations	27.965 -79.937 E -13.37 24.4913
Floats and drifters deployed	none
Moorings deployed or recovered	none

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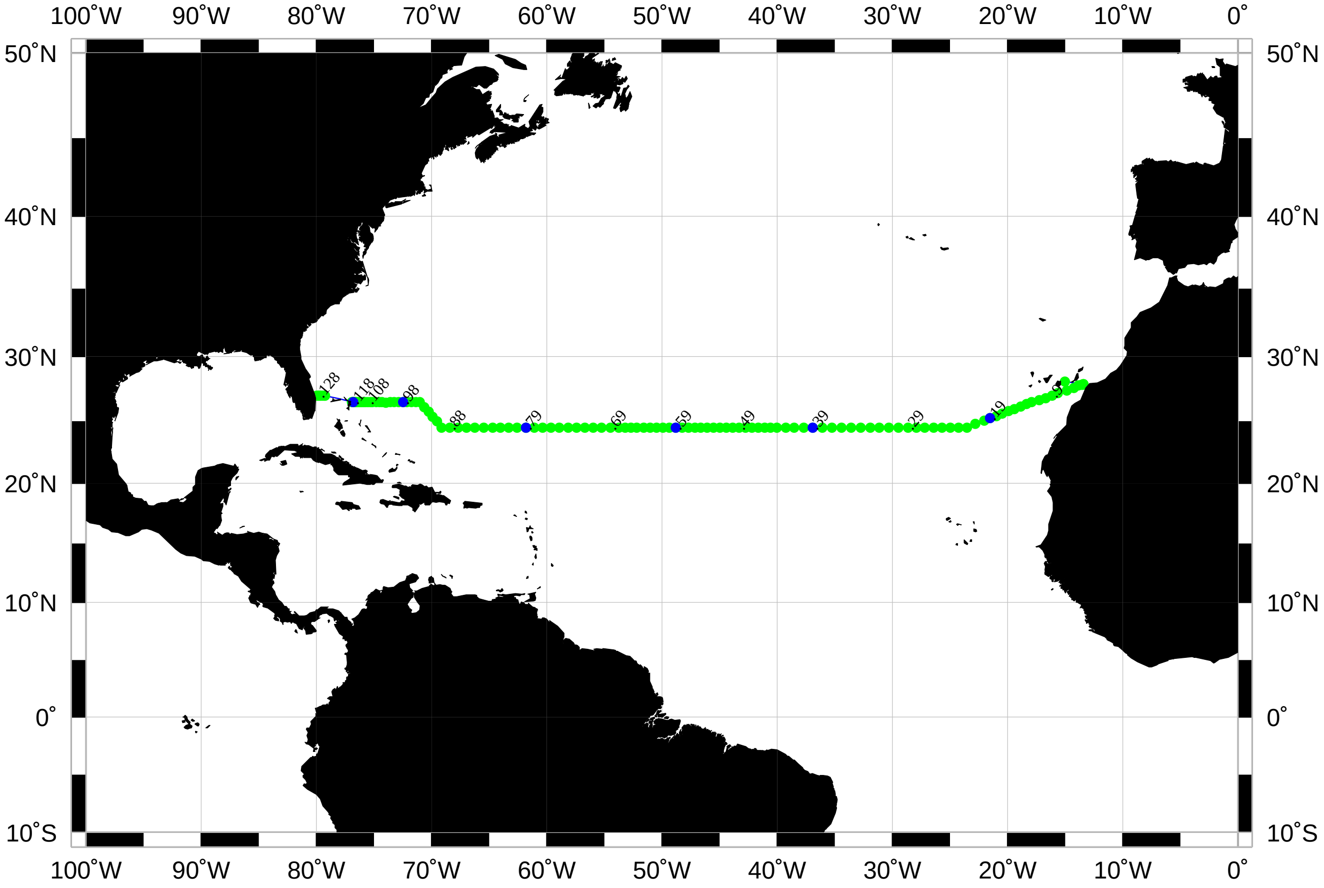
*Chief Scientist
Atlantic Oceanographic and Meteorological Laboratory
Cooperative Institute for Marine and Atmospheric Studies
4301 Rickenbacker Cwy
Miami, FL 33149-1098

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	
	Salinity
	Oxygen
	Nutrients
	CFCs
Principal Investigators for all measurements	
Cruise Participants	
	Radiocarbon
	CO2 system parameters
Underway Data Information	**Acknowledgments**
Navigation	**References**
Acoustic Doppler Current Profiler (ADCP)	**Figures**
	Tables
	Data Status Notes

Station locations for AR01 : BARINGER



Produced from .sum file by WHPO-SIO

Abstracted from NOAA data report 0AR AOML-41

Atlantic Oceanographic and Meteorological Laboratory
Miami, Florida
June 2001

NOAA: National Oceanic and Atmospheric Administration
Ocean and Atmospheric Research Laboratories

NOTICE

ELECTRONIC ACCESS TO DATA LISTED IN THIS REPORT

The data presented in this report is available on the World Wide Web (WWW) at the following sites:

Bottle and CTD data:	http://www.aoml.noaa.gov/ocd/oaces/24n98.html
UWpCO2 data:	http://www.aoml.noaa.gov/ocd/oaces/1998data.html
ADCP data:	http://ilikai.soest.hawaii.edu/sadcp/woce.html
LADCP data:	http://www.nodc.noaa.gov/General/NODC-About/NODC-overview.html#services

For further information regarding the data sets contact:

Ms. Betty E. Huss
Data Manager, OACES/GCC
at: U.S. Dept. of Commerce
NOAA/AOML/OCD
4301 Rickenbacker Causeway
Miami, Florida 33149-1026
Telephone: (305) 361-4395
Email address: huss@aoml.noaa.gov

LIST OF PARTICIPANTS

Leg1:

Function	**Name**	**Institution**
Chief Scientist	Gregg Thomas	AOML
pCO2	Dana Greeley	PMEL
Total Alkalinity	Mary Roche	UM
M-AERI	Jennifer Hanafin	UM
M-AERI	Erica Key	UM

Leg 2:

Function	**Name**	**Institution**
Chief Scientist	Kitack Lee	AOML/CIMAS
Co-Chief Scientist	David Bitterman	AOML
CTD	Christiane Fleurant	AOML/CIMAS
CTD/ET	Douglas Anderson	AOML
CTD	Kristene McTaggart	PMEL
Salinity	Gregg Thomas	AOML
Oxygen/ET	Robert Roddy	AOML
Oxygen	George Berberian	AOML
LADCP	Ryan Smith	AOML/CIMAS
LADCP	Richard Sikorski	UM
LADCP	Deanna Spindler	UM
DIC	Marilyn Roberts	PMEL
DIC	Esa Peltola	AOML/CIMAS
pCO2	Dana Greeley	PMEL
pCO2	Hua Chen	AOML
CFC	David Wisegarver	PMEL
CFC	Fredrick Menzia	PMEL
Nutrients	Calvin Mordy	PMEL/JISAO
Nutrients	Charles Fisher	AOML
Total Alkalinity	Cindy Moore	UM
Total Alkalinity	Xiaorong Zhu	UM
pH	Jason Joliff	UM
pH	Xuewn Liu	UM
TOC/TN, and TP	Rachel Parsons	BBSR
TOC/TN, and TP	Amy Richie	BBSR
13C/12C	Tania Westby	UW

The Chief Survey Technician aboard the R/V RONALD BROWN for the cruise was Jonathan Shannahoff.

Institutional Abbreviation	**Institution**	**Address**
AOML	Atlantic Oceanographic and Meteorological Laboratory,	4301 Rickenbacker Cwy, Miami, FL 33149-1098
BBSR	Bermuda Biological Station for Research	St. Georges, GE-01, Bermuda
PMEL	Pacific Marine Environmental Laboratory	7600 Sand Point Way NE, Seattle, WA 98115-0070
UM	University of Miami/Rosenstiel School of Marine and Atmospheric Science	4600 Rickenbacker Cwy, Miami, FL 33149-1098
- CIMAS	Cooperative Institute for Marine and Atmospheric Studies	
UW	University of Washington	Box 357940, Seattle, WA 98195-7940
- JISAO	Joint Institute for Study of the Atmosphere and Ocean	

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FIGURES

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A.2. Cruise Summary

CHEMICAL AND HYDROGRAPHIC MEASUREMENTS ON A CLIMATE AND GLOBAL CHANGE CRUISE ALONG 24° N IN THE ATLANTIC OCEAN WOCE SECTION AR01 DURING JANUARY-FEBRUARY, 1998

E. Peltola, K. Lee, R. Wanninkhof R. Feely, M. Roberts, D. Greeley, M. Baringer, G. Johnson, J. Bullister, C. Mordy, J.-Z. Zhang, P. Quay, F. Millero, D. Hansell, and P. Minnett

ABSTRACT

This document contains data and metadata from a zonal cruise along nominally 24.5 °N in the Atlantic Ocean from Las Palmas, Canary Islands in Spain to Miami, Florida. The cruise took place from January 23 to February 24, 1998 aboard the NOAA Ship RONALD H. BROWN under auspices of the National Oceanic and Atmospheric Administration (NOAA). This report presents the analytical and quality control procedures performed during the cruise and bottle data from the cruise. The research was sponsored by the NOAA Climate and Global Change Program under: (i) The Ocean- Atmosphere Carbon Exchange Study (OACES); and (ii) the World Ocean Circulation Experiment (WOCE) repeat hydrography program. Samples were taken from up to 36 depths at 130 stations. The data presented in this report includes the analyses of water samples for: salinity, nutrients, total dissolved inorganic carbon dioxide (DIC), fugacity of carbon dioxide (fCO2), total alkalinity (TA), pH, total organic carbon (TOC), total nitrogen (TN), total phosphorus (TP), chlorofluorocarbons, and stable carbon isotopic ratio of DIC ($_{13}$C/ $_{12}$C). Basic hydrographic parameters, pressure, CTD salinity, temperature and the calculated potential temperature, and potential density are included as well.

List of Principal Investigators

Project	Name	Institution
CTD/O_2, LADCP, ADCP, Salinity, Oxygen	Molly Baringer	AOML
CTD/O_2	Gregory Johnson	PMEL
pCO_2	Richard Wanninkhof	AOML
Total CO_2	Richard Feely	PMEL
Chlorofluorocarbons (CFCs)	John Bullister	PMEL
Nutrients	Calvin Mordy	PMEL/JISAO
Nutrients	Jia-Zhong Zhang	NOAA/CIMAS
$^{13}C/^{12}C$	Paul Quay	UW
Total Alkalinity, pH	Frank Millero	UM
TOC, TN, and TP	Dennis Hansell	BBSR
M-AERI	Peter Minnett	UM

A.3. INTRODUCTION

Since the world's oceans have a large capacity to sequester heat and carbon dioxide it is imperative that the oceans are studied in a comprehensive fashion to elucidate changes in the Earth's climate. An overall goal of the research is to observe and model the ocean sufficiently well to understand quantitatively how the ocean effects present climate, and how the ocean might change under a changing atmosphere. Thus, a long-term objective is to provide reliable predictions of climate change and associated regional implications on time scales ranging from seasons to centuries. Current predictions are uncertain, in part, because of poor understanding of source and sink patterns of greenhouse gases like carbon dioxide and the role of the ocean in mitigating or changing the timing of regional patterns associated with warmer climate.

This cruise was designed to support research sponsored by the National Oceanic and Atmospheric Administration (NOAA) Climate and Global Change Program under: (i) the Ocean-Atmosphere Carbon Exchange Study (OACES); and (ii) the World Ocean Circulation Experiment (WOCE) repeat hydrography program. The second leg of the cruise was conducted aboard the NOAA Ship RONALD H. BROWN from January 23 to February 24, 1998. The OACES objective of the cruise was to determine the fluxes of CO2 in the North Atlantic during the winter. A baseline of total carbon inventory in this region was established such that the uptake rate of atmospheric CO2 can be determined in future cruises. The objective of the WOCE (repeat) hydrography component was to understand the general circulation of the global ocean well enough to be able to model its present state and predict its evolution. The data presented in this report includes: hydrography, nutrients, total dissolved inorganic carbon dioxide (DIC), fugacity/partial pressure of carbon dioxide (fCO2/pCO2) 1 , total alkalinity (TA), pH, total organic carbon (TOC), total nitrogen (TN), total phosphorus (TP), chlorofluorocarbons, and stable carbon isotopic ratio of DIC (13 C/ 12 C).

Detailed information of the CTD operations can be found in NOAA Data Report, ERL PMEL-68 (McTaggart et al, 1999). [1]

A.4. DESCRIPTION OF STUDY AREA

A total of 130 full water column CTD stations were occupied, complete with water samples analyzed for salinity, oxygen and chlorofluorocarbon (CFC) content. A large amount of high quality measurements of all the carbonate parameters including underway surface water pCO2 and nutrients were also made.

The majority of the data were collected along 24.5° N from 23.5° W to 69° W. Completing the transatlantic section were data collected along a NE-SW dogleg off the

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[1] The fCO2 takes into account the non-ideality of CO2 gas and is the thermodynamic quantity mostly used in calculations. It is approximately 0.4 to 0.6 % lower than the corresponding pCO2. In this report we used theterms interchangeably. However, all reported values are fugacity values.

coast of Africa, and along a second, short, zonal section along 26.5° N off the coast of Abaco Island from 69° W to 77° W, jogging north along 27 o N in the Straits of Florida to 80° W. The cruise track and station locations are presented in Figure 1 and Table 1. The leg 1 followed this same trackline in the opposite direction, deploying XBTs to sample the temperature in the upper 750 m, and collecting underway pCO2.

B. DATA COLLECTION AND ANALYTICAL METHODS

One hundred and thirty CTD (Conductivity-Temperature- Depth) hydrographic stations were occupied to collect discrete water samples and hydrographic data. A CTD/Rosette unit with a Seabird-911 CTD instrument equipped with 36, specially designed 10-L samples bottles was utilized for these casts. These bottles have the same outer dimensions as standard Niskin bottles, but are modified to reduce chlorofluorocarbon sample contamination. Water samples were collected for salinity, oxygen, nutrients, chlorofluorocarbons, 13 C/ 12 C, as well as carbon related parameters including total dissolved inorganic CO2 (DIC), discrete fugacity of CO2 (fCO2), total alkalinity (TA), pH, total organic carbon (TOC), total nitrogen (TN), and total phosphorus (TP) on all casts during the cruise using these modified ioNiskinls style bottles. In the data tables the missing values are assigned a value of -9.0. The WOCE quality control flags have been listed in Appendix A. All the parameters plotted versus depth are shown in Figure 2. Detailed information on individual data collection, and analysis procedures may be found in the following method sections.

B.1. HYDROGRAPHIC METHODS

B.1.1. CTD AND HYDROGRAPHIC OPERATIONS

Description of Measurement Techniques and Calibrations

CTD and in situ O2

Depth profiles were obtained with a Seabird 911 plus CTD, deck unit, and rosette pylon. The CTD included dual temperature sensors, dual conductivity sensors, two Beckman oxygen sensors, one Paroscientific pressure transducer, and two pumps to decrease the response time. Thirty-six 10-l "Niskin" bottles were mounted on the frame, along with the CTD, pinger, Lowered Acoustic Doppler Current Profiler (LADCP), and LADCP external battery pack. The bottles were specially designed to reduce chlorofluorocarbon contamination. These bottles have the same outer dimensions as standard 10-l "Niskin" bottles, but use a modified end-cap design to minimize the contact of the water sample with the end-cap O-rings after closing. The O-rings used in these water sample bottles were vacuum-baked prior to the first station. Stainless steel springs covered with a nylon powder coat were substituted for the internal elastic tubing standardly used to close "Niskin" bottles. Seabird software was used to acquire, plot, and process the CTD data on PC's. Raw data were stored on VHS tapes, PC hard drives, and SyQuest drives. Typically each cast sampled to within 10 meters of the sea floor as indicated by the pinger signal. The CTD/O2 data were processed and calibrated following Seabird recommendations (CTD Data Acquisition Software and Technical Notes, Sea-Bird Electronics, Inc., 1808 - 136th Place NE, Bellevue, Washington 98005). Exceptional items are noted below. Details can be found in NOAA Data Report, ERL PMEL-68 (McTaggart et al, 1999).

Pre- and post-cruise pressure, temperature, and conductivity sensor calibrations were performed at Sea-Bird Electronics, Inc. in Bellevue, Washington. Secondary sensor pair T1075 and C1347 were selected for final data reduction for all stations.

The oxygen sensor was calibrated by using the pre- and post-cruise laboratory calibration. Secondary oxygen data from sensor s/n 353 was retained for stations 1-32 and 34; primary oxygen data from sensor s/n 381 was retained for stations 33 and 35-130.

Post-cruise calibrations were applied to CTD data associated with bottle data using the PMEL program CALBOT. WOCE quality flags were appended to bottle data records using the PMEL program FLAG. Quality flags were determined by plotting the absolute value of sample residuals versus pressure and selecting a cutoff value for bad flags. Values which were 2.8 standard deviations from the mean were considered bad. Of the 4313 sample salinities, 0.4% were flagged as bad and 3.6% were flagged as questionable. Of the 4130 sample oxygens, 1.2% were flagged as bad and 4.9% were flagged as questionable.

Measurement of Currents

A hull-mounted RD Instruments 150 kHz narrowband acoustic Doppler current profiler (ADCP) operated continuously during the cruise. Velocity data, averaged in earth coordinates using gyrocompass heading, were logged in three-minute (approximately 180 pings) ensembles using RDI Data Acquisition Software (DAS) version 2.48. Vertical bin size was 8 meters. The center of the first bin was located at 16 meters. Range varied from 200 to 400 meters, depending primarily on sea state. A user exit program (UE4, provided by Eric Firing, U. Hawaii) was used to interface navigation and heading equipment. Position was logged at the beginning and end of each ensemble from a Trimble Centurion P-code GPS receiver (estimated position accuracy of 5 - 10 meters). Mean gyrocompass corrections for each ensemble were recorded from an Ashtech 3DF GPS attitude determination system; 3DF array orientation was calibrated using P-code GPS and ADCP bottom track comparison. These data are used in post-processing to calculate mean ship velocity to reference ensemble means, and to compensate for dynamic gyrocompass errors. Estimated errors for an ensemble are 1-2 cm/s for relative velocity and 3-4 cm/s for ship speed errors due to position inaccuracy; errors induced by heading inaccuracies are reduced to less than 1 cm/s using GPS heading data. This total error of 4-6 cm/s over a three minute ensemble is reduced further by averaging during postprocessing; the fifteen minute averages commonly used represent an average over five kilometers at cruising speed, and should be accurate to 1-3 cm/s. The

ADCP data will be available through internet address http://ilikai.soest.hawaii.edu/sadcp/woce.html

On-station velocity profiles were obtained using a RDI 150 kHz Narrowband ADCP (Lowered or LADCP) mounted looking downward from the CTD frame. This technique measures and records velocity shear profiles extending 150 to 350 meters below the instrument approximately once per second. In postprocessing, the individual shear profiles are averaged by depth to produce a full-depth shear profile, which is integrated to estimate the depth dependent (baroclinic) component of the velocity field. The depth-independent (barotropic) component of velocity can be recovered if positions at the start and end of the cast are known; positions were logged on this cruise using a Trimble Centurion P-code GPS receiver, accurate to 5 - 10 meters. Readers are advised to refer to Fischer and Visbeck (1993) for a full explanation of methods and standard processing procedures. The LADCP data will be available through internet address: http://www.nodc.noaa.gov/ General/NODC-About/NODC-overview.html#services

Salinity Analyses

A Guildline 8400B autosal was used for the salinity analysis with batch P125 standard water. The autosal room was maintained at 22 °C, and the autosal was set at 24 °C. A total of 4380 samples were measured and 37 of them were rejected.

Oxygen Technique

An automatic titration system was used for the oxygen analysis with the Carpenter modification of the Winkler method using a photometric determined endpoint. Reagents for the Carpenter method titration were mixed by the AOML/OCD Group of George Berberian as specified in Friederich's MBARI Technical Report #91-6 (Friederich et al, 1991). Apparent oxygen utilization (AOU) is defined as O2 measured- O2 sat., where O2 sat. is the saturation value at potential temperature and salinity of the sample determined according to Weiss (1970). A total of 4310 samples were measured and 52 of them were rejected.

B.1.2. NUTRIENT ANALYSIS METHODS

Sampling and analytical methods

Nutrient samples were collected from 10-L "Niskin" bottles in acid washed 25-ml linear polyethylene bottles after three complete seawater rinses and analyzed within 1 hour of sample collection. Measurements were made in a temperature-controlled laboratory (20 ± 2 ºC). Concentrations of nitrite (NO2 -), nitrate (NO3 -), phosphate (PO4 3-) and silicic acid (H4SiO4) were determined using an Alpkem Flow Solution Auto-Analyzer aboard the ship. The following analytical methods were employed:

Nitrate and Nitrite:

Nitrite was determined by diazotizing with sulfanilamide and coupling with N-1 naphthyl ethylenediamine dihydrochloride to form an azo dye. The color produced is measured at 540 nm (Zhang et al., 1997a). Samples for nitrate analysis were passed through a home made cadmium column (Zhang et al., 2000), which reduced nitrate to nitrite and the resulting nitrite concentration was then determined as described above. Nitrate concentrations were determined from the difference of nitrate + nitrite and nitrite.

