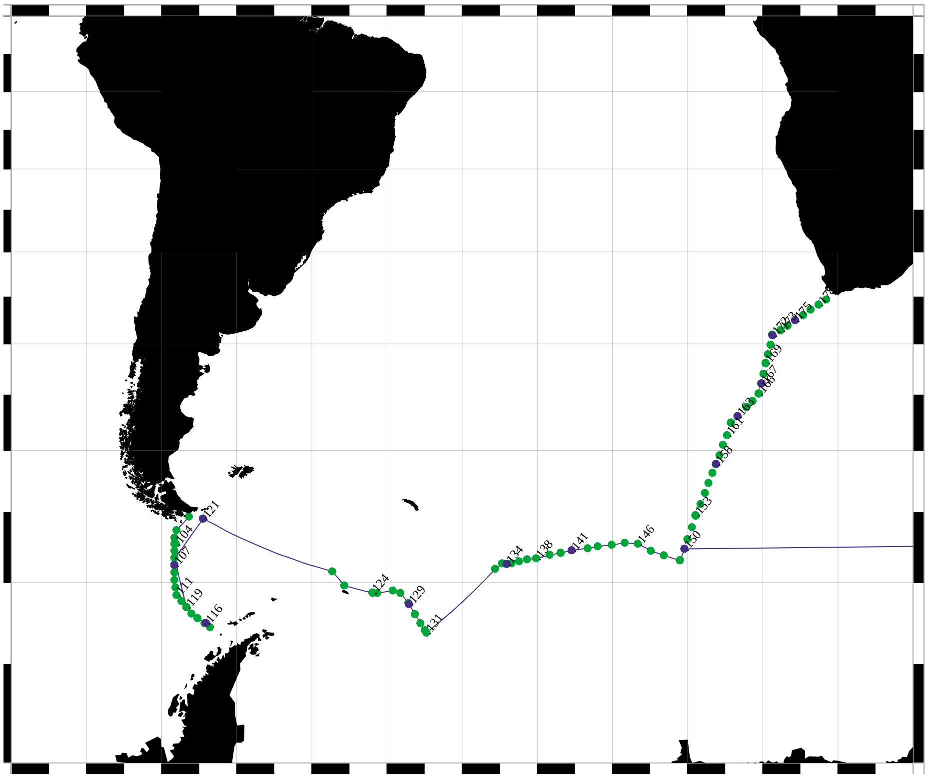
A. Cruise Narrative: A21_S04A_SR02



A.1. Highlights

WHP Cruise Summary Information

WOCE section designation	**A21_S04A_SR02**
Expedition designation (EXPOCODE)	**06MT11_5**
Chief Scientist/affiliation	**Wolfgang Roether/UB***
Dates	1990 JAN 23 - 1990 MAR 08
Ship	*RV* METEOR
Ports of call	Ushuaia to Cape Town
Number of stations	79
Geographic boundaries of the stations	41° 57.90' S 68°15.80' W 18°27.00' E 63° 10.60' S
Floats and drifters deployed	10 prototype ALACE floats
Moorings deployed or recovered	0
Contributing Authors	B. Klein, A. Kozyr, A.F. Gaslightwala, R.G. Patrick, R. Van Woy, R Millard, A. Mantyla, J.C. Jennings

*Universität Bremen • Kusteiner Strasse • Postfach 33 04 40 • D-28359 Bremen • Germany
Tel: 49-421-218-3511 or -4221 • Fax: 49-421-218-3601 or -7018
email: wroether@physik.uni-bremen.de