Phosphate:
Phosphate in the samples was determined by reacting with molybdenum (VI) and antimony (III) in an acidic medium to form an antimonyphosphomolybdate complex at room temperature. This complex was subsequently reduced with ascorbic acid to form a blue complex and the absorbance was measured at 710 nm (Grasshoff et al. ,1983). A total of 4306 samples were measured and 1248 of them were rejected.

Silicic Acid:
Silicic acid in the sample was analyzed by reacting the aliquote with molybdate in a acidic solution to form • -molybdosilicic acid . The • -molybdosilicic acid was then reduced by ascorbic acid to form molybdenum blue (Zhang et al., 1997b). The absorbance of the molybdenum blue was measured at 660 nm.

Calibration and standards:
Stock standard solutions were prepared by dissolving high purity standard materials (KNO3 , NaNO2 , KH2PO4 and Na2SiF6) in deionized water. Working standards were freshly made at each station by diluting the stock solutions in low nutrient seawater. The low nutrient seawater used for the preparation of working standards, determination of blank, and wash between samples was filtered seawater obtained from the surface of the Gulf Stream. Standardizations were performed prior to each sample run with working standard solutions. Two or three replicate samples were collected from the "Niskin" bottle sampled at deepest depth at each cast. The relative standard deviation from the results of these replicate samples were used to estimate the overall precision obtained by the sampling and analytical procedures. The precisions of these samples were 0.04 µmol/kg for nitrate, 0.01 µmol/kg for phosphate and 0.1 µmol/kg for silicic acid.

B.2. CARBON PARAMETERS

B.2.1. TOTAL DISSOLVED INORGANIC CARBON (DIC)

The DIC analytical equipment was set up in a seagoing laboratory van. The analysis was done by coulometry with two analytical systems (PMEL-1 and PMEL-2) used simultaneously on the cruise. Each system consisted of a coulometer (UIC, Inc.) coupled with a SOMMA (Single Operator Multiparameter Metabolic Analyzer) inlet system developed by Kenneth Johnson (Johnson et al., 1985,1987,1993; Johnson, 1992) formerly of Brookhaven National Laboratory (BNL). In the coulometric analysis of DIC, all carbonate species are converted to CO2 (gas) by addition of excess hydrogen ion (acid) to the seawater sample, and the evolved CO2 gas is swept into the titration cell of the coulometer with compressed nitrogen, where it reacts quantitatively with a proprietary reagent based on ethanolamine to generate hydrogen ions. These are subsequently titrated with coulometrically generated OH-. CO2 is thus measured by integrating the total charge required to achieve this.

The coulometers were calibrated by injecting aliquots of pure CO2 (99.995%) by means of an 8-port valve outfitted with two sample loops that had been calibrated at BNL (Wilke, 1993). The CO2 gas volumes bracketed the amount of CO2 extracted from the water samples for the two PMEL systems. All DIC values were corrected for dilution by 0.2 ml of HgCl2 used for sample preservation. The total water volume was 540 ml. The correction factor used for dilution was 1.00037. The instruments were calibrated at the beginning, middle, and end of each coulometer cell solution with a set of the gas loop injections. The coulometer cell solution was replaced after 25 mg of carbon was titrated, typically after 9-12 hours of continuous use. Sample titration times were 9-16 minutes.

Certified Reference Materials (CRMs), consisting of poisoned, filtered, and UV irradiated seawater supplied by Dr. A. Dickson of Scripps Institution of Oceanography (SIO), were run on each cell. The results were close to the values determined manometrically by Dr. Charles D. Keeling at SIO as shown below. The CRM results have been presented in Figure 3 and Table 2. The overall accuracy and precision for the CRMs on both instruments combined was -0.1 +/-2.1 (n=125). DIC data reported for this cruise have been corrected to the Batch 40 CRM value by adding the difference between the certified value and the mean shipboard CRM value (certified value - shipboard analyses) on a per instrument/per leg basis.

Av. value of CRMs run on PMEL-1: 1987.3 ± 2.0 µmol/kg (n = 59)

Av. value of CRMs run on PMEL-2: 1984.6 ± 1.2 µmol/kg (n = 66)

Manometric value [SIO reference material batch #40] was 1985.8±0.7 µmol/kg (n=10)

Samples were drawn from the "Niskin" bottles into cleaned, precombusted 500-ml Pyrex bottles using Tygon tubing according to procedures outlined in the Handbook of Methods for CO2 Analysis (DOE, 1994). Bottles were rinsed once and filled from the bottom, overflowing half a volume. Care was taken not to entrain any bubbles. The tube was pinched off and withdrawn, creating a 5-ml headspace, and 0.2 ml of saturated HgCl2 solution was added as a preservative. The sample bottles were sealed with glass stoppers lightly covered with Apiezon-L grease, and were stored at room temperature for a maximum of 12 hours prior to analysis.

Replicate seawater samples were taken from both the surface and 1000 m "Niskin" sample bottles and run at different times during the cell. The first replicate of the surface water was used at the start of the cell with fresh coulometer solution, the second surface water replicate in the middle of the cell after about 12 mg of C were titrated. The first one of the 1000 m replicates was run at the end of the cell after about 25 mg of C were titrated, while the second one of the 1000 replicate samples was run using a new coulometer cell solution. No systematic difference between the replicates was observed.

As example, the 1000m replicate samples run on both PMEL1 and PMEL2 combined had a standard deviation of 1.3 µmol/kg for 32 sets of duplicates, and the results of the surface replicates yielded a standard deviation of 0.9 µmol/kg for 98 sets of duplicates. The deviation is very similar to that observed for the CRMs and suggest no strong dependency of results with amount of carbon titrated for a particular cell. The results of the duplicate samples have been presented in Figure 4 and Table 3.

Calculations Calculation of the amount of CO2 injected was according to the Department of Energy (DOE) CO2 handbook [DOE, 1994]. The gas loops yielded a calibration factor for the instrument defined as:

$$\text{Cal. Factor} = \frac{\text{calculated moles of CO2 injected from gas loop}}{\text{actual moles of CO2 injected}} \qquad (1)$$

The concentration of CO2 ([CO2]) in the samples were determined according to:

$$[\text{CO2}] = \text{Cal factor} * \frac{(\text{Counts} - \text{Blank} * \text{Run Time}) * \text{K } \mu\text{mol/count}}{\text{pipette volume} * \text{density of sample}} \qquad (2)$$

where "Counts" is the instrument reading at the end of the analysis, "Blank" is the counts/minute determined from blank runs performed at least once for each cell of the solution, "Run Time" is the length of coulometric titration (in minutes), and K is the conversion factor from counts to µmol which is dependent on the slope and intercept relation between instrument response and charge. For a unit with Ecal slope of 1 and intercept of 0, the constant is 2.0728 * 10 -4 .

The pipette volume was determined by taking aliquots at known temperature of distilled water from the volumes prior to, during, and after the cruise. The weights with the appropriate densities were used to determine the volume of the syringes and pipette.

Calculation of pipette volumes, density, and final CO2 concentration were performed according to procedures outlined in the DOE CO2 handbook (DOE, 1994).

B.2.2. FUGACITY OF CO2 (fCO2)

Gas Chromatographic (GC) Method A total of 1463 discrete fCO2 samples from 130 stations were taken and analyzed on the cruise using an analysis system based on gas chromatography (Neill et al., 1997). Sampling from the "Niskin" bottles occurred immediately after O2 samples were drawn. Samples were drawn into 120 ml Pyrex septum bottles after rinsing the bottles several times. On the final fill water was drawn into the bottom of the bottle and overflowed at least one half volume. A Teflon lined septum was crimp sealed on the bottle ensuring that no headspace was present.

Prior to analysis 5-ml water was withdrawn and replaced with a headspace of known CO2 concentration that was expected to closely match that of the water. The remaining water and headspace were equilibrated by rotating the bottles for at least 40 minutes in a constant temperature bath at 20 °C. The fCO2 of the headspace was measured in a flame ionization detector (FID) after quantitative conversion of the CO2 to methane. The analyses were referenced against a series of six gas standards with the following mole fractions: 198.09, 348.16, 977.79, 508.35, 1479.46, 717.4. The standards, which were run after each dozen samples, bracketed most of the concentrations measured in the water column. The precision of the fCO2 measurements was estimated at 0.86% of the signal based on 89 replicate samples (see Table 4). The fCO2 measurements had a data gap mid- cruise because of a catastrophic instrument failure caused by water being injected onto the column and catalyst. Good, full water column, coverage was obtained at the Eastern and Western side of the basin.

The surface water measurements showed that the water undersaturated for most of the transect except at the boundaries. The undersaturation reaches its greatest value of -45 to - 50 µatm between 60 and 75 °E. The fCO2 in the deep water showed a strong trend with lower concentrations in the West due to better ventilation of the Western half of the basin.

B.2.3. TOTAL ALKALINITY (TA)

Seawater samples were drawn from the "Niskin" bottles with a 40-cm length of silicon tubing. One end of the tubing was fit over the petcock of the "Niskin" bottle and the other end was inserted into the bottom of a 500-ml Corning glass-stoppered sample bottle. The sample bottle was rinsed three times with approximately 300 ml of seawater. The sample bottle was slowly filled from the bottom. Once filled, the sample bottles were kept in a constant water bath at 25°C for half-hour before analysis.

The titration system used to determine TA consisted of a Metrohm 665 Dosimat titrator and an Orion 720A pH meter controlled by a personal computer (Millero et al., 1993). The acid titrant, in a water-jacketed burette, and the seawater sample, in a water-jacketed cell, were kept at 25±0.1°C with a Neslab constant-temperature bath. The plexiglass water-jacketed cells were similar to those used by Bradshaw et al. (1988), except that a larger volume (200 ml) was used to increase the precision. The cells had fill and drain valves with zero dead-volume to increase the reproducibility of the cell volume.

The HCl solutions used throughout the cruise were made, standardized, and stored in 500-ml glass bottles in the laboratory for use at sea. The 0.2489 M HCl solutions (Batch 9601) were prepared by dilution of concentrated HCl in 0.45 M NaCl to yield an ionic strength equivalent to that of average seawater (0.7 M). The acid was independently standardized using a coulometric technique (Taylor and Smith, 1959; Marinenko and Taylor, 1968) by the University of Miami and by Dr. Dickson of Scripps Institution of Oceanography (SIO). The two standardization techniques agreed to +/-0.0001 N.

The volume of HCl delivered to the cell is traditionally assumed to have a small uncertainty (Dickson, 1981) and is equated with the digital output of the titrator.

Calibrations of the Dosimat burettes with Milli Q water at 25°C indicated that the systems deliver 3.000 ml (the value for a titration of seawater) to a precision of 0.0004 ml. This uncertainty resulted in an error of 0.4 µmol/kg in TA.

The titrators were calibrated in the laboratory before the cruise. Certified standard Reference Material (CRM) Batch 40 prepared by Dr. Dickson was used at sea to monitor the performance of the titrators. All TA data have been corrected based on CRM values for each cell and each leg (see Table 5) (Millero et al, 2000).

Carbonate parameters of surface waters indicate the occurrence of upwelling near the African coast. The surface carbonate parameters are consistent with those collected during the WOCE (World Ocean Circulation Experiment) 1992 cruise that sampled stations along the same latitude (24 o N). Both studies yield values for normalized TA (TA*35/S) of 2291±6 µmol kg -1 . The values of TA for the deep water are in good agreement (± 3.8 µmol/kg). Crossover comparison with OACES 1993 study also showed good agreement (±3 µmol/kg in TA). The pH is on average 0.004 higher than those made on the 1993 cruise.

Kitack Lee from AOML/OCD calculated total alkalinity (TA) from spectroscopic pH (25 o C) and coulometric total dissolved inorganic carbon (DIC) using the carbonic acid dissociation constants of Mehrbach et al. (1973) as refit by Dickson and Millero (1987). A value of 1.2 µmol kg -1 has been subtracted from calculated TA values because calculated values are 1.2 µmol kg -1 higher than measured values.

B.2.4. pH

Seawater samples were drawn from the "Niskin" bottles with a 20-cm length of silicon tubing. One end of the tubing was fit over the petcock of the "Niskin" bottle and the other end was attached over the opening of a 10-cm glass spectrophotometric cell. The spectrophotometric cell was rinsed three to four times with a total volume of approximately 200 ml of seawater; the Teflon endcaps were also rinsed and then used to seal a sample of seawater in the glass cell. While drawing the sample, care was taken to make sure that no air bubbles were trapped within the cell. The sample cells were kept in a waterbath at 25°C for a half an hour before analysis.

Seawater pH was measured using the spectrophotometric procedure (Byrne, 1987) and the indicator calibration of Clayton and Byrne (1993). The indicator was an 8.0-mM solution of Kodak m-cresol purple sodium salt (C21H17O5Na) in MilliQ water. The absorbance ratio of the concentrated indicator solution (RI = 578A/434A) was 0.95. All absorbance ratio measurements were obtained in the thermostatted (25.0±0.05°C) cell compartments of HP 8453 UV-visible Diode Array Spectrophotometers. Measurements of pH were taken at 25°C on the total hydrogen ion concentration ([H+]T) scale, in mol/kg solution, and converted to seawater scale ([H+]sw). The overall precision of the pH measurements obtained from the duplicate samples was ±0.0006. A total of 1997 samples were measured and 24 of them were rejected.

B.2.5. TOTAL ORGANIC CARBON, TOTAL NITROGEN AND TOTAL PHOSPHORUS

Total Organic Carbon Analyses TOC samples were analyzed by a high-temperature combustion (HTC) method using custom made instruments. Samples were analyzed with a furnace divided into two temperature zones (Hansell and Peltzer, 1998; Carlson et al., 1999). Ultra high purity O2 flowed through the instrument at 175 ml/min. Samples were acidified (10 µl of 85% H3PO4 per 10 ml of sample) and sparged with CO2 free oxygen for at least 10 minutes to remove inorganic carbon. One hundred µl of sample was injected manually through a septumless port into the quartz combustion tube packed with Pt gauze (Aldrich), 7% Pt on alumina catalyst (Shimadzu), Sulfix (Wako Pure Chemical Industries, Inc.) and CuO wire (Leeman Labs). The Pt gauze and Pt beads were heated to 800°C in the upper zone while the remaining packing material was heated to 600°C in the lower zone. The resulting CO2 flowed through two water traps and a final copper halide trap then detected with a LiCor 6252 CO2 analyzer. The signal was integrated with chromatographic software (Dynamax Macintegrator I version 1.3; Rainin Inst.).

Extensive conditioning of the combustion tube was essential to minimize the machine blank. The system blank (<10 µM) was assessed daily with ampoulated low carbon waters (LCW). The system response was standardized daily with a four point calibration curve of glucose solution in LCW. Deep Sargasso Sea water (>2000 m), which had been acidified and ampoulated, served as a daily reference material. Analyzing low carbon water and reference deep seawater several times a day allowed us to assess the system stability from run-to-run and day-to-day, ensuring confidence in our analysis. Both the low carbon and the deep Sargasso Sea references waters are part of an international certified reference material program for marine DOC measurement, run by the laboratory of Dr. Hansell. As such, the TOC analyses from the 24°N line are referenced to the international community of DOC laboratories using the CRM™s.

Total Nitrogen Analyses Concentrations of TN (total nitrogen, or the sum or organic and inorganic N) were determined by high temperature combustion and detection of the nitric oxide produced. Samples had been collected into 60 ml polyethylene bottles for frozen storage until analysis in the shore laboratory. In the high temperature system, a •ls quartz combustion tube was held at 900 °C in the upper zone and 800-900 °C in the lower zone of a 2-zone Thermcraft tube furnace. The combustion tube has a 12 cm head space, 2-3 screens of pure Pt (52 mesh), an 8 cm bed of 7% Pt on alumina (Shimadzu, Inc.), and a 10 cm bed of quartz beads. 100 µl injections of seawater were made into the combustion tube by syringe through a septum. The carrier gas (UHP oxygen) flowed at a rate of 200 ml/min. Recovery of known standards (glycine, urea, EDTA, etc.) was >90%. Detection of NO was done with an Antek Model 7020 chemiluminescence detector.

Oxygen flow through the ozone generator was 28 ml/min. Standardization was performed daily with potassium nitrate in Milli-Q water. Q water was used as the system blank, and it was assumed to have zero N content. The system blank was normally <1 µM. Low nutrient sea water, collected at the surface of the Sargasso Sea, was used as a reference material for daily use. The coefficient of variation in low nutrient surface water (4-5 µM TN) was 3-4%, while in deep water (>20 µM TN) it was 1%. Data acquisition was performed on a Dynamax Macintegrator I version 1.3, produced by Rainin Instruments.

Total Phosphorus Analyses Concentrations of TP (total phosphorus; organic plus inorganic P) were determined by UV photo-oxidation. Samples had been stored frozen in 60 ml polyethylene bottles until shore based analysis. A 6 ml aliquot was removed from each sample bottle and placed in a 20 ml fused quartz tube equipped with a Pyrex ground stopper (Quartz Scientific, Inc.). One hundred µl of 30% hydrogen peroxide was added to each tube and placed in a homemade irradiation unit (2 hours). The irradiation unit contained a 1200 W UV lamp (Hanovia) protected by a quartz jacket. A 2-tiered aluminum tube holder (40 tubes total) fitted around the lamp and held the samples 7 cm from the lamp. A fan placed at the bottom of the unit blew air across the samples for cooling. A hinged aluminum cylinder, open at the top and bottom, was fitted around the samples to keep stray UV light from leaving the system. This entire unit was placed in a fume hood, the front of which was covered with a black curtain while in use (again to collect stray UV light).

After irradiation, aliquots of the samples that had not been oxidized, and the photo-oxidized aliquots, were analyzed for phosphate using a colorimetric method on a Technicon Autoanalyzer II (Knap et al. 1997). Daily calibration was achieved from 4 point calibration curves using KH2PO4. Low nutrient seawater (Sargasso Sea surface water) was always processed with the samples as a daily quality control measure. Coefficients of variation for the measurement was X and X% for shallow and deep water samples.

B.2.6. $^{13}C/^{12}C$ OF DISSOLVED INORGANIC CARBON

Shipboard Sample Collection Methods Samples were collected in pre-washed and baked (450 ºC) 500 ml ground glass- stoppered bottles using the following method. A length of Tygon tubing was attached to the "Niskin" bottle or seawater line and flushed for a few seconds. The end of the tubing was then placed at the bottom of the upright sample bottle and the bottle was filled, then overflowed with an amount equal to its volume if "Niskin" water volume permitted, otherwise with at least half its volume. Flow was stopped as the Tygon tubing was removed from the top of the bottle to avoid any splashing in the top. Using a syringe or turkey baster, 10 to 20 ml were withdrawn off the top of the sample to lower the water level to approximately 1 ml below the neck of the bottle, avoiding backwash of water from the turkey baster into the sample. The ground glass joint of the bottle was wiped dry with Kimwipes. Then 100 µl of a saturated HgCl2 solution (per 250 ml of seawater) was injected beneath the surface of the sample using an Eppendorf pipet. The ground-glass stopper, which had been pre-greased with Apiezon M grease, was then inserted straight into the bottle without twisting. If any air streaks in the grease seal were visible, the stopper was removed, cleaned, and regreased, and the bottle was resealed. Clips (if required for the bottle neck-type) were placed on the necks of the bottles, and two heavy rubber bands were placed around the stopper and bottle to prevent leakage. The sample bottle was then inverted a couple of times to mix the HgCl2 throughout the sample.

Laboratory Methods CO2 is extracted from the DIC seawater sample using a modification of the helium stripping technique described by Kroopnick (1974) as described in Quay et al (1992). The stripper is comprised of a glass tube with a stainless steel fitting and silicone-greased glass stopcock at the bottom (which connects to the He line), a glass frit which the He passes through, and a stainless steel fitting containing a 3-layer silicone rubber septum at the top. Approximately 1 ml phosphoric acid is injected into the stripper and bubbled with He for 10 minutes. The gas is then evacuated out of the stripper and the stripper is weighed. Then 80 to 125 ml of the sample is drawn into the stripper and it is weighed again to calculate the weight of water analyzed. A stainless steel needle pierces the septum and connects the stripper to the extraction line, which has been evacuated and filled with helium. The sample is stripped with 99.997% pure He at a flow rate of 200 ml/min for 20 minutes. Water is trapped out in two glass traps submerged in Dewars containing a slush mixture of dry ice and isopropanol at -70ºC. CO2 is collected at -196ºC in glass loop traps submerged in liquid N2. The • 13 C is then measured on a Finnigan MAT 251 mass spectrometer. The efficiency of the extraction method is 100 ± 0.5 percent based on gravimetrically prepared Na2CO3 standards. The precision of the 13 C/ 12 C analysis is ± 0.02 0 /00 based on a replicate analysis of standards and seawater samples.

B.2.7. CHLOROFLUOROCARBONS (CFC)

As described above specially designed 10-l water sample bottles were used on the cruise to reduce CFC contamination.

Samples for the analysis of dissolved CFC-11, CFC-12 and CFC-113 were drawn from approximately 1700 of the 4300 water samples collected during the expedition. Samples for carbon tetrachloride (CCl4 or CFC-10) analysis were drawn from approximately 430 samples. When taken, water samples for CFC analysis were usually the first samples drawn from the 10-l bottles. Care was taken to co-ordinate the sampling of CFCs with other samples to minimize the time between the initial opening of each bottle and the completion of sample drawing. In most cases, dissolved oxygen, fCO2, total CO2, alkalinity and pH samples were collected within several minutes of the initial opening of each bottle. To minimize contact with air, the CFC samples were drawn directly through the stopcocks of the 10-l bottles into 100-ml precision glass syringes equipped with 2-way metal stopcocks. The syringes were immersed in a holding tank of clean surface seawater until analyzed.

To reduce the possibility of contamination from high levels of CFCs frequently present in the air inside research vessels, the CFC extraction/analysis system and syringe holding tank were housed in a modified 20' laboratory van on the aft deck of the ship.

For air sampling, a 100 meter length of 3/8" OD Dekaron tubing was run from the CFC lab van to the bow of the ship. A flow of air was drawn through this line into the CFC van using an Air Cadet pump. The air was compressed in the pump, with the downstream pressure held at 1.5 atm using a back-pressure regulator. A tee allowed a flow (100 cc min -1) of the compressed air to be directed to the gas sample valves, while the bulk flow of the air (>7 l min -1) was vented through the back pressure regulator. Air samples were only analyzed when the relative wind direction was within 60 degrees of the bow of the ship to reduce the possibility of shipboard contamination. The Air Cadet pump was run for at least 60 minutes prior to analyzing each batch of air samples to insure that the air inlet lines and pump were thoroughly flushed

Concentrations of CFC-11, CFC-12 and CFC-113 in air samples, seawater and gas standards on the cruise were measured by shipboard electron capture gas chromatography (EC-GC), using techniques similar to those described by Bullister and Weiss (1988). For seawater analyses, a 30-ml aliquot of seawater from the glass syringe was transferred into the glass sparging chamber. The dissolved CFCs in the seawater sample were extracted by passing a supply of CFC-free purge gas through the sparging chamber for a period of 4 minutes at 70 cc min -1 . Water vapor was removed from the purge gas during passage through an 18 cm long x 3/8 inch diameter glass tube packed with the desiccant magnesium perchlorate. The sample gases were concentrated on a cold-trap consisting of a 1/8 inch OD stainless steel tube with an about 7 cm section packed tightly with Porapak N (60-80 mesh). To cool the trap, isopropanol cooled by a Neslab Cryocool refrigeration system was forced from a reservoir beneath the trap to a level above the packing with a stream of compressed nitrogen. After quickly bringing the isopropanol to the top of the trap, a low flow of nitrogen was bubbled through the bath to reduce gradients and maintained a temperature of -20 o C. After 4 minutes of purging the seawater sample, the sparging chamber was closed and the trap was held open for an additional 1 minute to allow nitrous oxide (N20) to pass through the trap and thereby minimize its interference with CFC-12. The trap was isolated, the cold isopropanol in the bath was drained, and the trap was heated electrically to 125 o C. The sample gases held in the trap were then injected onto a precolumn (30 cm of 1/8 inch O.D. stainless steel tubing packed with 80-100 mesh Porasil C, held at 90 o C), for the initial separation of the CFCs and other rapidly eluting gases from the more slowly eluting compounds. The CFCs then passed into the main analytical column (about 183 cm of 1/8 inch OD stainless steel tubing packed with Carbograph 1AC, 80-100 mesh, held at 90 o C) for final separation, and into the EC detector for quantification.

The analysis of carbon tetrachloride was made on a separate, but nearly identical apparatus to the electron capture-gas chromatography system used in the analysis of CFC- 11, CFC-12 and CFC-113 (Bullister and Weiss, 1988). Samples were drawn in the same type of syringes used for the CFC analysis. In the CCl4 system, the sample injection port was flushed with 30-40 ml of sample before injecting sample into a calibrated loop (about 30 ml). After filling, an additional 30 ml of water was pushed through the loop and allowed to overflow. For analysis, a valve was switched and the water sample held in the loop was pushed into the stripper with the same CCl4 free nitrogen that was used to strip the sample. The gases removed from the sample were dried while passing through an ~18 cm x 3/8 inch OD tube of magnesium perchlorate and concentrated on a trap packed with four inches of Porapak N and held at -30 °C during trapping. At the conclusion of stripping, the trap was heated electrically and the contents swept onto the precolumn (0.53mm I. D. x 30 meters, DB624 capillary column, 45 °C)) with clean nitrogen. The desired gases passed on to the main analytical column (0.53mm I. D. x 30 meters, DB624 capillary column, 45 °C), before the precolumn vented the later peaks. All other aspects of the analysis were the same as the CFC analysis.

Both of the analytical systems were calibrated frequently using a standard gas of known CFC composition. Gas sample loops of known volume were thoroughly flushed with standard gas and injected into the system. The temperature and pressure was recorded so that the amount of gas injected could be calculated. The procedures used to transfer the standard gas to the trap, precolumn, main chromatographic column and EC detector were similar to those used for analyzing water samples. Two sizes of gas sample loops were present in the CFC analytical system, while four calibrated sample loops were used in the CCl4 system. Multiple injections of these loop volumes could be made to allow the system to be calibrated over a relatively wide range of concentrations. Air samples and system blanks (injections of loops of CFC-free gas) were injected and analyzed in a similar manner. The typical analysis time for a seawater, air, standard or blank sample was 12 minutes on the CFC system and 20 minutes on the CCl4 system.

Concentrations of the CFC's and CCl4 in air, seawater samples and gas standards are reported relative to the SIO93 calibration scale (Cunnold, et. al., 1994). Concentrations in air and standard gas are reported in units of mole fraction CFC in dry gas, and are typically in the parts-per-trillion (ppt) range. Dissolved CFC and CCl4 concentrations are given in units of picomoles per kg seawater (pmol kg -1). CFC and CCl4 concentrations in air and seawater samples were determined by fitting their chromatographic peak areas to multi-point calibration curves, generated by injecting multiple sample loops of gas from a working standard (PMEL cylinder 33790 for CFC-11, CFC-12 and CFC-113; PMEL cylinder 33780 for CCl4) into the analytical instrument. The concentrations of CFC-11 and CFC-12 in this working standard were calibrated before and after the cruise versus a primary standard (36743) (Bullister, 1984). No measurable drift in the concentrations of CFC-11 and CFC-12 in the working standard could be detected during this interval. Full range calibration curves were run at intervals of 3 days during the cruise. Single injections of a fixed volume of standard gas at one atmosphere were run much more18 frequently (at intervals of 1 to 2 hours) to monitor short term changes in detector sensitivity.

Extremely low (<0.01 pmol kg -1) CFC concentrations were measured in deep water (>3000 meters) in the Eastern Basin of the North Atlantic between 25 ºW and 45 ºW along this section. Based on the median of CFC concentration measurements in the deep water of this region, which is believed to be nearly CFC-free, blank corrections of 0.003 to 0.015 pmol kg -1 for CFC-11, 0.006 to 0.007 pmol kg -1 for CFC-12 and 0.006 to 0.011 pmol kg -1 for CFC-113 have been applied to the data set. If the measured

CFC concentration for a sample is very low, subtracting a blank can result in a very small negative number reported (see Figure 2). No blank corrections were required for the CCl4 data.

On this expedition, we estimate precision (1 standard deviation) of 1% or 0.005 pmol kg -1 (whichever is greater) for dissolved CFC-11, 2% or 0.005 pmol kg -1 (whichever is greater) for dissolved CFC-12 measurements (see listing of replicate samples given in Table 6), 4.4% or 0.002 pmol kg -1 for CFC-113 and 1.4% or 0.006 pmol kg -1 for CCl4 (Table 7). The results of the CFC air measurements are reported in Tables 8 and 9.

A number of water samples had clearly anomalous concentrations relative to adjacent samples for one or more of the trace gases. These anomalous samples appeared to occur more or less randomly during the cruise, and were not clearly associated with other features in the water column (e.g. elevated oxygen concentrations, salinity or temperature features, etc.). This suggests that the high values were due to individual, isolated low- level CFC contamination events. Measured concentrations for these samples are included in this report, but are given a quality flag of either 3 (questionable measurement) or 4 (bad measurement). A total of 4 analyses of CFC-11, 8 analyses of CFC-12, 3 analyses of CFC-113 and 2 analyses of CCl4 were assigned a flag of 3. A total of 9 analyses of CFC- 11, 8 analyses of CFC-12, 18 analyses of CFC-113 and 4 analyses of CCl4 were assigned a value of 4.

B.3. UNDERWAY MEASUREMENT METHODS

B.3.1. UNDERWAY fCO2

Underway pCO 2 system version 2.5 (analogous to those described in Ho et al. 1997, and Feely et al. 1998) was used to determine the pCO 2 of surface water and overlaying air on a continuous basis (Keeling 1965, Wanninkhof and Thoning 1993). When in operation, seawater is drawn from the uncontaminated seawater intake from the bow intake approximately 6 meters below the water line to a 30-l shower head equilibrator located in the main laboratory, where the headspace and seawater reach equilibrium on a short time scale. At specific times during an hourly cycle, the content of the headspace is measured by an infrared CO 2 analyzer. Uncontaminated air from the marine boundary layer is drawn continuously from the bow mast to the underway pCO 2 system. At a designated time, air is analyzed by a the infrared CO 2 analyzer, otherwise the air is bled off through a vent .

The CO 2 measurements are made by a Li-Cor differential, non-dispersive, infrared (NDIR) CO 2 analyzer (model 6251), and the result is based on the difference in absorption of infrared (IR) radiation passing through two gas cells. The reference cell is continuously flushed with a gas of known CO 2 concentration using the lowest concentration of three reference gas standards. During the hourly cycle the sample cell is flushed with one of three reference gas standards, marine boundary layer air, or headspace gas from the equilibrator.

The data may be downloaded via WWW site:
http://www.aoml.noaa.gov/ocd/oaces/1998data.html

C. ACKNOWLEDGMENTS

The dedication and assistance of the officers and crew of the NOAA Ship RONALD H. BROWN is gratefully appreciated and hereby acknowledged. This research was supported by the Ocean Atmospheric Carbon Exchange Study (OACES) and the World Ocean Circulation Experiment (WOCE). We wish to acknowledge the OACES program managers Drs. James Todd and Lisa Dilling for supporting the field program.

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APPENDIX A

WOCE quality flag definitions for water bottles.

Flag	Definition
1	Bottle information unavailable
2	No problems noted
3	Leaking
4	Did not trip correctly
5	Not reported
7	Unknown problem
9	Samples not drawn from this bottle

WOCE water quality flag definitions.

Flag	Definition
1	Sample drawn but analysis not received
2	Acceptable measurement
3	Questionable measurement
4	Bad measurement
5	Not reported
6	Mean of replicate measurements
9	Sample not drawn for measurement

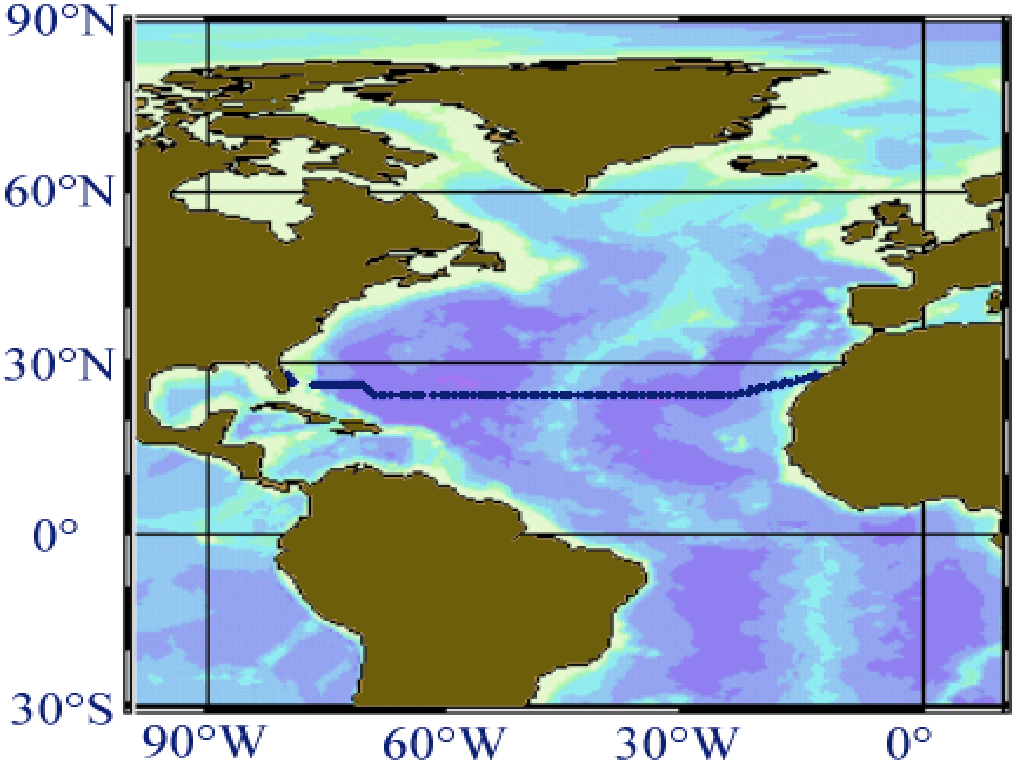

Figure 1. Cruise track for the Atlantic Ocean cruise AR01 in January and February 1998

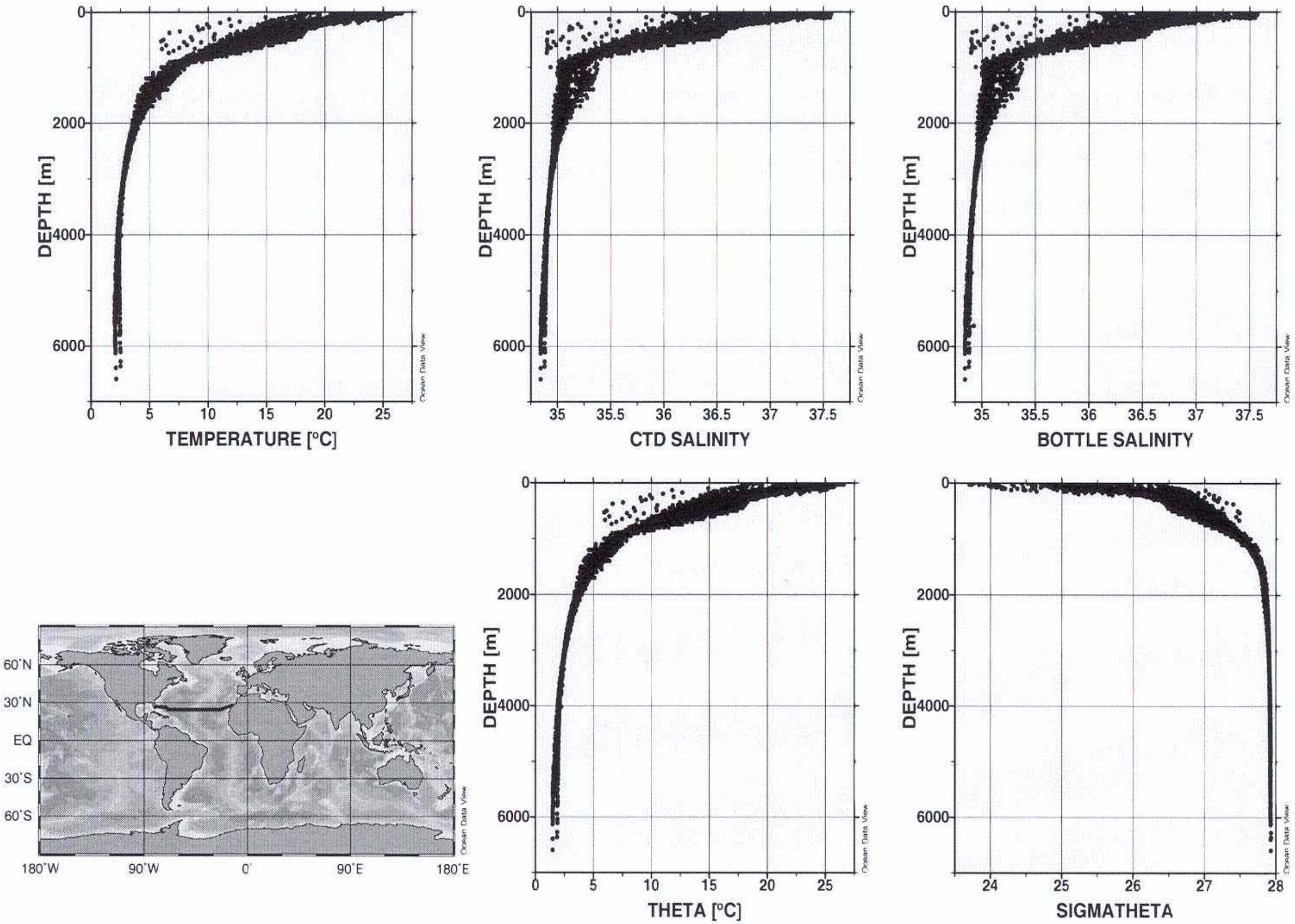

Figure 2. All parameters measured vs. depth

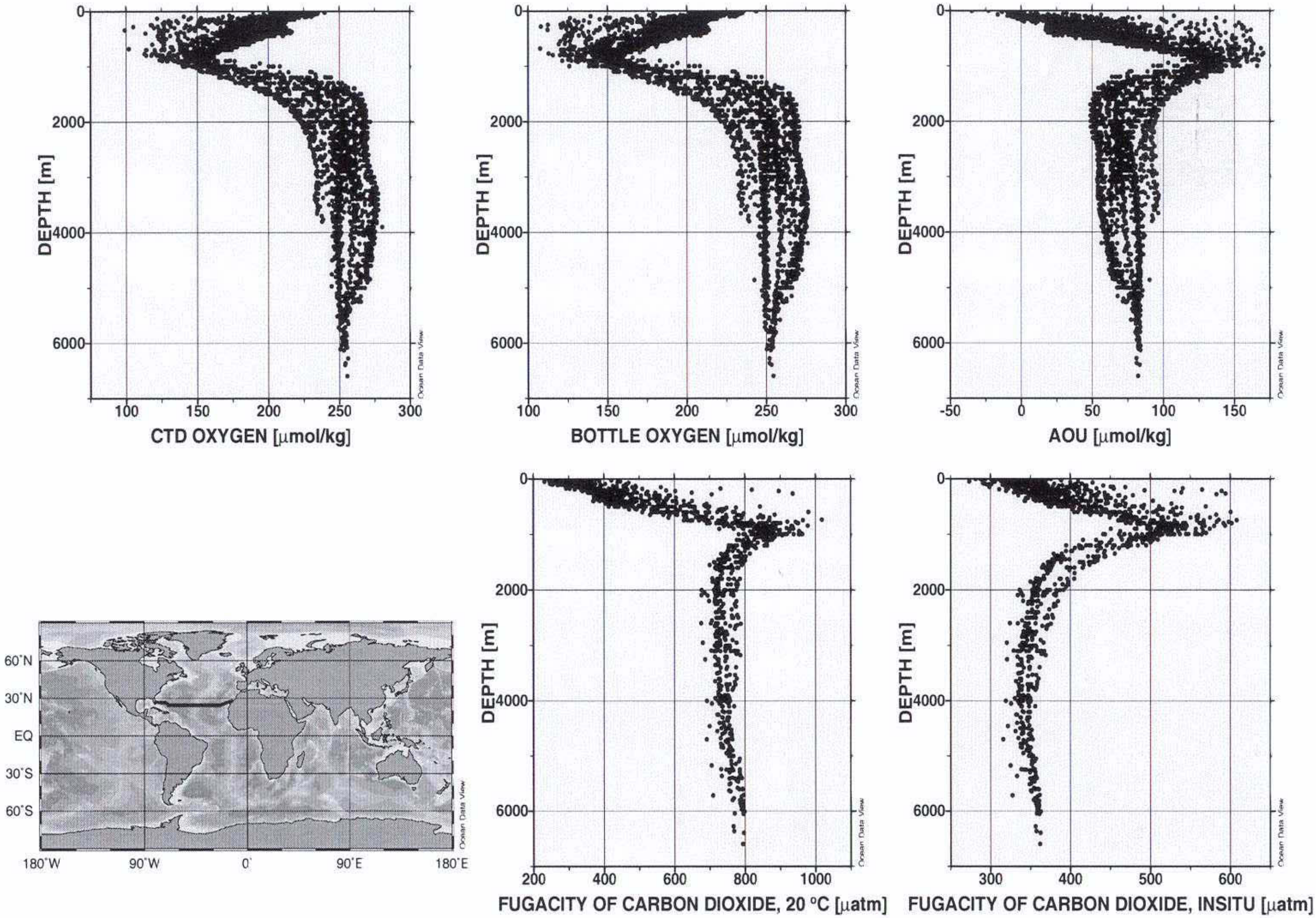

Figure 2. All the data vs. depth (continued)