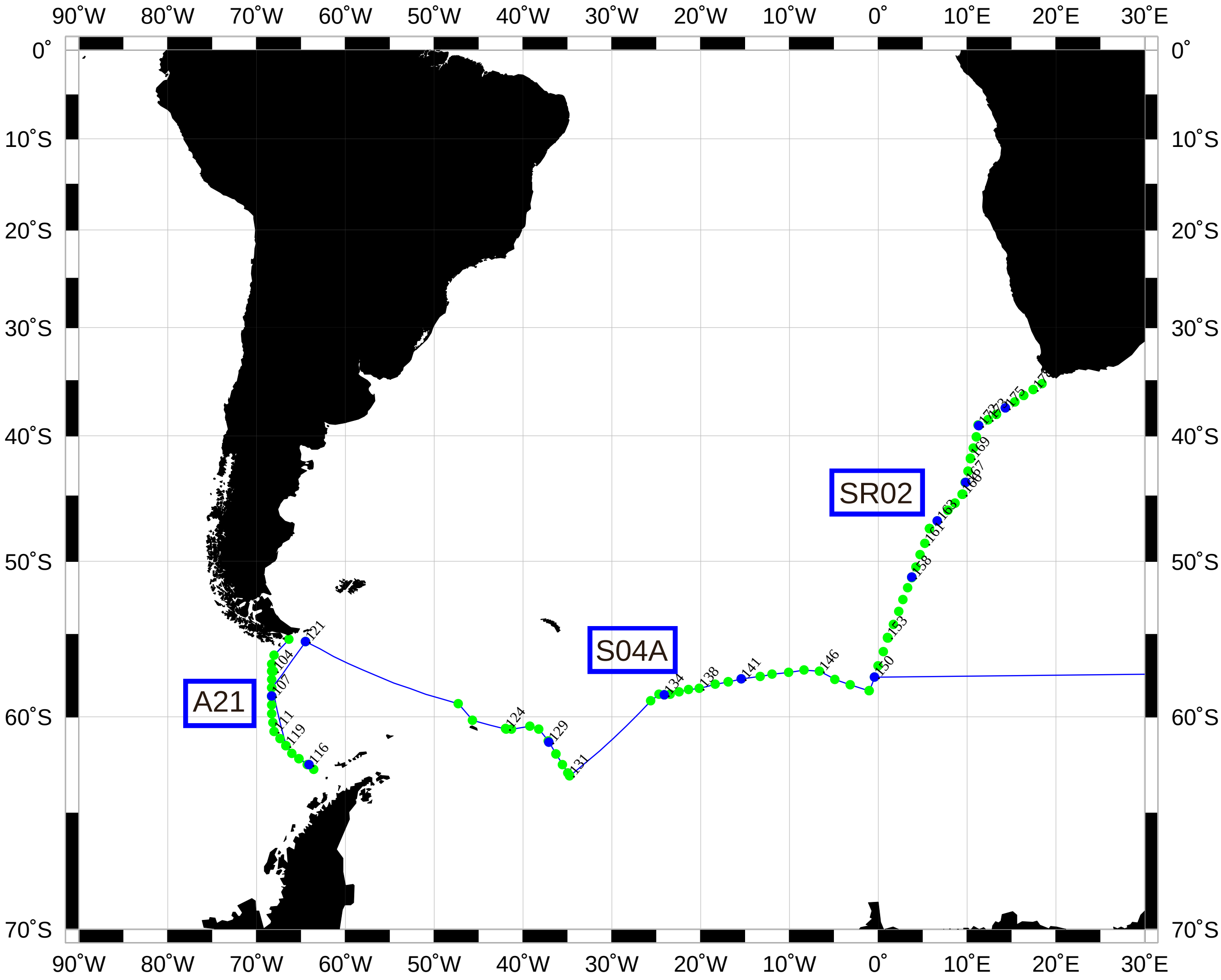
WHP Cruise and Data Information

Instructions: Click on headings below to locate primary reference or use navigation tools above. (Shaded headings were not available when this report was assembled)