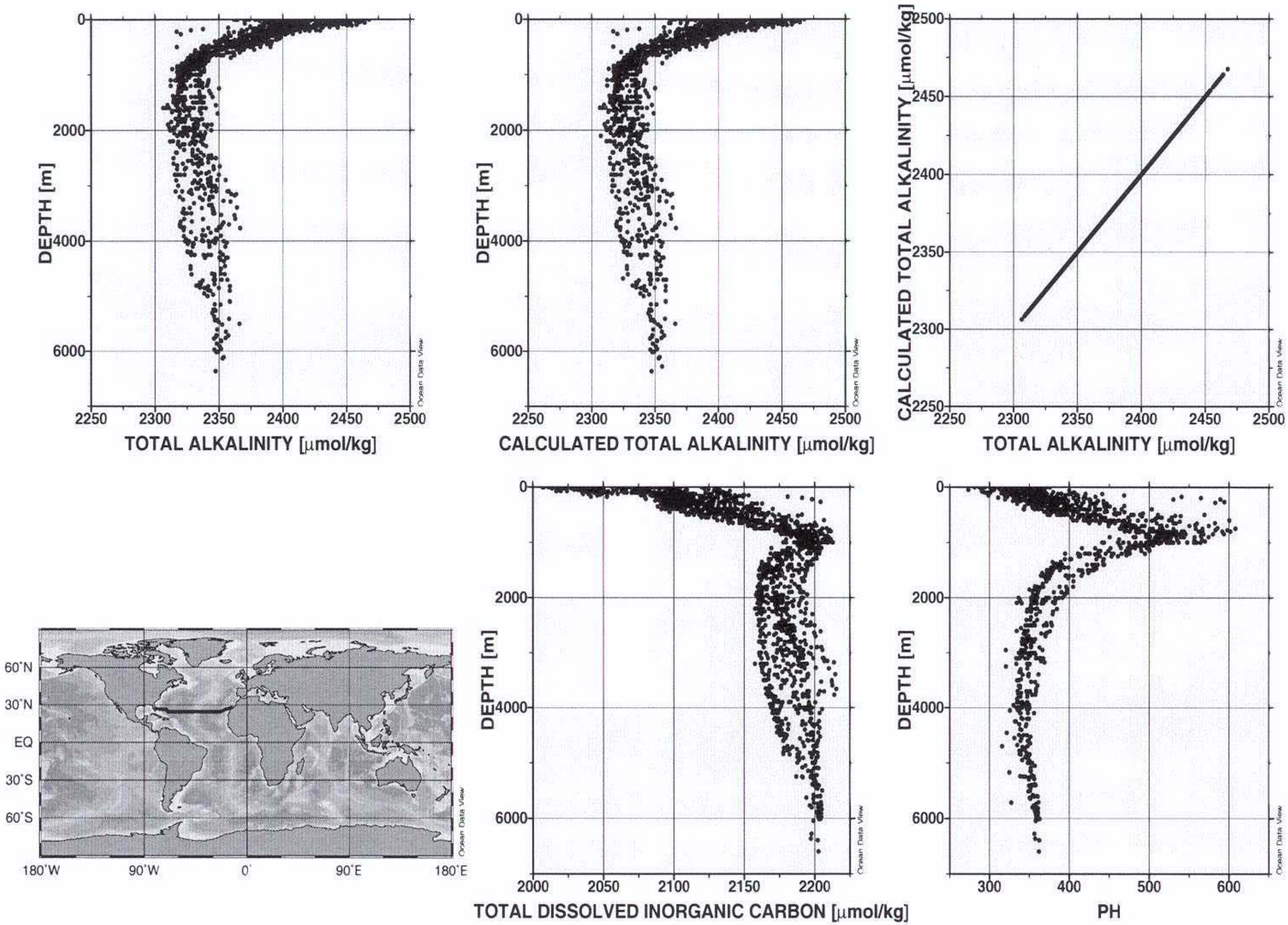

Figure 2. All the data vs. depth (continued)

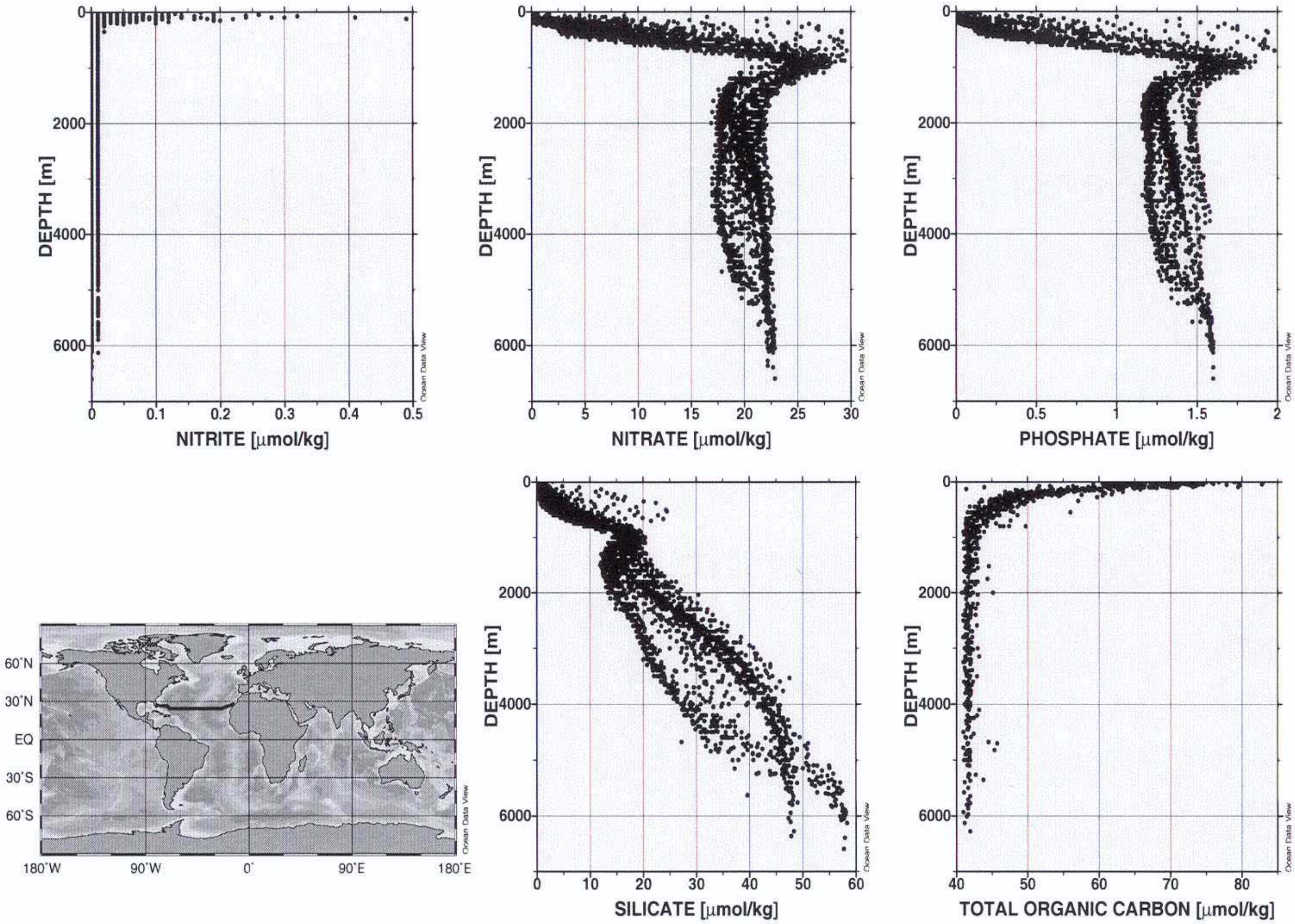

Figure 2. All the data vs. depth (continued)

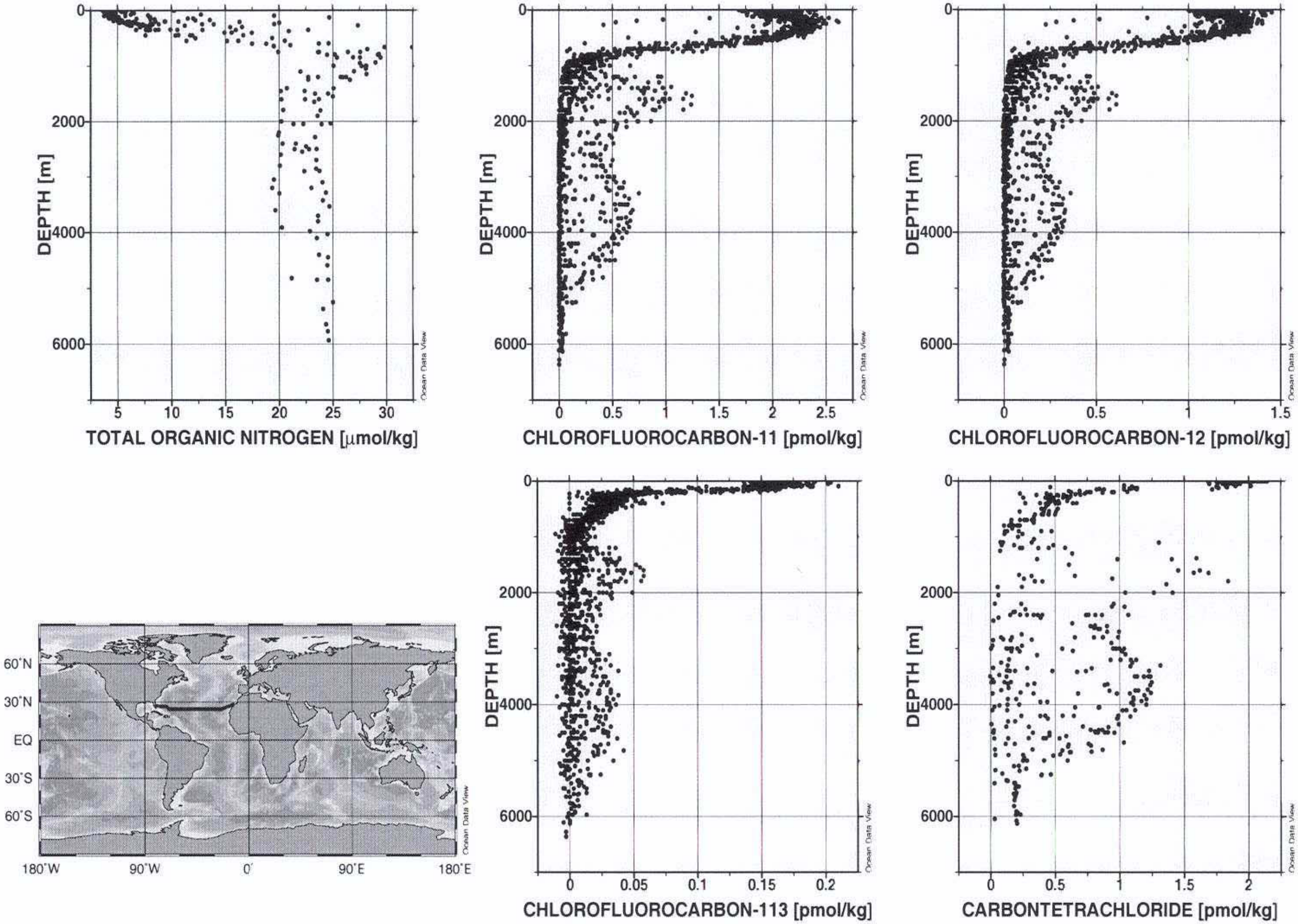

Figure 2. All the data vs. depth (continued)

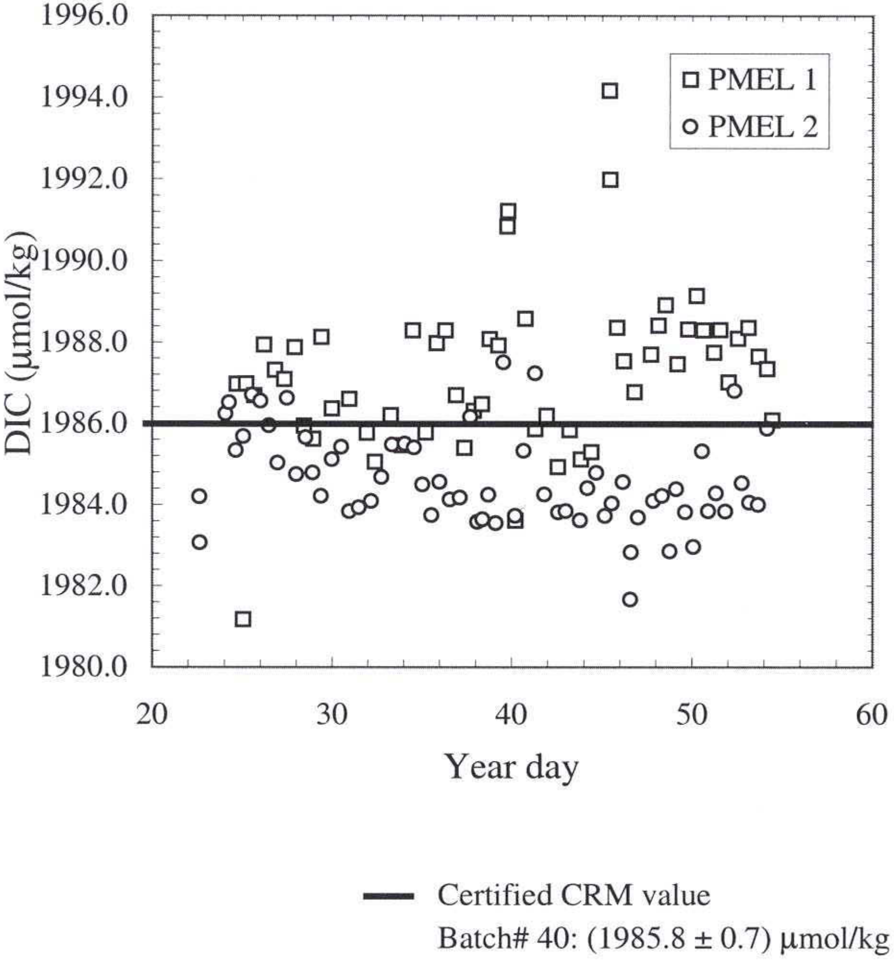

Figure 3. The results of the CRM measurements

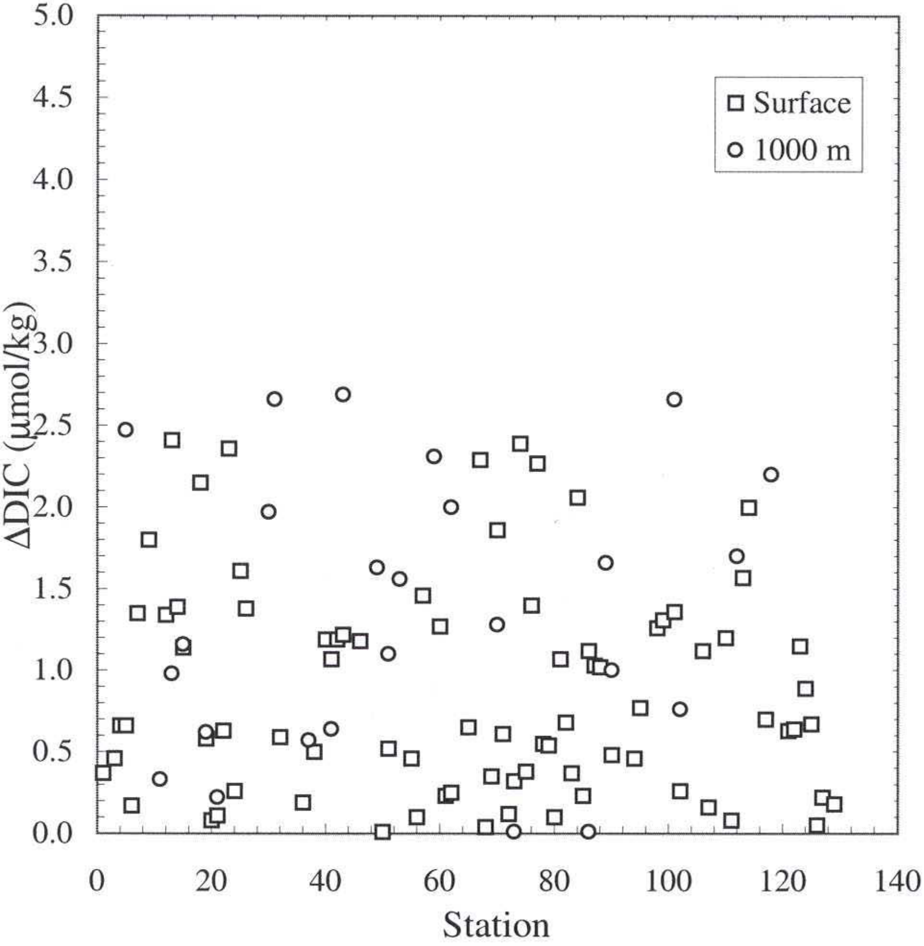

Figure 4. The results of the DIC duplicates during the course of the cruise

Table 1. Station locations

Station	Cast	Latitude (°N)	Longitude (°W)	Date
1	1	27.917	13.370	1/24/1998
2	1	27.965	13.404	1/24/1998
3	1	27.883	13.417	1/24/1998
4	1	27.849	13.417	1/24/1998
5	1	27.799	13.816	1/24/1998
6	1	27.617	14.235	1/24/1997
7	1	27.433	14.851	1/24/1998
8	1	27.232	15.596	1/25/1998
9	1	27.032	16.115	1/25/1998
10	1	26.833	16.668	1/25/1998
11	1	26.667	17.199	1/25/1998
12	1	26.517	17.867	1/25/1998
13	1	26.498	18.335	1/26/1998
14	1	26.167	18.817	1/26/1998
15	1	25.983	19.365	1/26/1998
16	1	25.800	19.899	1/26/1998
17	1	25.617	20.433	1/26/1998
18	1	25.424	20.949	1/27/1998
19	1	25.250	21.484	1/27/1998
20	1	25.057	22.032	1/27/1998
21	1	24.783	22.800	1/28/1998
22	1	24.500	23.484	1/28/1998
23	1	24.499	24.216	1/28/1998
24	1	24.500	24.950	1/28/1998
25	1	24.500	25.683	1/28/1997
26	1	24.500	26.416	1/29/1998
27	1	24.499	27.150	1/29/1998
28	1	24.500	27.883	1/29/1998
29	1	24.499	28.617	1/30/1998
30	1	24.499	29.433	1/30/1998
31	1	24.500	30.267	1/30/1998
32	1	24.500	31.084	1/31/1998
33	1	24.500	31.916	1/31/1998
34	1	24.500	32.733	1/31/1998
35	1	24.498	33.567	2/1/1998

Table 1. Station locations (continued)

Station	Cast	Latitude (^oN)	Longitude (^oW)	Date
36	1	24.502	34.383	2/1/1998
37	1	24.500	35.217	2/1/1998
38	1	24.500	36.033	2/2/1998
39	1	24.500	36.867	2/2/1998
40	1	24.500	37.683	2/2/1998
41	1	24.500	38.513	2/2/1998
42	1	24.500	39.250	2/3/1998
43	1	24.500	39.983	2/3/1998
44	1	24.500	40.533	2/3/1998
45	1	24.500	41.083	2/4/1998
46	1	24.500	41.633	2/4/1998
47	1	24.500	42.183	2/4/1998
48	1	24.500	42.733	2/4/1998
49	1	24.500	43.284	2/4/1998
50	1	24.500	43.473	2/5/1998
51	1	24.500	44.386	2/5/1998
52	1	24.500	44.934	2/5/1998
53	1	24.500	45.484	2/5/1998
54	1	24.500	46.034	2/5/1998
55	1	24.500	46.584	2/6/1998
56	1	24.500	47.134	2/6/1998
57	1	24.501	47.684	2/6/1998
58	1	24.500	48.234	2/6/1998
59	1	24.500	48.782	2/7/1998
60	1	24.500	49.333	2/7/1998
61	1	24.491	49.883	2/7/1998
62	1	24.501	50.433	2/8/1998
63	1	24.501	50.984	2/8/1998
64	1	24.501	51.533	2/8/1998
65	1	24.500	51.149	2/9/1998
66	1	24.501	52.637	2/9/1998
67	1	24.499	53.183	2/9/1998
68	1	24.500	53.733	2/9/1998
69	1	24.499	54.467	2/10/1998
70	1	24.499	55.201	2/10/1998

Table 1. Station locations (continued)

Station	Cast	Latitude (^oN)	Longitude (^oW)	Date
71	1	24.500	55.933	2/10/1998
72	1	24.500	56.667	2/11/1998
73	1	24.500	57.400	2/11/1998
74	1	24.500	58.134	2/11/1998
75	1	24.500	58.867	2/12/1998
76	1	24.500	59.600	2/12/1998
77	1	24.500	60.332	2/12/1998
78	1	24.500	60.067	2/12/1998
79	1	24.500	61.801	2/13/1998
80	1	24.500	63.534	2/13/1998
81	1	24.499	63.264	2/13/1998
82	1	24.500	64.000	2/14/1998
83	1	24.500	64.667	2/14/1998
84	1	24.501	65.469	2/14/1998
85	1	24.500	65.200	2/15/1998
86	1	24.500	66.933	2/15/1998
87	1	24.500	67.667	2/15/1998
88	1	24.500	68.401	2/15/1998
89	1	24.500	69.133	2/16/1998
90	1	25.016	69.502	2/16/1998
91	1	25.383	69.867	2/16/1998
92	1	25.759	70.235	2/17/1998
93	1	26.141	70.615	2/17/1998
94	1	26.501	71.012	2/17/1998
95	1	26.500	71.351	2/17/1998
96	1	26.500	71.734	2/18/1998
97	1	26.501	72.100	2/18/1998
98	1	26.501	72.467	2/18/1998
99	1	26.500	72.850	2/18/1998
100	1	26.500	73.217	2/18/1998
101	1	26.500	73.583	2/19/1998
102	1	26.500	73.967	2/19/1998
103	1	26.500	74.251	2/19/1998
104	1	26.500	74.517	2/19/1998
105	1	26.500	74.800	2/19/1998