Cruise Summary Information	**Hydrographic Measurements**
Description of scientific program	**CTD Calibration**
	CTD - general
Geographic boundaries of the survey	CTD - pressure
Cruise track (figure)	CTD - temperature
Description of stations	CTD - conductivity/salinity
Description of parameters sampled	CTD - dissolved oxygen
Bottle depth distributions (figure)	
Floats and drifters deployed	**Bottle Data**
	Salinity
	Oxygen
Principal Investigators for all measurements	Nutrients
Cruise Participants	CFCs
	Helium
Problems and goals not achieved	Tritium
	Radiocarbon
	CO_2 system parameters
Underway Data Information	Other parameters
	DQE Reports
	CTD
Thermosalinograph and related measurements	S/O2/nutrients:
XBT and/or XCTD	Mantyla Jennings
	CFCs

Acknowledgments	**References**	**Data Processing Notes**
	CO_2	
	Nutrients DQE	

Station Positions for Meteor 11_5 1989 OCT 03: Roether



Produced from .sum file by WHPO-SIO

Description of scientific program:

The cruise did A21 (Drake Passage) and SR02 (passage south of Africa; incomplete), with full tracer coverage. Additional work was carried out in WOCE WHP section S04A (northern Weddell Sea). Taken together this work at the same time completed the SAVE field work, and by this the large-volume WOCE tracer work in the Atlantic sector. Fig. 1 gives the cruise track and Table 1 some basics for the cruise. Table 2 lists the measurements taken and the PIs responsible. A list of participants is given in Table 3. An account of the cruise (in German, including all 5 legs of cruise no. 11) has been given to Roether et al. (1990). Basic cruise funding came from the Deutsche Forschungsgemeinschaft and the Bundesministerium für Forschung und Technologie, Bonn, Germany.

Table 1: METEOR Cruise No. 11, Leg 5

leave Ushuaia	January 23, 1990
return for winch repair	Feb. 2-3, 1990
enter Cape Town	Mar. 8, 1990
scientists	30
crew	32
master	Henning Papenhagen
stations	79
tracers	full suite
WOCE sections	S1/A21, S2/A12

Table 2: Principal Investigators for all measurements

Parameter	Institution	PI
CTD, Salinity	AWI	G. Rohardt, E. Fahrbach
Nutrients, Oxygen	ODF Scripps	J. Swift, F. Delahoyde
CFMs	Uni Bremen	W. Roether
Tritium, 3He	Uni Bremen	W. Roether
^{14}C (L-V & AMS)	IUP Heidelberg	P. Schlosser, K.O. Munnich
39Ar	Uni Bern	H.H. Loosli
85Kr	LDGO	W. M. Smethie
CO_2-Parameters	LDGO	D. Chipmann, T. Takahashi
226/228Ra	Uni Princeton	R. Key
	IfM Kiel	M. Rhein
XBT, Thermosalinograph	AWI	U. Schauer, E. Fahrbach
ADCP	AWI	E. Fahrbach
CTD-intercomparison	AWI/ODF Scripps	G. Rohardt, F. Delahoyde
ALACE Drifter	SIO, Texas A&M	R. Davis, W.D. Nowlin

Table 3: Cruise Participants

Name	Responsibility	Institution
Roether, Wolfgang, Prof. Dr.	Chief Scientist	UBTO
Arango, Jose Maria	Observer	IADO
Beining, Peter	CFM measurement	UBTO
Bulsiewicz, Klaus	CFM measurement	UBTO
Ballegooyen, R. C.van	Observer	NRIO
Bargen, D. van	Meteorologist	DWD
Bos, David L.	Nutrients	ODF
Breger, Dee	CO_2	LDGO
Chipman, David W.	CO_2	LDGO
Costello, James. P.,	Oxygen	ODF
Delahoyde, Frank M.,	CTD, data processing	ODF
Döscher, H.-J.	Meteorology	DWID
Fraas, Gerhard	Rosette, sampling	UBTO
Helas, G., Dr.	Air chemistry	MPCB
Junghans, Christel	^{14}C processing	IUP
Junghans, Hans-Georg	^{14}C processing	IUP
Key, Robert M., Dr.	Ra processing	AOSP
Legutke, Stefanie.	CTD	IfM
Nowlin, Worth D., Prof. Dr.	Data analysis, ADCP	TAMU
Plep, Wilfried	Rosette, sampling	UBTO
Putzka, Alfted, Dr.	CFM measurement	UBTO
Ritschel, Kirstin	^{14}C processing	IUP
Rohardt, Gerd	CTD, data processing	AWI
Schlitzer, Reiner, Dr.	Bottle data analysis	UBTO
Schlosser, Peter, Dr.	L-V sampling	LDGO
Schauer, Ursel	CTD, XBT	AWI
Schebeske, G.	Air chemistry	MPCB
Theisen, Stefan	Rosette, sampling	UBTO
Weppernik, Ralph	39Ar, 85Kr processing	PIB
Zaucker, Friedrich	L-V sampling	LDGO