Table 1. Station locations (continued)

Station	Cast	Latitude (^oN)	Longitude (^oW)	Date
106	1	26.500	75.084	2/20/1998
107	1	26.500	75.300	2/20/1998
108	1	26.500	75.500	2/20/1998
109	1	26.500	75.701	2/20/1998
110	1	26.500	75.900	2/20/1998
111	1	26.500	76.083	2/20/1998
112	1	26.500	76.200	2/21/1998
113	1	26.483	76.300	2/21/1998
114	1	26.505	76.422	2/21/1998
115	1	26.500	76.517	2/21/1998
116	1	26.500	76.617	2/21/1998
117	1	26.500	76.683	2/22/1998
118	1	26.499	76.753	2/22/1998
119	1	26.500	76.784	2/22/1998
120	1	26.500	76.816	2/22/1998
121	1	26.520	76.901	2/22/1998
122	1	27.001	79.200	2/23/1998
123	1	27.002	79.283	2/23/1998
124	1	27.001	79.381	2/23/1998
125	1	27.038	79.481	2/23/1998
126	1	27.013	79.605	2/23/1998
127	1	27.020	79.674	2/23/1998
128	1	27.002	79.788	2/23/1998
129	1	27.006	79.857	2/23/1998
130	1	26.999	79.937	2/23/1998

Table 2. Results of the certified reference material, CRM (Assigned value by SIO batch 40 = (1985.8 ± 0.7) mmol/kg) Coulometer: PMEL-2

Date	GMT (h:min)	Year Day	DIC (µmol/kg)
24-Jan-98	16:02	24	1987.0
25-Jan-98	0:41	25	1981.2
25-Jan-98	4:47	25	1987.0
25-Jan-98	15:19	25	1986.7
26-Jan-98	4:29	26	1987.9
26-Jan-98	18:48	26	1987.3
27-Jan-98	7:36	27	1987.1
27-Jan-98	21:31	27	1987.9
28-Jan-98	9:37	28	1985.9
28-Jan-98	22:19	28	1985.6
29-Jan-98	9:02	29	1988.1
29-Jan-98	23:31	29	1986.4
30-Jan-98	22:36	30	1986.6
31-Jan-98	22:11	31	1985.8
1-Feb-98	9:06	32	1985.1
2-Feb-98	6:16	33	1986.2
2-Feb-98	21:23	33	1985.5
3-Feb-98	11:32	34	1988.3
4-Feb-98	4:54	35	1985.8
4-Feb-98	19:43	35	1988.0
5-Feb-98	7:07	36	1988.3
5-Feb-98	21:35	36	1986.7
6-Feb-98	8:47	37	1985.4
6-Feb-98	21:16	37	1986.3
7-Feb-98	7:48	38	1986.5
7-Feb-98	18:14	38	1988.1
8-Feb-98	5:50	39	1987.9
8-Feb-98	17:42	39	1990.8
8-Feb-98	18:36	39	1991.2

Table 2. (continued) Results of the certified reference material, CRM (Assigned value by SIO batch 40 = (1985.8 ± 0.7) µol/kg) Coulometer: PMEL-2

Date	GMT (h:min)	Year Day	DIC (µmol/kg)
9-Feb-98	4:39	40	1983.6
9-Feb-98	17:46	40	1988.6
10-Feb-98	6:53	41	1985.9
10-Feb-98	22:02	41	1986.2
11-Feb-98	13:17	42	1984.9
12-Feb-98	4:52	43	1985.8
12-Feb-98	19:40	43	1985.1
13-Feb-98	9:40	44	1985.3
14-Feb-98	9:27	45	1994.2
14-Feb-98	10:25	45	1992.0
14-Feb-98	19:54	45	1988.4
15-Feb-98	4:46	46	1987.5
15-Feb-98	19:09	46	1986.8
16-Feb-98	17:09	47	1987.7
17-Feb-98	3:02	48	1988.4
17-Feb-98	12:21	48	1988.9
18-Feb-98	4:13	49	1987.5
18-Feb-98	18:30	49	1988.3
19-Feb-98	5:36	50	1989.1
19-Feb-98	14:48	50	1988.3
20-Feb-98	5:01	51	1987.7
20-Feb-98	13:07	51	1988.3
21-Feb-98	0:18	52	1987.0
21-Feb-98	13:12	52	1988.1
22-Feb-98	2:59	53	1988.4
22-Feb-98	16:47	53	1987.7
23-Feb-98	3:41	54	1987.4
23-Feb-98	10:54	54	1986.1

Table 2. (continued) Results of the certified reference material, CRM (Assigned value by SIO batch 40 = (1985.8 ± 0.7) µol/kg) Coulometer: PMEL-2

Date	GMT (h:min)	Year Day	DIC (µmol/kg)
22-Jan-98	15:02	22	1984.2
22-Jan-98	15:16	22	1983.1
24-Jan-98	1:39	24	1986.2
24-Jan-98	6:19	24	1986.5
24-Jan-98	15:19	24	1985.3
25-Jan-98	1:02	25	1985.7
25-Jan-98	12:58	25	1986.7
25-Jan-98	23:54	25	1986.6
26-Jan-98	11:18	26	1985.9
26-Jan-98	22:56	26	1985.0
27-Jan-98	11:22	27	1986.6
27-Jan-98	23:46	27	1984.7
28-Jan-98	12:28	28	1985.7
28-Jan-98	21:53	28	1984.8
29-Jan-98	8:57	29	1984.2
29-Jan-98	23:35	29	1985.1
30-Jan-98	12:19	30	1985.4
30-Jan-98	23:14	30	1983.8
31-Jan-98	11:51	31	1983.9
1-Feb-98	4:27	32	1984.1
1-Feb-98	18:18	32	1984.7
2-Feb-98	8:21	33	1985.5
3-Feb-98	1:09	34	1985.5
3-Feb-98	13:40	34	1985.4
4-Feb-98	0:49	35	1984.5
4-Feb-98	13:06	35	1983.7
4-Feb-98	23:48	35	1984.6
5-Feb-98	13:50	36	1984.1
6-Feb-98	2:55	37	1984.2

Table 2. (continued) Results of the certified reference material, CRM (Assigned value by SIO batch 40 = (1985.8 ± 0.7) µol/kg) Coulometer: PMEL-2

Date	GMT (h:min)	Year Day	DIC (µmol/kg)
6-Feb-98	16:49	37	1986.2
7-Feb-98	2:25	38	1983.6
7-Feb-98	9:08	38	1983.6
7-Feb-98	17:03	38	1984.2
8-Feb-98	3:00	39	1983.5
8-Feb-98	12:46	39	1987.5
9-Feb-98	4:50	40	1983.7
9-Feb-98	15:56	40	1985.3
10-Feb-98	7:15	41	1987.2
10-Feb-98	19:42	41	1984.3
11-Feb-98	13:58	42	1983.8
12-Feb-98	0:04	43	1983.8
12-Feb-98	19:06	43	1983.6
13-Feb-98	4:42	44	1984.4
13-Feb-98	16:36	44	1984.8
14-Feb-98	4:10	45	1983.7
14-Feb-98	13:23	45	1984.0
15-Feb-98	3:48	46	1984.6
15-Feb-98	14:02	46	1981.7
15-Feb-98	14:42	46	1982.8
16-Feb-98	0:12	47	1983.7
16-Feb-98	20:14	47	1984.1
17-Feb-98	7:55	48	1984.2
17-Feb-98	18:25	48	1982.8
18-Feb-98	2:52	49	1984.4
18-Feb-98	15:04	49	1983.8
19-Feb-98	2:04	50	1983.0
19-Feb-98	13:42	50	1985.3
19-Feb-98	21:50	50	1983.8

Table 2. (continued) Results of the certified reference material, CRM (Assigned value by SIO batch 40 = (1985.8 ± 0.7) μol/kg) Coulometer: PMEL-2

Date	GMT (h:min)	Year Day	DIC (μmol/kg)
20-Feb-98	8:11	51	1984.3
20-Feb-98	20:36	51	1983.8
21-Feb-98	8:47	52	1986.8
21-Feb-98	18:37	52	1984.5
22-Feb-98	4:37	53	1984.1
22-Feb-98	16:08	53	1984.0
23-Feb-98	4:18	54	1985.9

Table 3. Dissolved inorganic carbon duplicates

Station#	Bottle#	Pressure/db	DIC µmol/kg	Stdev
1	9	2	2119.7	0.26
3	20	2	2103.9	0.33
4	22	4	2100.8	0.47
5	7	995	2209.6	1.75
5	27	3	2105.0	0.47
6	30	3	2096.4	0.12
7	31	3	2096.4	0.95
9	32	4	2097.8	1.27
11	16	1001	2205.0	0.23
12	36	4	2098.4	0.95
13	17	1001	2212.5	0.69
13	35	4	2099.4	1.70
14	32	3	2100.1	0.98
15	17	1000	2209.1	0.82
15	36	4	2086.9	0.81
18	36	4	2100.1	1.52
19	18	1000	2212.8	0.44
19	36	5	2101.0	0.41
20	36	6	2099.1	0.06
21	19	1000	2207.9	0.16
21	36	6	2098.6	0.08
22	36	4	2096.7	0.45
23	36	5	2098.3	1.67
24	36	3	2096.2	0.18
25	36	4	2099.6	1.14
26	36	6	2098.6	0.98
30	18	1000	2200.1	1.39
31	18	1000	2200.6	1.88
32	36	6	2101.8	0.42
36	36	5	2094.6	0.13
37	20	1002	2200.4	0.40

Table 3. Dissolved inorganic carbon duplicates (continued)

Station#	Bottle#	Pressure/db (db)	DIC (μmol/kg)	Stdev
38	36	4	2090.6	0.35
40	36	4	2087.9	0.84
41	19	999	2200.8	0.45
41	36	6	2085.0	0.76
42	36	3	2076.3	0.84
43	17	1000	2195.0	1.90
43	36	4	2080.1	0.86
46	36	4	2081.0	0.83
49	20	997	2194.9	1.15
50	36	5	2077.0	0.01
51	19	1001	2193.5	0.78
51	36	5	2073.1	0.37
53	18	1001	2197.6	1.10
55	36	5	2073.1	0.33
56	36	5	2075.5	0.07
57	36	5	2072.2	1.03
59	17	1000	2197.5	1.63
60	36	4	2075.7	0.90
61	36	4	2064.1	0.16
62	18	999	2194.8	1.41
62	36	3	2066.6	0.18
65	36	6	2065.9	0.46
67	36	5	2050.1	1.62
68	36	4	2056.2	0.03
69	36	4	2060.2	0.25
70	18	1000	2195.2	0.91
70	36	5	2056.3	1.32
71	36	6	2046.5	0.43
72	36	4	2046.1	0.08
73	17	1000	2195.1	0.01
73	36	4	2044.4	0.23

Table 3. Dissolved inorganic carbon duplicates (continued)

Station#	Bottle#	Pressure/db (db)	DIC (μmol/kg)	Stdev
74	36	7	2033.7	1.69
75	36	5	2041.7	0.27
76	36	6	2038.2	0.99
77	36	5	2037.6	1.61
78	36	7	2035.3	0.39
79	36	5	2035.2	0.38
80	36	6	2023.7	0.07
81	36	4	2016.1	0.76
82	36	4	2036.6	0.48
83	36	4	2041.5	0.26
84	36	6	2036.9	1.46
85	36	4	2017.7	0.16
86	17	999	2202.1	0.01
86	36	4	2018.4	0.79
87	36	5	2028.5	0.73
88	36	5	2032.7	0.72
89	17	1001	2179.8	1.17
90	16	1001	2186.1	0.71
90	36	4	2037.9	0.34
94	36	4	2034.8	0.33
95	36	4	2035.4	0.54
98	36	4	2043.1	0.89
99	36	5	2042.8	0.93
101	18	1001	2191.6	1.88
101	36	4	2042.2	0.96
102	18	999	2187.3	0.54
102	36	5	2047.7	0.18
106	36	4	2041.5	0.79
107	36	4	2041.6	0.11
110	36	4	2037.3	0.85
111	36	4	2039.0	0.06

Table 3. Dissolved inorganic carbon duplicates (continued)

Station#	Bottle#	Pressure/db (db)	DIC (μmol/kg)	Stdev
112	18	999	2190.4	1.20
113	36	3	2040.1	1.11
114	36	4	2040.5	1.41
117	36	3	2036.4	0.49
118	15	999	2185.3	1.56
121	18	5	2023.1	0.45
122	18	4	2014.1	0.45
123	20	3	2013.4	0.81
124	21	4	2006.8	0.63
125	23	4	2007.7	0.47
126	21	3	2011.0	0.04
127	20	4	2016.7	0.16
129	11	4	2026.3	0.13

Table 4. Replicate pCO$_2$ analyses

Station	Bottle	Latitude (˘N)	Longitude (˘W)	Depth (m)	Ave (fCO2,20C) (μatm)	Stdev(fCO2,20C) (μatm)
2	10	28	13	149	480.1	2.05
6	30	28	14	3	361.7	5.59
7	12	27	15	849	881.1	3.11
8	17	27	16	847	803.0	5.23
8	33	27	16	3	344.1	0.14
10	32	27	17	117	392.5	6.79
13	15	26	18	1201	863.0	0.71
14	17	26	19	800	950.8	3.11
18	16	25	21	1229	827.3	0.57
19	18	25	21	1000	953.0	4.60
21	3	25	23	4499	752.0	0.64
22	26	25	23	449	691.3	1.63
23	10	24	24	2879	743.1	7.14
24	36	25	25	3	338.1	4.17
25	13	25	26	2497	733.8	4.88
27	36	24	27	4	318.4	2.83
28	18	25	28	1201	854.9	5.52
30	18	24	29	1000	872.6	11.88
30	30	24	29	248	418.4	0.28
34	5	25	33	4589	531.7	318.83
34	12	25	33	2401	741.1	2.69
34	14	25	33	2002	746.4	3.61
38	17	25	36	1250	831.4	13.65
39	12	25	37	2096	735.1	0.71
40	36	25	38	4	312.2	8.56
42	14	25	39	1999	742.9	7.78
43	8	25	40	2949	680.4	13.08
45	5	25	41	4051	706.1	5.16
45	13	25	41	2050	685.9	10.82
46	4	25	42	4000	691.8	7.99

Table 4. Replicate pCO$_2$ analyses (continued)

Station	Bottle	Latitude (˘N)	Longitude (˘W)	Depth (m)	Ave (fCO2,20C) (µatm)	Stdev(fCO2,20C) (µatm)
47	5	25	42	3098	712.2	27.79
47	9	25	42	2092	676.5	7.07
48	36	25	43	7	289.9	29.63
49	5	25	43	3201	715.0	7.42
49	10	25	43	2198	698.2	2.97
50	5	25	43	3092	704.4	10.68
51	14	25	44	1500	743.3	25.24
51	34	25	44	100	253.7	0.64
52	36	25	45	7	316.9	44.90
53	8	25	45	2000	711.8	13.22
53	19	25	45	901	851.9	4.95
53	36	25	45	6	267.9	18.10
54	36	25	46	5	272.3	10.25
55	9	25	47	1999	726.2	8.13
56	36	25	47	5	283.8	1.41
57	36	25	48	5	278.4	0.71
58	20	25	48	902	844.0	15.06
58	21	25	48	802	777.8	17.96
58	22	25	48	700	689.0	20.36
58	29	25	48	276	385.5	11.74
58	36	25	48	5	262.5	18.60
59	36	25	49	4	277.7	1.84
60	36	25	49	4	278.2	25.31
61	36	24	50	4	274.1	2.40
62	36	25	50	3	274.1	2.26
64	1	25	52	5363	733.8	8.27
65	36	25	51	6	276.4	1.70
66	16	25	53	1248	809.2	5.16
67	6	24	53	3999	743.7	6.01
67	13	24	53	1951	725.5	15.77

Table 4. Replicate pCO_2 analyses (continued)

Station	Bottle	Latitude (˘N)	Longitude (˘W)	Depth (m)	Ave (fCO2,20C) (µatm)	Stdev(fCO2,20C) (µatm)
67	20	24	53	802	784.3	0.57
67	30	24	53	248	380.8	4.81
67	36	24	53	5	261.1	10.32
68	35	25	54	3	266.5	6.23
69	19	24	54	1051	848.9	5.80
70	1	24	55	6008	798.2	5.09
70	16	24	55	1402	743.8	1.20
70	36	24	55	5	260.2	4.24
71	2	25	56	6050	794.8	4.03
72	36	25	57	4	275.5	2.05
73	12	25	57	1900	721.2	7.35
74	6	25	58	3900	730.5	4.95
75	36	25	59	5	276.2	6.43
76	36	25	60	6	272.2	0.07
77	4	25	60	4698	691.1	67.18
79	1	25	62	5891	794.9	3.68
80	36	25	64	6	263.6	3.04
81	6	24	63	3966	736.2	2.40
82	1	25	64	5862	785.8	3.11
82	16	25	64	1049	840.5	1.48
83	13	25	65	1851	708.1	4.95
84	36	25	65	6	275.6	1.56
85	13	25	65	2101	720.4	8.41
86	1	25	67	5816	792.9	4.95
86	26	25	67	400	446.3	3.96
87	2	25	68	5291	784.6	4.81
88	36	25	68	5	275.1	0.35
89	1	25	69	5736	789.8	7.92
90	4	25	70	4450	740.8	9.55
91	36	25	70	5	283.8	0.49

Table 4. Replicate pCO$_2$ analyses (continued)

Station	Bottle	Latitude (˘N)	Longitude (˘W)	Depth (m)	Ave (fCO2,20C) (µatm)	Stdev(fCO2,20C) (µatm)
94	3	27	71	4840	733.1	7.78
94	30	27	71	225	374.2	5.87
95	36	27	71	4	282.4	3.61
97	11	27	72	1998	725.7	3.46
98	1	27	72	5263	762.5	5.37
99	36	27	73	5	285.4	1.84
101	36	27	74	4	294.5	0.28
102	25	27	74	349	376.2	2.19
103	36	27	74	4	297.7	1.56
107	36	27	75	4	292.8	3.32
108	1	27	76	4751	748.1	6.22
110	34	27	76	96	301.3	3.25
111	36	27	76	4	285.8	0.42
113	36	26	76	3	287.6	3.32
114	3	27	76	4100	735.0	3.11
115	36	27	77	4	289.3	1.06
116	3	27	77	4188	736.3	5.37
117	36	27	77	3	288.9	1.70
120	3	27	77	1300	765.7	9.69
121	3	27	77	351	412.4	3.75
123	20	27	79	3	282.8	5.30
124	21	27	79	4	276.3	2.19
126	21	27	80	3	278.2	1.91
127	20	27	80	4	281.4	1.48
130	6	28	80	3	304.9	2.62

Table 5. Correction factors applied to raw data based upon carbonate parameters for Certified Reference Materials

CRM	TA (µmol/kg)	pH
Batch #40	2196.4	7.91

CELL	TA (µmol/kg)		pH		
	Measured	C.F.	Measured	C.F.	N
2[a]	2193.2 ± 1.2	1.001489	7.883 ± 0.004	0.026	12
	2198.5 ± 1.3	0.999062	7.883 ± 0.005	0.027	19
	2193.0 ± 1.3	1.001547	7.872 ± 0.004	0.039	11
12	2194.7 ± 2.7	1.000779	7.875 ± 0.006	0.035	4
18[b]	2200.3 ± 3.0	0.998228	7.874 ± 0.002	0.032	10
21	2198.9 ± 0.9	0.998863	7.859 ± 0.005	0.051	48

a. Three slightly different correction factors were applied to cell 2 due to the change in volume from a broken piston.

b. The weighted average was used

$TA_{corr} = TA_{sample} \times C.F.\ (TA)$

$pH_{corr} = pH_{sample} + C.F.(pH)$

Table 6. Replicate dissolved CFC-11 and CFC-12 analyses

Station	Bottle	CFC-11 (pmol/kg)	CFC-11 Stdev	CFC-12 (pmol/kg)	CFC-12 Stdev
3	9	2.227	0.025	1.189	0.005
5	6	0.184	0.006	0.092	0.004
7	14	0.814	0.012	0.415	0.001
7	28	2.348	0.018	1.325	0.009
8	27	2.403	0.040	1.319	0.016
9	6	0.012	0.005	0.012	0.001
9	30	2.253	0.021	1.306	0.032
11	12	0.147	0.004	0.092	0.013
11	18	0.468	0.002	0.242	0.003
11	33	2.228	0.010	1.295	0.009
13	28	2.352	0.013	1.301	0.002
14	6	0.001	0.003	-9.000	-9.000
14	32	2.159	0.018	1.221	0.010
16	19	0.141	0.001	-9.000	-9.000
16	30	2.286	0.008	1.305	0.001
19	5	0.008	0.000	0.005	0.001
19	29	2.445	0.008	1.310	0.027
21	19	0.135	0.005	0.077	0.006
22	5	0.004	0.001	-0.001	0.003
22	17	0.030	0.006	0.010	0.004
22	34	2.088	0.004	1.401	0.003
24	1	0.003	0.001	0.001	0.001
24	18	0.054	0.001	0.031	0.004
24	22	0.144	0.000	0.085	0.003
24	35	2.247	0.030	1.407	0.013
26	2	-0.001	0.001	0.000	0.001
26	12	0.007	0.000	-9.000	-9.000
26	14	0.010	0.003	0.003	0.002
26	24	2.161	0.019	1.132	0.006
26	35	1.978	0.013	1.143	0.010
28	9	-0.002	0.001	-0.002	0.001
28	17	0.039	0.001	0.021	0.001
28	22	0.652	0.011	0.331	0.002
28	30	2.358	0.016	1.324	0.012
29	2	0.002	0.001	-0.004	0.006
29	23	1.609	0.001	0.827	0.001
30	1	0.000	0.000	-0.003	0.002
30	19	0.143	0.001	0.078	0.004
30	28	2.370	0.018	1.294	0.009
30	35	2.015	0.012	1.167	0.008
31	30	2.372	0.006	1.317	0.007
32	1	-0.002	0.000	-0.001	0.004
32	20	0.137	0.000	0.064	0.004
32	34	2.033	0.007	1.172	0.001

Table 6. Replicate dissolved CFC-11 and CFC-12 analyses (continued)

Station	Bottle	CFC-11 (pmol/kg)	CFC-11 Stdev	CFC-12 (pmol/kg)	CFC-12 Stdev
34	21	0.367	0.001	0.171	0.002
34	34	1.962	0.012	1.137	0.005
35	4	-0.001	0.000	0.004	0.001
35	18	0.055	0.001	0.025	0.001
35	33	2.310	0.026	1.316	0.008
36	2	0.001	0.001	-0.001	0.001
36	14	0.005	0.001	-0.001	0.003
36	34	1.978	0.006	1.145	0.004
37	21	0.090	0.000	0.039	0.001
37	31	2.348	0.010	1.330	0.008
38	12	0.000	0.000	-0.004	0.001
38	22	0.766	0.001	0.361	0.006
38	30	2.375	0.013	1.315	0.008
39	7	0.001	0.000	-0.004	0.002
39	24	2.049	0.008	1.064	0.001
40	1	0.003	0.001	0.002	0.001
40	22	1.307	0.016	0.641	0.004
40	28	2.361	0.001	1.297	0.004
42	4	-0.001	0.002	-0.001	0.001
42	26	2.270	0.004	1.229	0.006
42	34	2.071	0.001	1.192	0.001
44	33	2.314	0.010	1.328	0.002
46	6	-0.001	0.001	-0.001	0.004
46	20	0.567	0.001	0.275	0.001
46	32	2.266	0.034	1.288	0.016
48	1	0.003	0.001	0.003	0.001
48	3	0.001	0.000	0.003	0.004
48	20	0.138	0.002	0.067	0.004
48	31	2.253	0.014	1.277	0.021
48	34	1.908	0.008	1.098	0.000
50	1	0.001	0.000	0.001	0.001
50	20	0.920	0.003	0.466	0.002
50	30	2.310	0.064	1.269	0.062
52	14	0.123	0.000	0.067	0.001
52	23	1.566	0.004	0.810	0.002
54	4	0.023	0.001	0.016	0.005
54	16	0.109	0.001	0.057	0.002
54	28	2.306	0.015	1.262	0.013
54	34	1.937	0.007	1.106	0.011
56	23	0.801	0.008	0.426	0.001
58	1	0.015	0.001	0.016	0.003
58	14	0.117	0.001	0.067	0.006
58	23	1.506	0.017	0.781	0.011
58	32	2.278	0.021	1.290	0.006

Table 6. Replicate dissolved CFC-11 and CFC-12 analyses (continued)

Station	Bottle	CFC-11 (pmol/kg)	CFC-11 Stdev	CFC-12 (pmol/kg)	CFC-12 Stdev
60	2	0.010	0.001	0.012	0.004
60	16	0.245	0.007	0.136	0.006
60	26	2.298	0.028	1.244	0.011
62	2	0.012	0.001	0.007	0.001
62	14	0.098	0.000	0.056	0.001
62	28	2.316	0.004	1.291	0.008
64	18	0.168	0.003	0.091	0.003
66	1	0.019	0.001	0.014	0.001
66	20	0.524	0.004	0.276	0.002
66	30	2.336	0.001	1.308	0.004
68	33	2.090	0.002	1.182	0.001
70	1	0.026	0.002	0.021	0.000
70	20	0.211	0.001	0.114	0.001
70	22	0.748	0.001	0.386	0.002
70	32	2.308	0.006	1.283	0.001
72	21	0.334	0.004	0.180	0.005
74	5	0.033	0.001	0.018	0.001
74	16	0.355	0.003	0.184	0.003
74	32	2.286	0.000	1.284	0.001
76	34	2.105	0.001	1.193	0.005
78	2	0.031	0.002	0.023	0.001
78	16	0.219	0.003	0.122	0.001
78	27	2.338	0.000	1.295	0.005
80	28	2.327	0.001	1.284	0.006
81	8	0.073	0.001	0.039	0.003
82	6	0.062	0.001	0.029	0.000
82	13	0.219	0.001	0.115	0.003
82	21	0.952	0.003	0.488	0.000
82	32	2.334	0.001	1.306	0.000
84	5	0.151	0.001	0.080	0.001
86	5	0.121	0.001	0.068	0.001
86	14	0.793	0.009	0.390	0.001
86	30	2.295	0.004	1.265	0.005
88	17	0.712	0.005	0.352	0.006
88	31	2.221	0.009	1.223	0.004
90	7	0.150	0.000	0.081	0.001
90	20	0.708	0.002	0.364	0.004
92	14	0.216	0.006	0.113	0.003
92	16	0.302	0.000	0.159	0.001
92	26	2.207	0.003	1.188	0.000
92	32	2.222	0.003	1.248	0.004
94	5	0.324	0.003	0.165	0.001
94	15	0.770	0.002	0.381	0.001
94	26	2.312	0.003	1.261	0.006

Table 6. Replicate dissolved CFC-11 and CFC-12 analyses (continued)

Station	Bottle	CFC-11 (pmol/kg)	CFC-11 Stdev	CFC-12 (pmol/kg)	CFC-12 Stdev
96	6	0.410	0.001	0.206	0.000
96	28	2.319	0.023	1.288	0.016
98	6	0.614	0.004	0.298	0.001
98	18	0.321	0.002	0.167	0.003
98	26	2.321	0.004	1.270	0.007
100	16	0.997	0.006	0.486	0.004
100	25	2.251	0.125	1.227	0.093
102	15	0.990	0.004	0.486	0.002
102	24	2.197	0.066	1.196	0.042
104	3	0.508	0.003	0.248	0.006
104	29	2.303	0.000	1.263	0.003
106	18	0.269	0.001	0.142	0.000
108	16	0.972	0.004	0.476	0.001
108	26	2.321	0.011	1.271	0.003
110	3	0.515	0.005	0.253	0.000
110	32	2.284	0.017	1.294	0.010
112	18	0.331	0.001	0.167	0.001
112	30	2.074	0.004	1.190	0.004
114	2	0.524	0.178	0.259	0.078
114	13	1.245	0.007	0.609	0.001
114	24	2.370	0.019	1.328	0.010
116	8	0.610	0.122	0.301	0.061
116	16	1.190	0.001	0.585	0.004
116	26	2.192	0.002	1.198	0.013
118	10	0.862	0.368	0.420	0.180
118	12	1.164	0.008	0.568	0.001
118	22	2.265	0.001	1.238	0.001
120	16	1.655	0.371	0.867	0.204
120	20	2.224	0.117	1.248	0.040
125	10	1.673	0.001	0.891	0.001
125	22	1.715	0.004	1.005	0.001
129	7	2.069	0.008	1.180	0.007

Table 7. Replicate dissolved CFC-113 and CCL4 analyses

Station	Bottle	CFC-113 (pmol/kg)	CFC-113 Stdev	CCl_4 (pmol/kg)	CCl_4 Stdev
3	9	0.043	0.024	-9.000	-9.000
5	6	0.002	0.006	-9.000	-9.000
7	14	0.018	0.006	-9.000	-9.000
7	28	0.178	0.008	-9.000	-9.000
8	27	0.056	0.006	-9.000	-9.000
9	6	0.000	0.000	-9.000	-9.000
9	30	0.174	0.008	-9.000	-9.000
11	12	-0.003	0.001	-9.000	-9.000
11	18	0.001	0.004	-9.000	-9.000
11	33	0.156	0.008	-9.000	-9.000
13	28	0.055	0.004	-9.000	-9.000
14	6	0.000	0.000	-9.000	-9.000
14	32	0.172	0.005	-9.000	-9.000
16	19	0.000	0.000	-9.000	-9.000
16	30	0.051	0.001	-9.000	-9.000
19	5	0.001	0.001	-9.000	-9.000
19	29	0.029	0.008	-9.000	-9.000
21	19	-0.004	0.000	-9.000	-9.000
22	5	0.001	0.001	-9.000	-9.000
22	17	-0.004	0.005	-9.000	-9.000
22	34	0.157	0.008	-9.000	-9.000
24	1	-0.002	0.001	-9.000	-9.000
24	18	-0.005	0.002	-9.000	-9.000
24	22	-0.001	0.006	-9.000	-9.000
24	35	0.163	0.007	-9.000	-9.000
26	2	-0.002	0.001	-9.000	-9.000
26	12	0.006	0.001	-9.000	-9.000
26	14	0.005	0.007	-9.000	-9.000
26	24	0.023	0.004	-9.000	-9.000
26	35	0.166	0.002	-9.000	-9.000
28	9	-0.006	0.001	-9.000	-9.000
28	17	0.001	0.002	-9.000	-9.000
28	22	0.004	0.002	-9.000	-9.000
28	30	0.059	0.004	-9.000	-9.000
29	2	-0.004	0.002	-9.000	-9.000
29	23	0.015	0.005	-9.000	-9.000
30	1	-0.003	0.004	-9.000	-9.000
30	19	-0.001	0.001	-9.000	-9.000
30	28	0.031	0.005	-9.000	-9.000
30	35	0.176	0.001	-9.000	-9.000
31	30	0.039	0.002	-9.000	-9.000
32	1	-0.005	0.001	-9.000	-9.000
32	20	-0.002	0.010	-9.000	-9.000
32	34	0.160	0.011	-9.000	-9.000

Table 7. Replicate dissolved CFC-113 and CCL4 analyses (continued)

Station	Bottle	CFC-113 (pmol/kg)	CFC-113 Stdev	CCl$_4$ (pmol/kg)	CCl$_4$ Stdev
33	1	-9.000	-9.000	0.031	0.001
33	26	-9.000	-9.000	0.451	0.002
33	35	-9.000	-9.000	1.912	0.046
34	21	0.004	0.004	-9.000	-9.000
34	34	0.169	0.006	-9.000	-9.000
35	4	-0.003	0.000	-9.000	-9.000
35	18	-0.009	0.002	-9.000	-9.000
35	33	0.140	0.004	-9.000	-9.000
36	2	-0.002	0.004	-9.000	-9.000
36	3	-9.000	-9.000	0.021	0.002
36	14	-0.004	0.000	-9.000	-9.000
36	18	-9.000	-9.000	0.086	0.006
36	33	-9.000	-9.000	1.095	0.032
36	34	0.154	0.003	-9.000	-9.000
37	21	0.002	0.005	-9.000	-9.000
37	31	0.067	0.001	-9.000	-9.000
38	12	0.002	0.001	-9.000	-9.000
38	22	0.011	0.005	-9.000	-9.000
38	30	0.038	0.003	-9.000	-9.000
39	7	-0.001	0.001	-9.000	-9.000
39	10	-9.000	-9.000	0.022	0.006
39	24	0.032	0.001	-9.000	-9.000
39	29	-9.000	-9.000	0.566	0.008
40	1	-0.001	0.001	-9.000	-9.000
40	22	0.021	0.002	-9.000	-9.000
40	28	0.031	0.001	-9.000	-9.000
42	4	0.001	0.001	-9.000	-9.000
42	26	0.029	0.001	-9.000	-9.000
42	34	0.182	0.012	-9.000	-9.000
43	1	-9.000	-9.000	0.035	0.001
43	19	-9.000	-9.000	0.227	0.013
43	34	-9.000	-9.000	1.036	0.016
44	33	0.154	0.001	-9.000	-9.000
46	6	-0.001	0.001	-9.000	-9.000
46	20	0.008	0.001	-9.000	-9.000
46	32	0.091	0.006	-9.000	-9.000
47	1	-9.000	-9.000	0.028	0.001
47	31	-9.000	-9.000	0.956	0.011
48	1	0.003	0.001	-9.000	-9.000
48	3	0.002	0.002	-9.000	-9.000
48	20	0.002	0.001	-9.000	-9.000
48	31	0.112	0.008	-9.000	-9.000
48	34	0.188	0.013	-9.000	-9.000
50	20	0.009	0.001	-9.000	-9.000

Table 7. Replicate dissolved CFC-113 and CCL4 analyses (continued)

Station	Bottle	CFC-113 (pmol/kg)	CFC-113 Stdev	CCl$_4$ (pmol/kg)	CCl$_4$ Stdev
50	30	0.023	0.033	-9.000	-9.000
51	1	-9.000	-9.000	0.067	0.013
51	17	-9.000	-9.000	0.230	0.009
51	26	-9.000	-9.000	0.442	0.042
52	14	0.005	0.005	-9.000	-9.000
52	23	0.017	0.004	-9.000	-9.000
54	4	0.001	0.002	-9.000	-9.000
54	16	0.005	0.001	-9.000	-9.000
54	28	0.031	0.004	-9.000	-9.000
54	34	0.182	0.025	-9.000	-9.000
56	23	0.010	0.006	-9.000	-9.000
56	27	-9.000	-9.000	0.451	0.012
58	1	0.002	0.003	-9.000	-9.000
58	14	0.008	0.002	-9.000	-9.000
58	23	0.020	0.000	-9.000	-9.000
58	32	0.081	0.003	-9.000	-9.000
60	2	0.002	0.001	-9.000	-9.000
60	5	-9.000	-9.000	0.130	0.008
60	16	0.007	0.001	-9.000	-9.000
60	26	0.035	0.003	-9.000	-9.000
60	33	-9.000	-9.000	1.077	0.017
62	2	0.006	0.001	-9.000	-9.000
62	14	0.005	0.001	-9.000	-9.000
62	28	0.035	0.001	-9.000	-9.000
64	1	-9.000	-9.000	0.127	0.006
64	2	-9.000	-9.000	0.131	0.003
64	18	0.006	0.002	-9.000	-9.000
64	33	-9.000	-9.000	0.844	0.039
66	1	0.006	0.002	-9.000	-9.000
66	20	0.008	0.002	-9.000	-9.000
66	30	0.035	0.006	-9.000	-9.000
68	1	-9.000	-9.000	0.199	0.004
68	3	-9.000	-9.000	0.190	0.001
68	33	0.162	0.008	-9.000	-9.000
70	1	-0.002	0.002	-9.000	-9.000
70	20	0.005	0.001	-9.000	-9.000
70	22	0.013	0.006	-9.000	-9.000
70	32	0.038	0.009	-9.000	-9.000
72	1	-9.000	-9.000	0.205	0.001
72	4	-9.000	-9.000	0.408	0.004
72	14	-9.000	-9.000	0.342	0.181
72	17	-9.000	-9.000	0.451	0.011
72	21	0.006	0.001	-9.000	-9.000
72	35	-9.000	-9.000	1.935	0.043

Table 7. Replicate dissolved CFC-113 and CCL4 analyses (continued)

Station	Bottle	CFC-113 (pmol/kg)	CFC-113 Stdev	CCl_4 (pmol/kg)	CCl_4 Stdev
74	4	-9.000	-9.000	0.327	0.008
74	5	0.012	0.001	-9.000	-9.000
74	16	0.011	0.001	-9.000	-9.000
74	32	0.078	0.007	-9.000	-9.000
76	2	0.007	0.001	-9.000	-9.000
76	4	-9.000	-9.000	0.294	0.004
76	8	-9.000	-9.000	0.143	0.005
76	25	-9.000	-9.000	0.436	0.003
78	2	0.007	0.001	-9.000	-9.000
78	16	0.008	0.001	-9.000	-9.000
78	27	0.035	0.000	-9.000	-9.000
80	13	-9.000	-9.000	0.944	0.016
80	28	0.039	0.005	-9.000	-9.000
80	33	-9.000	-9.000	0.822	0.010
81	8	0.006	0.001	-9.000	-9.000
82	6	0.004	0.002	-9.000	-9.000
82	13	0.008	0.002	-9.000	-9.000
82	21	0.012	0.001	-9.000	-9.000
82	32	0.056	0.001	-9.000	-9.000
84	4	-9.000	-9.000	0.455	0.006
84	5	0.010	0.006	-9.000	-9.000
84	34	-9.000	-9.000	1.751	0.012
86	5	0.005	0.003	-9.000	-9.000
86	14	0.030	0.001	-9.000	-9.000
86	30	0.024	0.003	-9.000	-9.000
88	4	-9.000	-9.000	0.533	0.011
88	17	0.022	0.002	-9.000	-9.000
88	31	0.030	0.006	-9.000	-9.000
88	33	-9.000	-9.000	0.463	0.006
90	4	-9.000	-9.000	0.865	0.006
90	7	0.006	0.005	-9.000	-9.000
90	20	0.010	0.000	-9.000	-9.000
92	5	-9.000	-9.000	0.654	0.294
92	14	0.005	0.003	-9.000	-9.000
92	16	0.008	0.003	-9.000	-9.000
92	26	0.026	0.004	-9.000	-9.000
92	32	0.055	0.005	-9.000	-9.000
94	5	0.020	0.001	-9.000	-9.000
94	6	-9.000	-9.000	0.884	0.002
94	15	0.033	0.002	-9.000	-9.000
94	26	0.027	0.003	-9.000	-9.000
96	4	-9.000	-9.000	0.988	0.001
96	6	0.018	0.001	-9.000	-9.000
96	28	0.037	0.001	-9.000	-9.000

Table 7. Replicate dissolved CFC-113 and CCL4 analyses (continued)

Station	Bottle	CFC-113 (pmol/kg)	CFC-113 Stdev	CCl$_4$ (pmol/kg)	CCl$_4$ Stdev
98	4	-9.000	-9.000	1.169	0.028
98	6	0.024	0.000	-9.000	-9.000
98	18	0.010	0.006	-9.000	-9.000
98	26	0.033	0.008	-9.000	-9.000
100	4	-9.000	-9.000	1.051	0.006
100	16	0.036	0.001	-9.000	-9.000
100	25	0.037	0.008	-9.000	-9.000
102	6	-9.000	-9.000	1.135	0.006
102	15	0.043	0.001	-9.000	-9.000
102	24	0.041	0.004	-9.000	-9.000
104	3	0.032	0.007	-9.000	-9.000
104	4	-9.000	-9.000	1.105	0.007
104	29	0.021	0.001	-9.000	-9.000
104	32	-9.000	-9.000	0.607	0.318
104	34	-9.000	-9.000	2.017	0.059
106	12	-9.000	-9.000	1.044	0.000
106	18	0.003	0.001	-9.000	-9.000
108	16	0.039	0.006	-9.000	-9.000
108	26	0.022	0.003	-9.000	-9.000
110	3	0.028	0.001	-9.000	-9.000
110	5	-9.000	-9.000	1.249	0.013
110	26	-9.000	-9.000	0.639	0.012
110	32	0.103	0.005	-9.000	-9.000
112	18	0.006	0.007	-9.000	-9.000
112	30	0.164	0.004	-9.000	-9.000
114	2	0.028	0.001	-9.000	-9.000
114	4	-9.000	-9.000	1.241	0.020
114	6	-9.000	-9.000	1.129	0.028
114	13	0.055	0.001	-9.000	-9.000
114	24	0.059	0.001	-9.000	-9.000
116	8	0.021	0.007	-9.000	-9.000
116	10	-9.000	-9.000	0.996	0.002
116	16	0.052	0.001	-9.000	-9.000
116	26	0.030	0.001	-9.000	-9.000
118	4	-9.000	-9.000	1.128	0.026
118	10	0.049	0.017	-9.000	-9.000
118	12	0.058	0.007	-9.000	-9.000
118	22	0.033	0.002	-9.000	-9.000
120	16	0.017	0.005	-9.000	-9.000
120	20	0.045	0.035	0.429	0.015
125	8	-9.000	-9.000	0.270	0.008
125	22	0.145	0.003	-9.000	-9.000
129	7	0.136	0.003	-9.000	-9.000
130	6	-9.000	-9.000	2.107	0.021