AOSP Program in Atmospheric & Oceanic Sci., Dept. of Geol. & Geophys. Sci., Princeton University, P.0. Box CN 7 10, Princeton, NJ 08544-0710, USA
AWI Alfred-Wegner-Institut für Polar- und Meeresforschung, Columbusstraße, 2850 Bremerhaven
DWD Deutscher Wetterdienst, Seewetteramt, Postfach 301190, 2000 Hamburg 36
IADO Instituto Argentina de Oceanografia, Av. Alem 53, CP 8000 Bahia Blanca, Argentinien
IfM Institut für Meereskunde, Universität Hamburg, Troplowitzstr. 7, 2000 Hamburg 54
IUP Institut für Umweltphysik, Universität Heidelberg, Im Neuenheimer Feld 366, 6900 Heidelberg

LDGO Lamont - Doherty, Geological Observatory, Geochemstry Dept., Palisades, N.Y. 10964, USA
MPCB Abteilung Biogeochemie, Max-Planck-Institut für Chernie, Postfach 3060, 6500 Mainz
NRIO National Research Institute for Oceanology, CSIR, P.0. Box 320, 7600 Stellenbosch, Südafrika
ODF Oceanographic Data Facility, Scripps Institution of Oceanography, U. Cal. S. D., La Jolla, CA 92093, USA
PIB Physikalisches Institüt der Universtät Bern, Bern, Schweiz
TAMU Department of Oceanography, Texas A & M University, College Station, TX 77843-3146, USA
UBTO Universität Bremen, FB, 1, Tracer-Ozeanographie, Postfach 330 440, 2800 Bremen 33

Description of stations

The work was limited by the available ship time. The two WOCE sections and in particular the Drake Passage section were given highest priority. On SR02 about 60nm station spacing was achieved. The work in between consisted of a short section north and east of the South Orkney Islands, in order to cross a possible deep-water outflow from the Weddell Sea, as well as boundary flow at the northern margin of the Weddell Basin. Furthermore, a section was obtained from the South Sandwich Trench eastward up to the African Passage section, crossing the deep outflow through the trench as well as a possible north-south exchange across the American-Antarctic Ridge. Sta. 149 (Fig. 1) reoccupied Sta. 234 of WWSP 86, and, nearly, GEOSECS station 89'. WWSP 86 (Huber et al., 1989), that likewise included small and large-volume tracers, may be taken as the southward extension of our African passage section southward to the Antarctic continent. The Drake Passage section was placed westward of the "classical" ones (Sievers and Nowlin, 1984). While this coincided with the section as indicated in the WOCE implementation Plan, the idea behind was to stay west of major deep topography, in order to characterize the waters inflowing from the Pacific and minimum admixture from the Atlantic sector. As the Polar Front bends southward around the South Shetlands, our choice meant a rather wide Polar Frontal Zone. As for the passage south of Africa, we attempted to stay west of the Agulhas Retroflexion, and to follow the deep topography in order to enable characterization of deep and bottom waters in the Agulhas and Cape Basins. This resulted in crossing the ACC at least than 90 degrees, so that the fronts in our section appear as rather more gradual (cf. Witworth and Nowlin, 1987), as well as in some curvature in the track. The part east of the South Sandwich trench was placed just north of the axis of the Antarctic American Ridge.