Table 8. CFC air measurements

Date	GMT (hhmm)	Latitude (˘N)	Longitude (˘W)	CFC-11 (ppt)	CFC-12 (ppt)	CFC-113 (ppt)	CCl_4 (ppt)
24-Jan-98	1840	27.433	14.850	259.836	535.550	79.192	-9.000
24-Jan-98	1851	27.433	14.851	260.321	537.726	79.103	-9.000
24-Jan-98	1902	27.433	14.851	261.361	534.915	77.644	-9.000
24-Jan-98	1913	27.433	14.851	261.377	536.906	77.760	-9.000
24-Jan-98	1924	27.424	14.891	262.772	537.277	77.314	-9.000
27-Jan-98	1946	24.909	22.448	262.927	540.885	79.736	-9.000
27-Jan-98	1956	24.876	22.532	263.902	543.954	82.513	-9.000
27-Jan-98	2006	24.871	22.547	263.581	547.197	78.311	-9.000
27-Jan-98	2026	24.840	22.632	263.681	548.454	79.922	-9.000
27-Jan-98	2036	24.834	22.646	264.611	549.683	78.559	-9.000
27-Jan-98	2046	24.834	22.646	265.075	549.246	77.953	-9.000
28-Jan-98	2106	24.500	24.961	263.434	537.866	79.534	-9.000
28-Jan-98	2116	24.501	25.026	262.535	538.353	77.246	-9.000
28-Jan-98	2126	24.503	25.062	263.367	540.686	78.619	-9.000
28-Jan-98	2146	24.504	25.080	262.361	538.433	78.813	-9.000
28-Jan-98	2156	24.503	25.182	259.377	534.339	79.203	-9.000
28-Jan-98	2206	24.503	25.199	259.908	536.414	77.986	-9.000
29-Jan-98	1239	24.500	26.755	265.207	539.051	77.299	-9.000
29-Jan-98	1309	24.499	26.869	264.325	543.569	81.042	-9.000
29-Jan-98	1319	24.501	26.932	265.751	543.250	81.041	-9.000
29-Jan-98	1329	24.501	26.966	261.947	539.318	81.010	-9.000
29-Jan-98	1339	24.500	26.983	264.225	543.042	78.873	-9.000
29-Jan-98	1420	24.500	27.146	265.708	542.256	81.572	-9.000
31-Jan-98	2100	24.500	32.733	260.684	533.662	80.721	-9.000
31-Jan-98	2110	24.500	32.733	262.469	537.215	80.101	-9.000
31-Jan-98	2120	24.500	32.733	260.907	533.539	78.561	-9.000
31-Jan-98	2150	24.500	32.750	258.837	532.814	77.423	-9.000
31-Jan-98	2200	24.500	32.784	263.848	541.865	77.622	-9.000
31-Jan-98	2210	24.500	32.801	259.333	532.263	77.621	-9.000
1-Feb-98	1413	24.502	34.383	-9.000	-9.000	-9.000	89.351
1-Feb-98	1433	24.502	34.383	-9.000	-9.000	-9.000	85.866
1-Feb-98	1453	24.502	34.383	-9.000	-9.000	-9.000	84.658
3-Feb-98	1515	24.500	39.983	262.053	536.784	79.448	-9.000
3-Feb-98	1525	24.498	39.996	262.736	536.844	78.944	-9.000
3-Feb-98	1535	24.498	40.029	261.965	536.178	78.790	-9.000
3-Feb-98	1545	24.498	40.029	261.492	536.176	79.798	-9.000
3-Feb-98	1615	24.501	40.143	262.094	539.114	77.696	-9.000
3-Feb-98	1625	24.501	40.240	261.884	539.831	78.942	-9.000
3-Feb-98	1803	24.500	40.533	-9.000	-9.000	-9.000	94.672
3-Feb-98	1823	24.500	40.533	-9.000	-9.000	-9.000	93.793
4-Feb-98	734	41.633	40.533	-9.000	-9.000	-9.000	92.265
4-Feb-98	754	41.633	40.533	-9.000	-9.000	-9.000	94.492
4-Feb-98	834	41.633	40.533	-9.000	-9.000	-9.000	91.098
4-Feb-98	854	41.633	40.533	-9.000	-9.000	-9.000	93.565

Table 8. CFC air measurements (continued)

Date	GMT (hhmm)	Latitude (˘N)	Longitude (˘W)	CFC-11 (ppt)	CFC-12 (ppt)	CFC-113 (ppt)	CCl_4 (ppt)
6-Feb-98	1137	24.500	47.134	-9.000	-9.000	-9.000	94.687
6-Feb-98	1157	24.500	47.134	-9.000	-9.000	-9.000	92.685
6-Feb-98	1237	24.500	47.134	-9.000	-9.000	-9.000	91.974
6-Feb-98	1257	24.500	47.134	-9.000	-9.000	-9.000	93.088
7-Feb-98	1224	24.500	49.333	262.958	538.920	79.104	-9.000
7-Feb-98	1234	24.500	49.333	261.579	540.095	80.068	-9.000
7-Feb-98	1244	24.500	49.333	261.338	538.346	79.588	-9.000
7-Feb-98	1314	24.500	49.333	265.800	540.404	81.139	-9.000
7-Feb-98	1324	24.500	49.333	262.774	539.189	79.657	-9.000
7-Feb-98	1334	24.500	49.333	262.934	539.476	79.559	-9.000
7-Feb-98	1531	24.500	49.461	258.404	531.774	78.156	-9.000
8-Feb-98	1914	24.501	51.533	261.171	537.612	80.509	-9.000
8-Feb-98	1924	24.500	51.533	262.143	538.129	79.696	-9.000
8-Feb-98	1934	24.499	51.546	265.034	538.779	80.208	-9.000
8-Feb-98	2004	24.500	51.636	262.012	536.424	80.017	-9.000
8-Feb-98	2014	24.500	51.636	261.953	537.730	79.940	-9.000
8-Feb-98	2024	24.499	51.699	263.807	538.928	79.901	-9.000
8-Feb-98	2056	24.501	51.533	-9.000	-9.000	-9.000	95.090
8-Feb-98	2116	24.501	51.533	-9.000	-9.000	-9.000	93.306
8-Feb-98	2156	24.501	51.533	-9.000	-9.000	-9.000	93.817
8-Feb-98	2216	24.501	51.533	-9.000	-9.000	-9.000	91.694
9-Feb-98	2244	24.502	53.784	261.719	537.661	81.545	-9.000
9-Feb-98	2254	24.504	53.851	262.597	539.557	80.872	-9.000
9-Feb-98	2304	24.504	53.880	261.726	537.667	79.912	-9.000
9-Feb-98	2324	24.503	53.956	264.344	541.163	80.720	-9.000
9-Feb-98	2334	24.502	53.987	262.269	536.927	80.020	-9.000
9-Feb-98	2344	24.502	53.987	262.205	536.721	80.565	-9.000
10-Feb-98	2032	24.500	55.933	-9.000	-9.000	-9.000	94.388
10-Feb-98	2052	24.500	55.933	-9.000	-9.000	-9.000	93.208
10-Feb-98	2112	24.500	55.933	-9.000	-9.000	-9.000	92.775
10-Feb-98	2132	24.500	55.933	-9.000	-9.000	-9.000	91.823
11-Feb-98	339	24.500	56.667	-9.000	-9.000	-9.000	94.978
11-Feb-98	359	24.500	56.667	-9.000	-9.000	-9.000	95.100
11-Feb-98	439	24.500	56.667	-9.000	-9.000	-9.000	93.361
11-Feb-98	459	24.500	56.667	-9.000	-9.000	-9.000	94.658
11-Feb-98	2204	24.500	58.134	-9.000	-9.000	-9.000	96.657
11-Feb-98	2224	24.500	58.134	-9.000	-9.000	-9.000	96.483
11-Feb-98	2244	24.500	58.134	-9.000	-9.000	-9.000	96.476
13-Feb-98	115	24.500	61.067	262.315	536.445	81.119	-9.000
13-Feb-98	125	24.500	61.067	262.475	538.298	82.255	-9.000
13-Feb-98	135	24.500	61.067	261.623	538.645	80.140	-9.000
13-Feb-98	155	24.506	61.071	261.686	538.295	79.729	-9.000
13-Feb-98	205	24.505	61.105	262.698	538.700	80.228	-9.000
13-Feb-98	215	24.505	61.105	261.676	536.758	79.115	-9.000

Table 8. CFC air measurements (continued)

Date	GMT (hhmm)	Latitude (˘N)	Longitude (˘W)	CFC-11 (ppt)	CFC-12 (ppt)	CFC-113 (ppt)	CCl_4 (ppt)
13-Feb-98	229	24.500	61.801	-9.000	-9.000	-9.000	93.299
13-Feb-98	249	24.500	61.801	-9.000	-9.000	-9.000	94.033
13-Feb-98	329	24.500	61.801	-9.000	-9.000	-9.000	94.533
13-Feb-98	349	24.500	61.801	-9.000	-9.000	-9.000	95.347
14-Feb-98	1944	24.500	65.468	262.707	539.047	80.631	-9.000
14-Feb-98	1954	24.500	65.467	262.465	538.199	81.209	-9.000
14-Feb-98	2004	24.501	65.467	262.275	536.354	80.125	-9.000
14-Feb-98	2024	24.500	65.467	262.132	536.824	80.285	-9.000
14-Feb-98	2034	24.501	65.467	262.028	537.808	80.243	-9.000
14-Feb-98	2044	24.501	65.467	262.004	537.114	80.121	-9.000
16-Feb-98	146	24.504	68.440	262.523	540.348	80.763	-9.000
16-Feb-98	156	24.503	68.544	263.901	539.621	81.137	-9.000
16-Feb-98	206	24.502	68.562	261.984	538.864	79.805	-9.000
16-Feb-98	226	24.498	68.666	263.276	540.683	79.877	-9.000
16-Feb-98	236	24.498	68.684	263.034	541.216	79.900	-9.000
16-Feb-98	246	24.498	68.684	263.002	541.274	80.052	-9.000
16-Feb-98	250	24.500	69.133	-9.000	-9.000	-9.000	94.950
16-Feb-98	310	24.500	69.133	-9.000	-9.000	-9.000	95.214
16-Feb-98	330	24.500	69.133	-9.000	-9.000	-9.000	93.795
19-Feb-98	25	26.500	73.216	262.293	538.847	80.539	-9.000
19-Feb-98	35	26.500	73.217	262.142	538.710	80.844	-9.000
19-Feb-98	45	26.500	73.217	261.824	539.329	80.451	-9.000
19-Feb-98	55	26.501	73.309	262.074	540.199	80.325	-9.000
19-Feb-98	110	26.500	73.583	-9.000	-9.000	-9.000	96.505
19-Feb-98	130	26.500	73.583	-9.000	-9.000	-9.000	96.064
19-Feb-98	150	26.500	73.583	-9.000	-9.000	-9.000	95.901
19-Feb-98	210	26.500	73.583	-9.000	-9.000	-9.000	94.810
20-Feb-98	1324	26.500	75.500	-9.000	-9.000	-9.000	96.687
20-Feb-98	1344	26.500	75.500	-9.000	-9.000	-9.000	95.869
20-Feb-98	1424	26.500	75.500	-9.000	-9.000	-9.000	95.886
20-Feb-98	1444	26.500	75.500	-9.000	-9.000	-9.000	95.399
20-Feb-98	2333	26.500	75.900	-9.000	-9.000	-9.000	96.398
20-Feb-98	2353	26.500	75.900	-9.000	-9.000	-9.000	95.629
21-Feb-98	1549	26.510	76.427	262.483	540.744	80.515	-9.000
21-Feb-98	1559	26.510	76.428	262.273	539.635	80.446	-9.000
21-Feb-98	1609	26.511	76.428	262.793	541.135	80.816	-9.000
21-Feb-98	1629	26.514	76.431	262.827	538.937	79.301	-9.000
21-Feb-98	1639	26.516	76.434	263.024	538.655	78.736	-9.000
21-Feb-98	1649	26.508	76.482	262.900	538.355	79.284	-9.000
22-Feb-98	108	26.500	76.617	261.254	537.878	79.587	-9.000
22-Feb-98	152	26.500	76.683	260.123	536.113	78.455	-9.000
22-Feb-98	234	26.500	76.683	-9.000	-9.000	-9.000	96.873
22-Feb-98	254	26.500	76.683	-9.000	-9.000	-9.000	96.657
23-Feb-98	237	26.111	78.494	264.570	540.167	81.155	-9.000

Table 8. CFC air measurements (continued)

Date	GMT (hhmm)	Latitude (˘N)	Longitude (˘W)	CFC-11 (ppt)	CFC-12 (ppt)	CFC-113 (ppt)	CCl$_4$ (ppt)
23-Feb-98	247	26.111	78.494	264.310	539.409	80.459	-9.000
23-Feb-98	257	26.163	78.587	262.826	539.090	79.707	-9.000
23-Feb-98	307	26.168	78.606	262.319	538.885	79.498	-9.000
23-Feb-98	337	26.171	78.731	262.246	539.018	79.676	-9.000
23-Feb-98	539	27.001	79.200	-9.000	-9.000	-9.000	93.798
23-Feb-98	559	27.001	79.200	-9.000	-9.000	-9.000	93.073
23-Feb-98	619	27.001	79.200	-9.000	-9.000	-9.000	93.724
23-Feb-98	1401	27.038	79.481	-9.000	-9.000	-9.000	97.231
23-Feb-98	1421	27.038	79.481	-9.000	-9.000	-9.000	96.196
23-Feb-98	1441	27.038	79.481	-9.000	-9.000	-9.000	95.753
24-Feb-98	250	26.999	79.937	-9.000	-9.000	-9.000	97.861
24-Feb-98	310	26.999	79.937	-9.000	-9.000	-9.000	97.393

Table 9. CFC air values (interpolated to station locations)

Station	Date	Latitude (˘N)	Longitude (˘W)	CFC-11 (ppt)	CFC-12 (ppt)	CFC-113 (ppt)	CCl_4 (ppt)
6	24-Jan-98	27.433	14.850	259.836	535.550	79.192	-9.000
7	24-Jan-98	27.433	14.851	260.321	537.726	79.103	-9.000
7	24-Jan-98	27.433	14.851	261.361	534.915	77.644	-9.000
7	24-Jan-98	27.433	14.851	261.377	536.906	77.760	-9.000
7	24-Jan-98	27.424	14.891	262.772	537.277	77.314	-9.000
20	27-Jan-98	24.909	22.448	262.927	540.885	79.736	-9.000
20	27-Jan-98	24.876	22.532	263.902	543.954	82.513	-9.000
20	27-Jan-98	24.871	22.547	263.581	547.197	78.311	-9.000
20	27-Jan-98	24.840	22.632	263.681	548.454	79.922	-9.000
20	27-Jan-98	24.834	22.646	264.611	549.683	78.559	-9.000
20	27-Jan-98	24.834	22.646	265.075	549.246	77.953	-9.000
24	28-Jan-98	24.500	24.961	263.434	537.866	79.534	-9.000
24	28-Jan-98	24.501	25.026	262.535	538.353	77.246	-9.000
24	28-Jan-98	24.503	25.062	263.367	540.686	78.619	-9.000
24	28-Jan-98	24.504	25.080	262.361	538.433	78.813	-9.000
24	28-Jan-98	24.503	25.182	259.377	534.339	79.203	-9.000
24	28-Jan-98	24.503	25.199	259.908	536.414	77.986	-9.000
26	29-Jan-98	24.500	26.755	265.207	539.051	77.299	-9.000
26	29-Jan-98	24.499	26.869	264.325	543.569	81.042	-9.000
26	29-Jan-98	24.501	26.932	265.751	543.250	81.041	-9.000
26	29-Jan-98	24.501	26.966	261.947	539.318	81.010	-9.000
26	29-Jan-98	24.500	26.983	264.225	543.042	78.873	-9.000
26	29-Jan-98	24.500	27.146	265.708	542.256	81.572	-9.000
34	31-Jan-98	24.500	32.733	260.684	533.662	80.721	-9.000
34	31-Jan-98	24.500	32.733	262.469	537.215	80.101	-9.000
34	31-Jan-98	24.500	32.733	260.907	533.539	78.561	-9.000
34	31-Jan-98	24.500	32.750	258.837	532.814	77.423	-9.000
34	31-Jan-98	24.500	32.784	263.848	541.865	77.622	-9.000
34	31-Jan-98	24.500	32.801	259.333	532.263	77.621	-9.000
36	1-Feb-98	24.502	34.383	-9.000	-9.000	-9.000	89.351
36	1-Feb-98	24.502	34.383	-9.000	-9.000	-9.000	85.866
36	1-Feb-98	24.502	34.383	-9.000	-9.000	-9.000	84.658
42	3-Feb-98	24.500	39.983	262.053	536.784	79.448	-9.000
42	3-Feb-98	24.498	39.996	262.736	536.844	78.944	-9.000
42	3-Feb-98	24.498	40.029	261.965	536.178	78.790	-9.000
42	3-Feb-98	24.498	40.029	261.492	536.176	79.798	-9.000
42	3-Feb-98	24.501	40.143	262.094	539.114	77.696	-9.000
42	3-Feb-98	24.501	40.240	261.884	539.831	78.942	-9.000
44	3-Feb-98	24.500	40.533	-9.000	-9.000	-9.000	94.672
44	3-Feb-98	24.500	40.533	-9.000	-9.000	-9.000	93.793
44	4-Feb-98	41.633	40.533	-9.000	-9.000	-9.000	92.265
44	4-Feb-98	41.633	40.533	-9.000	-9.000	-9.000	94.492
44	4-Feb-98	41.633	40.533	-9.000	-9.000	-9.000	91.098
44	4-Feb-98	41.633	40.533	-9.000	-9.000	-9.000	93.565

Table 9. CFC air values (interpolated to station locations, continued)

Station	Date	Latitude (˘N)	Longitude (˘W)	CFC-11 (ppt)	CFC-12 (ppt)	CFC-113 (ppt)	CCl_4 (ppt)
56	6-Feb-98	24.500	47.134	-9.000	-9.000	-9.000	94.687
56	6-Feb-98	24.500	47.134	-9.000	-9.000	-9.000	92.685
56	6-Feb-98	24.500	47.134	-9.000	-9.000	-9.000	91.974
56	6-Feb-98	24.500	47.134	-9.000	-9.000	-9.000	93.088
60	7-Feb-98	24.500	49.333	262.958	538.920	79.104	-9.000
60	7-Feb-98	24.500	49.333	261.579	540.095	80.068	-9.000
60	7-Feb-98	24.500	49.333	261.338	538.346	79.588	-9.000
60	7-Feb-98	24.500	49.333	265.800	540.404	81.139	-9.000
60	7-Feb-98	24.500	49.333	262.774	539.189	79.657	-9.000
60	7-Feb-98	24.500	49.333	262.934	539.476	79.559	-9.000
60	7-Feb-98	24.500	49.461	258.404	531.774	78.156	-9.000
64	8-Feb-98	24.501	51.533	261.171	537.612	80.509	-9.000
64	8-Feb-98	24.500	51.533	262.143	538.129	79.696	-9.000
64	8-Feb-98	24.499	51.546	265.034	538.779	80.208	-9.000
64	8-Feb-98	24.500	51.636	262.012	536.424	80.017	-9.000
64	8-Feb-98	24.500	51.636	261.953	537.730	79.940	-9.000
64	8-Feb-98	24.499	51.699	263.807	538.928	79.901	-9.000
64	8-Feb-98	24.501	51.533	-9.000	-9.000	-9.000	95.090
64	8-Feb-98	24.501	51.533	-9.000	-9.000	-9.000	93.306
64	8-Feb-98	24.501	51.533	-9.000	-9.000	-9.000	93.817
64	8-Feb-98	24.501	51.533	-9.000	-9.000	-9.000	91.694
58	9-Feb-98	24.502	53.784	261.719	537.661	81.545	-9.000
58	9-Feb-98	24.504	53.851	262.597	539.557	80.872	-9.000
58	9-Feb-98	24.504	53.880	261.726	537.667	79.912	-9.000
58	9-Feb-98	24.503	53.956	264.344	541.163	80.720	-9.000
58	9-Feb-98	24.502	53.987	262.269	536.927	80.020	-9.000
58	9-Feb-98	24.502	53.987	262.205	536.721	80.565	-9.000
71	10-Feb-98	24.500	55.933	-9.000	-9.000	-9.000	94.388
71	10-Feb-98	24.500	55.933	-9.000	-9.000	-9.000	93.208
71	10-Feb-98	24.500	55.933	-9.000	-9.000	-9.000	92.775
71	10-Feb-98	24.500	55.933	-9.000	-9.000	-9.000	91.823
72	11-Feb-98	24.500	56.667	-9.000	-9.000	-9.000	94.978
72	11-Feb-98	24.500	56.667	-9.000	-9.000	-9.000	95.100
72	11-Feb-98	24.500	56.667	-9.000	-9.000	-9.000	93.361
72	11-Feb-98	24.500	56.667	-9.000	-9.000	-9.000	94.658
74	11-Feb-98	24.500	58.134	-9.000	-9.000	-9.000	96.657
74	11-Feb-98	24.500	58.134	-9.000	-9.000	-9.000	96.483
74	11-Feb-98	24.500	58.134	-9.000	-9.000	-9.000	96.476
79	13-Feb-98	24.500	61.067	262.315	536.445	81.119	-9.000
79	13-Feb-98	24.500	61.067	262.475	538.298	82.255	-9.000
79	13-Feb-98	24.500	61.067	261.623	538.645	80.140	-9.000
79	13-Feb-98	24.506	61.071	261.686	538.295	79.729	-9.000
79	13-Feb-98	24.505	61.105	262.698	538.700	80.228	-9.000
79	13-Feb-98	24.505	61.105	261.676	536.758	79.115	-9.000