METEOR entered Ushuaia Jan. 20, 1990 and installation of equipment started immediately. Some gear was found to be stuck at Buenos Aires, but finally reached the ship in time before departure. METEOR left Ushuaia on the morning of Jan. 23, 1990. We managed to start station work across Drake Passage already the next morning, following a trial station immediately after laving the Beagle Channel. The section started SW of Cape Horn on the shelf, and continued south at 30nm spacing. Basic equipment was a

Neil Brown Mark IIIB CTD (AWI, calibrated at Scripps ODF) and a 24 x 12 liter GO Rosette system. A special cast was carried out to check for CFM sampling blanks, which were found to be vanishingly small except for a certain set of Niskin bottles that we consequently avoided to use. Large-volume stations (Fig. 1) were placed between the fronts so as to characterize the four principle hydrographic zones of the passage (Sievers and Nowlin, 1984). Apart from pCO_2 which became operative only toward the end of the section, all measurements were carried out successfully. Salinity, nutrient and oxygen measurements were made in standard fashion. ^{14}C, 39Ar and 85Kr sample processing used the Heidelberg vacuum extraction system, and Ra processing the Princeton procedures. TCO_2 and pCO_2 measurement was coulometric. The CFM equipment employed was an automated system based on the Weiss and Bullister design (Bullister and Weiss, 1988). It was in routine use at sea for the first time, which led to some modification of procedures during the cruise. The section was accompanied by XBT drops at 10nm spacing, and thermosalinograph readings were obtained continuously.

We also ran the ship's ADCP, together with calibration runs. Quality of the ADCP data is open at this stage, and only partial GPS availability was a drawback.

Floats and drifters deployed

A total of 10 prototype ALACE floats were deployed north of the Polar Front. Deployment was found to be straightforward, and 8 of the instruments, which were set at 750 m depth and fortnightly surfacing, have operated perfectly since. Weather was advantageous for all of the Drake Passage section.

Problems and goals not achieved

After three days of station work, a breakdown of the winch computer system was encountered. The ship managed to provide makeshift operation for the CTD/Rosette winch, and trawl winch operation was similarly resumed two days later. It was decided to continue the section, and to return to Ushuaia for repair thereafter. The section was ended at the break of the South Shetland Arc shelf off Smith Island. It consisted of 13 standard and 4 large-volume stations. However, the large-volume part in the Polar Frontal Zone was only done on the way back to Ushuaia, i.e. not simultaneous with the corresponding main CTD/Rosette work. Likewise on the way back, some CFM fill-in sampling was carried out. A related 39Ar station (Sta. 121) was only done away from the Drake Passage section proper. In total, at least four days were lost by the incident.

After leaving Ushuaia (Feb. 2-3, 1990) again, station work was resumed on Feb. 6, 1990 with a short section north and east of the South Orkneys (Stas. 122-131). From here on and up to the Bouvet Fracture Zone region the ship encountered icebergs and growlers regularly. After a further break, and after having rounded Southern Thule of the South Sandwich Islands, station work started once more on Feb. 12, 1990 near to the South

Sandwich Trench, to be continued up to the African shelf (Stas. 132-179). These sections were again accompanied by XBT drops (30 to 45nm spacing).

The cruise had been planned with some contingency time to allow for delays enforced by bad weather. Actually, only about 40 hours were spent for this. Hydrographic and even large-volume sampling work turned out to be feasible up to considerable wind force, i.e. 8. A larger part of the bad weather contingency was used for the winch repair, and some in the ship's speed having to be lowered on account of growlers (2-6 knots at night). One bad storm was encountered, however, on Feb. 20-21, 1990 with 90nm gusts and 17m waves, and some lesser storms before and after this event. Between there and Cape Town, a table tennis tournament and a cruise party brought a little variety to the somewhat monotonous station work.