Table 9. CFC air values (interpolated to station locations, continued)

Station	Date	Latitude (˘N)	Longitude (˘W)	CFC-11 (ppt)	CFC-12 (ppt)	CFC-113 (ppt)	CCl_4 (ppt)
79	13-Feb-98	24.500	61.801	-9.000	-9.000	-9.000	93.299
79	13-Feb-98	24.500	61.801	-9.000	-9.000	-9.000	94.033
79	13-Feb-98	24.500	61.801	-9.000	-9.000	-9.000	94.533
79	13-Feb-98	24.500	61.801	-9.000	-9.000	-9.000	95.347
84	14-Feb-98	24.500	65.468	262.707	539.047	80.631	-9.000
84	14-Feb-98	24.500	65.467	262.465	538.199	81.209	-9.000
84	14-Feb-98	24.501	65.467	262.275	536.354	80.125	-9.000
84	14-Feb-98	24.500	65.467	262.132	536.824	80.285	-9.000
84	14-Feb-98	24.501	65.467	262.028	537.808	80.243	-9.000
84	14-Feb-98	24.501	65.467	262.004	537.114	80.121	-9.000
88	16-Feb-98	24.504	68.440	262.523	540.348	80.763	-9.000
88	16-Feb-98	24.503	68.544	263.901	539.621	81.137	-9.000
88	16-Feb-98	24.502	68.562	261.984	538.864	79.805	-9.000
88	16-Feb-98	24.498	68.666	263.276	540.683	79.877	-9.000
88	16-Feb-98	24.498	68.684	263.034	541.216	79.900	-9.000
88	16-Feb-98	24.498	68.684	263.002	541.274	80.052	-9.000
89	16-Feb-98	24.500	69.133	-9.000	-9.000	-9.000	94.950
89	16-Feb-98	24.500	69.133	-9.000	-9.000	-9.000	95.214
89	16-Feb-98	24.500	69.133	-9.000	-9.000	-9.000	93.795
100	19-Feb-98	26.500	73.216	262.293	538.847	80.539	-9.000
100	19-Feb-98	26.500	73.217	262.142	538.710	80.844	-9.000
100	19-Feb-98	26.500	73.217	261.824	539.329	80.451	-9.000
100	19-Feb-98	26.501	73.309	262.074	540.199	80.325	-9.000
101	19-Feb-98	26.500	73.583	-9.000	-9.000	-9.000	96.505
101	19-Feb-98	26.500	73.583	-9.000	-9.000	-9.000	96.064
101	19-Feb-98	26.500	73.583	-9.000	-9.000	-9.000	95.901
101	19-Feb-98	26.500	73.583	-9.000	-9.000	-9.000	94.810
108	20-Feb-98	26.500	75.500	-9.000	-9.000	-9.000	96.687
108	20-Feb-98	26.500	75.500	-9.000	-9.000	-9.000	95.869
108	20-Feb-98	26.500	75.500	-9.000	-9.000	-9.000	95.886
108	20-Feb-98	26.500	75.500	-9.000	-9.000	-9.000	95.399
110	20-Feb-98	26.500	75.900	-9.000	-9.000	-9.000	96.398
110	20-Feb-98	26.500	75.900	-9.000	-9.000	-9.000	95.629
114	21-Feb-98	26.510	76.427	262.483	540.744	80.515	-9.000
114	21-Feb-98	26.510	76.428	262.273	539.635	80.446	-9.000
114	21-Feb-98	26.511	76.428	262.793	541.135	80.816	-9.000
114	21-Feb-98	26.514	76.431	262.827	538.937	79.301	-9.000
114	21-Feb-98	26.516	76.434	263.024	538.655	78.736	-9.000
114	21-Feb-98	26.508	76.482	262.900	538.355	79.284	-9.000
116	22-Feb-98	26.500	76.617	261.254	537.878	79.587	-9.000
117	22-Feb-98	26.500	76.683	260.123	536.113	78.455	-9.000
117	22-Feb-98	26.500	76.683	-9.000	-9.000	-9.000	96.873
117	22-Feb-98	26.500	76.683	-9.000	-9.000	-9.000	96.657
122	23-Feb-98	26.111	78.494	264.570	540.167	81.155	-9.000

Table 9. CFC air values (interpolated to station locations, continued)

Station	Date	Latitude (˘N)	Longitude (˘W)	CFC-11 (ppt)	CFC-12 (ppt)	CFC-113 (ppt)	CCl_4 (ppt)
122	23-Feb-98	26.111	78.494	264.310	539.409	80.459	-9.000
122	23-Feb-98	26.163	78.587	262.826	539.090	79.707	-9.000
122	23-Feb-98	26.168	78.606	262.319	538.885	79.498	-9.000
122	23-Feb-98	26.171	78.731	262.246	539.018	79.676	-9.000
122	23-Feb-98	27.001	79.200	-9.000	-9.000	-9.000	93.798
122	23-Feb-98	27.001	79.200	-9.000	-9.000	-9.000	93.073
122	23-Feb-98	27.001	79.200	-9.000	-9.000	-9.000	93.724
125	23-Feb-98	27.038	79.481	-9.000	-9.000	-9.000	97.231
125	23-Feb-98	27.038	79.481	-9.000	-9.000	-9.000	96.196
125	23-Feb-98	27.038	79.481	-9.000	-9.000	-9.000	95.753
130	24-Feb-98	26.999	79.937	-9.000	-9.000	-9.000	97.861
130	24-Feb-98	26.999	79.937	-9.000	-9.000	-9.000	97.393

WHPO DATA PROCESSING NOTES

Date	Contact	Data Type	Data Status Summary
12/07/99	Baringer	BTL	Data Requested by d. bartolocci Also, may we make these data public, or should they be encrypted on our website? Would you be able to provide an estimated date for submission of the bottle file so we may update our records?
12/07/99	Baringer	DOC	Submitted
12/07/99	McTaggart	CTD/SUM	Submitted I've transferred 130 CTD data files, along with the .SUM file, from the 1998 OACES/ACCP trans-Atlantic cruise along 24N (WHPID A6) to the WHPO ftp site, whpo.ucsd.edu, subdirectory /INCOMING. Also find six text files of documentation and tables, and ten postscript files of figures representing the published documentation in the NOAA data report, "CTD/O2 Measurements Collected on a Climate and Global Change Cruise Along 24N in the Atlantic Ocean (WOCE Section A6) During January-February 1998" (ERL PMEL-68). A bottle data file (.SEA) will be submitted by Dr. Molly Baringer at a later date.
12/14/99	Bartolacci	CTD/SUM	Update Needed expocode too long, probs w/ lat/lon both sumfile and ctd files need work. The sumfile has bad lat/lons on line 256 and 311, and some of the columns have "NA" in them that cause sumchk to barf. I'm assuming that the expocode will need to be changed as well.
02/22/00	Huynh	DOC	Doc Update pdf, txt versions online
05/12/00	Bartolacci	CTD	Website Updated CTD data status is public
05/22/00	Kappa	DOC	ctd report added to text file
08/24/00	Mele	SUM	Submitted error: station 102; 29 95 N should be 29.95 N. there is a missing decimal place in the beginning position for station 102 in the sum file for ar01_a. -- phil mele
11/08/00	Bartolacci	BTL	Data Request sent to M. Barringer
11/27/00	Bartolacci	SUM	Data file Reformatted, online I have replaced the current file with the reformatted file and updated all references to reflect this change. NOTE: The line number for this cruise has been changed from the Chief Scientist's designation (of A06) to the WHP-ID AR01
11/28/00	Bartolacci	CTD	Data file Reformatted, online I have replaced the current online CTD files with the newly reformatted files (by D. Muus) and edited all references to reflect this change. Notes on merging reside in a ctd subdirectory in the original subdir. for this cruise.
11/28/00	Muus	CTD	Reformatted by WHPO AR01_a EXPOCODE 31RBOACES24N_2 CTD Stations 1-130. 1. Changed EXPOCODE in all ctd files from 31RBOACES24N/2 to 31RBOACES24N_2. 2. Changed WHP-ID from A6 to AR01. 3. Added WHPOSIO version number. 4. Changed file names from cg198w001.ctd to ar01_a0001.wct etc. cg198w130.ctd to ar01_a0130.wct 5. Changed from 1db interval to 2db interval and corrected No. RECORDS=. 6. Plotted all files and ran wctcvt. No apparent errors. Many stations between 033 and 101 had noisy oxygen values (+/- 3uM/L)

01/31/01	Diggs	BTL	Data Requested from M Baringer	

2001.01.22 S. Diggs telephones M. Baringer requesting bottle file. No reply as of 2001.01.31.

06/29/01	Uribe	CTD	Website Updated	CSV File Added

CTD have been converted to exchange format and put online.

01/20/02	Bartolacci	BTL/CO2	Submitted	

I have obtained a version of the bottle file for this cruise from Alex Kozyr at CDIAC as per Piers Chapmans suggestion. Currently the file is in OceanDataView format, NOT anywhere near WOCE format. I have placed the file in the original subdirectory for this cruise and have sent an email to Lee (Chi Sci) to request the file in another ascii format. Also requested public status of file. This email was copied to M. Baringer the data contact for this data. No formatting has taken place on these data yet, it is difficult to see what parameters are in the file at this time. Another RCS will be submitted once parameters are confirmed.

As per Alex Kozyr, CO2 data has not yet been dqe'd and he is awaiting the file conversion into WOCE format in order to dqe these parameters.

01/25/02	Bartolacci	BTL	Submitted	Data added to website

Comma separated bottle file was obtained from aoml website as per B. Huss (data contact for this cruise). File also contained parameters not tracked by WOCE (TOC, TON, FCO220C FCO2INSITU, CTALK [different from TALK]). File has been linked online although no reformatted has taken place at this time. All data are public as per Lee.

Please note that Baringer is not data contact for this file all queries are to be directed to B. Huss.

NOAA/AOML DATA PROCESSING NOTES

01/24/02 Huss BTL Data Updates prior to submisson to WHPO

This file is a chronology of changes and/additions to the master database for the 24 North 1998 cruise which took place from late January thru February, 1998. The database contains the final data.

AOU DATA

The apparent oxygen utilization, AOU (umol/kg) is calculated as the solubility for oxygen at the measured salinity and potential temperature minus the observed oxygen concentration. The solubility for oxygen at the measured salinity and potential temperature is determined from the algorithms presented in Weiss (1970). Note that at low temperature, the solubility determined by Weiss is up to 2 umol/kg higher than determined by Benson and Krause (1984) or Garcia and Gordon (1992).

Weiss, R.F., The solubility of nitrogen, oxygen and argon in water and seawater, Deep-Sea Research, 17, 721-735, 1970.

TALK Data

Total alkalinity (TALK) is calculated using spectroscopic pH (25∫C) and coulometric TCO2 using the carbonic acid dissociation constants of Mehrbach et al. (1973) as refit by Dickson and Millero (1987). The of 1.2 umol/kg has been subtracted from calculated total alkalinity CTALK) values because calculated values are 1.2 umol/kg higher than measured values.

PLEASE NOTE the following updates have been received but not incorporated in the current version. The most recent version with these updates can be obtained from Betty Huss (huss@aoml.noaa.gov):

None - all data received up to May 8, 2001 have been incorporated in Version D.

UNITS FOR THE 24N98 CRUISE

Field Name		Units	Last Modified
1. STATION	Station Number	integer	05/09/00
2. KEYFIELD	Concatenation of Station Number and Niskin Bottle Number	integer	
3. LATITUDE		Decimal Deg	08/19/99
4. LONGITUDE		Decimal Deg	08/19/99
5. PRESSURE	CTD Pressure	Decibar	05/09/00
6. SALINITY	Bottle Salinity	PSS-78	05/09/00
7. FSALINITY	QC Flag for Bottle Salinity	character	05/09/00
8. TEMP	CTD Temperature	Deg C	05/09/00
9. THETA	Potential Temperature	Deg C	05/09/00
10. SIGMATHETA	Potential Density		05/09/00
11. O2	Bottle Oxygen	umol/kg	05/09/00
12. FO2	QC Flag for O2	character	05/08/01
13. AOU	Apparent Oxygen Utilization	umol/kg	05/10/00
14. PO4	Phosphate	umol/kg	06/26/00
15. FPO4	QC Flag for PO4	character	06/26/00
16. NO2	Nitrite	umol/kg	06/26/00
17. FNO2	QC Flag for NO2	character	06/26/00
18. NO3	Nitrate	umol/kg	06/26/00
19. FNO3	QC Flag for NO3	character	05/08/01
20. SIO4	Silicate - SI(OH)4	umol/kg	06/26/00

21. FSIO4	QC Flag for SIO4	character	05/08/01
22. TCO2	Total CO2	umol/kg	08/28/00
23. FTCO2	QC Flag for TCO2	character	05/08/01
24. TALK	Total Alkalinity	umol/kg	10/30/00
25. CTALK	Calculated Alkalinity	umol/kg	04/12/01
26. FTALK	QC Flag for TALK	character	10/30/00
27. FCO220C	Fugacity of CO2 at 20 C	uatm	05/09/00
28. FCO2INSITU	Fugacity of CO2 at Potential Temp	uatm	05/09/00
29. FFCO2	QC Flag for FCO2 data	character	05/09/00
30. PH	Acidity	real number	04/05/00
31. FPH	QC Flag for PH	character	04/05/00
32. CFC11	Chlorofluorocarbon-11	pmol/kg	05/11/00
33. FCFC11	QC Flag for CFC11	character	05/11/00
34. CFC12	Chlorofluorocarbon-12	pmol/kg	05/11/00
35. FCFC12	QC Flag for CFC12	character	05/11/00
36. CFC113	Chlorofluorocarbon-13	pmol/kg	09/18/00
37. FCFC113	QC Flag for CFC113	character	09/18/00
38. CCL4	Carbon Tetrachloride	pmol/kg	09/18/00
39. FCCL4	QC Flag for CCL4	character	09/18/00
40. TOC	Total Organic Carbon	umol/kg	05/08/00
41. FTOC	QC Flag for TOC	character	05/08/01
42. TON	Total Organic Nitrogen	umol/kg	05/08/00
43. FTON	QC Flag for TON	character	05/08/01
44. CTDSAL	CTD Salinity	PSS-78	05/09/00
45. CTDOXY	CTD Oxygen	umol/kg	05/09/00
46. FCTDOXY	QC Flag for CTDOXY	character	05/09/00
47. BOTDEP	Bottom Depth	integer	05/09/00
48. MONTH		integer	08/19/99
49. DAY		integer	08/19/99
50. YEAR		integer	08/19/99
51. FBOTTLE	Bottle QC Flag	character	08/19/99

The 24N98 dataset includes the following files:
24N98D.CSV
24N98D.DBF
24N98.QC
24N98.DES
where the CSV file contains the data in comma-delimited format, the QC file contains the explanation of the quality control flags and the DES file is a chronological description of all changes/updates to the dataset.

05/12/01 Peng/Huss BTL Data ready for submission

The following is the file structure for version D of the 24N98 database being released today.

Structure for database: 24N98D.DBF
Number of data records: 4381
Date of last update: 5/08/2001

Field	Field Name	Type	Width	Dec
1	STATION	Numeric	3	
2	KEYFIELD	Numeric	6	

3	LATITUDE	Numeric	9	4
4	LONGITUDE	Numeric	9	4
5	PRESSURE	Numeric	8	1
6	SALINITY	Numeric	8	3
7	FSALINITY	Character	1	
8	TEMP	Numeric	7	3
9	THETA	Numeric	7	3
10	SIGMATHETA	Numeric	8	3
11	O2	Numeric	9	2
12	FO2	Character	1	
13	AOU	Numeric	8	2
14	PO4	Numeric	8	3
15	FPO4	Character	1	
16	NO2	Numeric	8	2
17	FNO2	Character	1	
18	NO3	Numeric	8	2
19	FNO3	Character	1	
20	SIO4	Numeric	8	2
21	FSIO4	Character	1	
22	TCO2	Numeric	8	2
23	FTCO2	Character	1	
24	TALK	Numeric	7	2
25	CTALK	Numeric	7	2
26	FTALK	Character	1	
27	FCO220C	Numeric	8	1
28	FCO2INSITU	Numeric	8	1
29	FFCO2	Character	1	
30	PH	Numeric	8	4
31	FPH	Character	1	
32	CFC11	Numeric	8	3
33	FCFC11	Character	1	
34	CFC12	Numeric	8	3
35	FCFC12	Character	1	
36	CFC113	Numeric	8	3
37	FCFC113	Character	1	
38	CCL4	Numeric	8	3
39	FCCL4	Character	1	
40	TOC	Numeric	9	2
41	FTOC	Character	1	
42	TON	Numeric	9	2
43	FTON	Character	1	
44	CTDSAL	Numeric	8	3
45	CTDOXY	Numeric	9	2
46	FCTDOXY	Character	1	
47	BOTDEP	Numeric	8	
48	MONTH	Numeric	2	
49	DAY	Numeric	2	
50	YEAR	Numeric	4	
51	FBOTTLE	Character	1	

05/08/01	Huss	TCARBN	Quality flags added	Added QC Flags for TOC and TON. Modified FO2 for sample number 4401 modified FTCO2 for sample number 8502, and FNO3, FSIO4 and FTCO2 for sample number 10601.
04/13/01	Huss	ALKALI	Added new field & merged	Added a new field called CTALK (Calculated TALK) and merged the calculated TALK data into the database. Update received from Kitack Lee.
10/30/00	Huss	ALKALI	Data update	Changed TALK and FTALK for sample numbers 8401, 8402 and 8403 (station 84).
09/20/00	Peng/Huss	BTL	Data update	Version C of the 24N98 database was released today.
09/18/00	Huss	CFCs	Merged into database	Merged the CFC113 and CCL4 (carbon tetrachloride) update into the database. Received data from John Bullister.
08/28/00	Huss	TCARBN	Merged into database	Merged TCO2 update into the database. Received data from Marilyn Roberts.
06/26/00	Huss	NUTs	Submitted	Received nutrient update from Dr. Zhang and merged the data into the database.
05/13/00	Huss	data update		Changed all longitude values to negative (East).
05/11/00	Huss	CFCs	Submitted/Merged	Received CFC11 and CFC12 update from John Bullister. Merged the data into the database.
05/10/00	Huss	THETA/AOU	Recalculated/merged	Recalculated THETA and AOU using the updated CTD data. Merged data into the database.
05/09/00	Huss	ALKALI	Updated QC flags	Changed TALK QC flags for sample numbers 1301, 9007, 9421, 10221, and 10225 to 3 (questionable). Corrected pH values for sample numbers 12621 and 13006.
05/09/00	Huss	TCARBN	Final data submitted	Received the final fCO2 update from Rik. Merged the data into the database. In February 2000, Kitack Lee noticed an offset in the fCO2 data. It was associated with using the wrong tank calibration value. This data was reduced using the right standard (508.35). Thus 547.37 was replaced by 508.38 in the program. Then it was run against all data files again. The quality of the data was checked performing an internal consistency check of DIC, TALK by fCO2. Outliers in fCO2 were labelled a "3".
05/09/00	Huss	TCARBN	Data update	Added station 1. Added TCO2 and fCO2 data for station 1. Modified database to include a bottom depth field and entered the bottom depths.
05/09/00	Huss	CTD	Submitted	Received CTD data. This data was extracted from the file 24nbottle2.dat obtained from Molly Baringer. This is considered the final CTD and O2 data. NOTE: Station 39 trip information was reconstructed from the calibrated CTD data upcast. Values should be considered questionable. Full data file with conductivities and information from both sensors can be obtained from Molly Baringer, baringer@aoml.noaa.gov.

05/08/00	Huss	TON	Data update	Received TON update from Dennis Hansell. Converted TON and TOC from umol/L to umol/kg and merged the data into the database.
05/03/00	Huss	TCARBN	Data update	Received the TCO2 update from Marilyn Roberts. Merged into the database.
05/01/00	Huss	NUTs	Submitted/merged	Merged the nutrient update (received from Calvin Mordy).
04/18/00	Huss	pCO2	Submitted/merged	Merged the pCO2 update (received from Rik Wanninkhof).
04/05/00	Huss	TCARBN/PH	Submitted/merged	Merged the TALK and pH update into the database. Received the data from Dr. Millero.
01/15/00	Peng/Huss	BTL	Data update	Release of Version B of the database.
01/12/00	Huss	BTL	Data update	Merged O2, FO2, CTDSAL, CTDOXY, FBOTTLE (bottle qc flag) update into the database.
01/05/00	Huss	TCARBN	Submitted/merged	Merged TCO2 into the master database. Received the data from Marilyn Roberts.
08/19/99	Peng/Huss	BTL	Data update	Release of Version A of the 24N98 database.
08/13/99	Huss	BTL	Data update	Calculated THETA, SIGMATHETA, and AOU.