In total, we managed to complete also the second WOCE section adequately. It ended at the African shelf break late on Mar. 6, 1990. CFM measurements were unfortunately missed on four consecutive stations of this section because of a system breakdown. Starting from Sta. 165 (45.5° S), we ran two Rosette/CTD systems, which enabled us to obtain about 36 sampling depths per station. Whereas further south 24 depths appeared as adequate to resolve the hydrographic structure, higher vertical resolution was now regarded as relevant. A shallow rosette cast was done first, which rosette was sampled while the deep rosette cast (carrying the primary CTD instrument) was made. This procedure meant no more than about 45 min extra time per station. During the cruise, and particularly while two rosette/CTS systems were operated, a comparison was made of the AWI and Scripps-ODF data handling and operation procedures. The comparison looked favorable, although a detailed account of has yet to be made.

METEOR entered Cape Town on the morning of Mar. 8, 1990. A historic remark: The German pre-war METEOR ran a cruise Ushuaia - Cape Town from Jan. 21 to March 10, 1926, which was cruise 5 of its famous South Atlantic survey. The scientific topic, i.e. hydrography, was quite similar. Stations totaled 34 (6 across Drake Passage), properties measured three (temperature, salinity, oxygen), and depths sampled were typically 26 (in three casts, naturally no continuous depth traces). Progress is slow after all.

Data obtained

Samples taken for shore-based measurement are listed in Table 4. The complete station list with some comment is given in Table 5. Data obtained aboard ship were quality-checked immediately, apart from the CFM data that were carefully evaluated and screened later on. A computerized bottle data list was set up. Working from it, sections were made using objective analysis with variable correlation length-scales (R. Schlitzer). A selection of these sections follows below.

XBT/Thermosalinograph
XBT temperature readings were corrected 0.25 K downward and depth upward (by 20 m at 300 m depth), according to comparisons with simultaneous CTD casts. Bucket and thermosalinograph temperatures were noted for each drop. Thermosalinograph readings were corrected upward by 0.05 ± 0.04 K and 0.33 ± 0.2 PSU.

Drake Passage: Fig. 2-6 give sections of potential temperature, salinity, density, silicate, and CFM 11, respectively. Subantarctic front is found near Sta. 105, Polar Front near Sta. 112, and Scotia Front near Sta. 116. The Fig. 2-5 sections are similar to previous ones, whereas a CFM section (Fig. 6) was done for the first time. Fig. 6 shows that the Lower Circumpolar Deep Water, represented by the salinity maximum layer in Fig. 3, i.e. the presumed source of Warm Deep Water in the Weddell Sea (Sievers and Nowlin, 1984), is CFM-free when entering Drake Passage from the west.

Orkney section: The CFM 11 section in Fig. 7 indicates higher concentrations in the Scotia Sea area (Sta. 126-128) than in the Weddell Basin (Sta. 129- 131).

Section South Sandwich Trench and east: Potential temperature (Fig. 8), oxygen (Fig. 9), and silicate (Fig. 10) show relative extreme in the trench area (Sta. 133-135), and well correlated features (eddies, front meanders?) in the top 1000m.

African Passage section: The hydrographic structure given in Figs. 11 and 12 is as expected from the literature (Witworth and Nowlin, 1987), but strong features related to the Agulhas retroflexion are apparent (Sta. 175ff).

XBT and thermosalinograph sections are displayed in Figs. 13-15, and an XBT list is given in Table 6.

Fig. 16 gives ALACE float motions Jan. - end of August, 1990.

Bottle Data Measurement Techniques and Instrumentation
Basic instrumentation was a 24 x 12 liter General Oceanics Rosette and a Neil Brown Mark IIIB CTD with oxygen sensor, both from the AWI, Bremerhaven. Pressure and temperature sensors were calibrated at SIO before the cruise and thereafter. During the cruise, the stability of the temperature and pressure sensors was monitored with reversing mercury and electronic thermometers and pressure gauges. The in-situ calibration of the conductivity and oxygen sensors was based on water samples from the Rosette, usually taken at 24 depth levels. Salinities were measured with a Guildline Autosal 8400A. 16 stations consist of two casts where samples in 36 depth levels have been taken. The shallow cast was carried out with a second 24 x 10 liter Rosette, with an identical CTD from Scripps/ODF.

During the entire cruise, two different CTD data acquisition and processing systems were operated in parallel; one system from SIO, and one system from the AWL The processed data sets consist of 2 decibar pressure series. No major differences were found in processing techniques or the data sets.

Nutrient and dissolved oxygen analysis was done by Scripps/ODF. Nutrient concentrations were analyzed colorimetrically using a 4-channel Technicon auto- analyzer system, one channel for each of NO2, NO3, PO4 and SiO3. No major problems were encountered in the analyses. Dissolved oxygen concentrations were analyzed using a modified Winkler titration method, again with no major problems.

The data set quality was monitored by cross-checking the independent measurements for consistency. Malfunctioning or leaking Niskin bottles were identified. Due to tripping problems, the bottle-depth relation had to be rotated in a few instances, but the true relation was always unambiguous.

Following is a description of the CFM measurements and an assessment of CFM data quality.

STS/ODF CTD and Bottle Data Report *
(J. Swift)
2/20/03

Initially, a single 24-place 12-liter rosette system (General Oceanics) was used with an NBIS Mark III CTD (AWI CTD #1069). Other sensors included dissolved O_2, and a transmissometer. Digital and mercury DSRTs and digital pressure gauges were employed as secondary integrity checks. A second 24-place 12-liter rosette system was constructed using ODF CTD #1 for 11 stations (164-176). This second rosette was used to provide greater vertical resolution on the SAVE section and was typically deployed to 800 M. On these stations, the AWI rosette was used for the second deep cast.

Large volume casts were performed by LDGO (P. Schlosser), Princeton (B. Key) and DHI (numerous) using DHI Gerard barrels. Mercury thermometers were used for temperature and pressure determination. Salinities and nutrients were analyzed from all barrels.

The AWI CTD data acquisition and processing system consisted of two IBM PC/AT computers, an NBIS 1150 deck unit, a 9-track mag tape unit connected to the 1150, and a dual transport audio cassette recorder for analog backup. The EG&G software package was employed for data acquisition during the down-cast. a custom program was run for the up-cast to extract rosette trip information, and had no graphical display capability. The CTD data processing capability is currently still under development, but 5 db pressure-series down-cast data (pressure, temperature and salinity) with sensor lags and pressure, temperature and salinity corrections were generated on the second PC.

ODF CTD data processing was performed in parallel with the AWI system. One ISI system was employed and was attached to two 1150 deck units, one for each rosette system. A serial link from the AWI data acquisition PC to the ISI allowed automatic start-up of CTD data acquisition for the AWI rosette. Deployment of the SIO rosette was performed in the conventional (interactive) manner, as the ISI was the only system acquiring data for the 11 shallow rosette casts. A serial link to the shipboard navigation system provided automatic navigation and bathymetry data.

The STS/ODF CTD #1 failed on the up-cast of 176/01, apparently due to a power supply failure.

Two separate CTD winches were used for the rosette work. Both employed 11 mm single-conductor wire. Three terminations were made, two for the AWI rosette and one for the SIO rosette. Terminations were performed by a ship's electrician and took about 20 minutes each.

* from an unpublished preliminary ODF cruise report

The trawl winch used for the Gerard casts developed a non-repairable electronic problem on station 116, making it necessary to return to Ushuaia for repairs.

Both pylons in the two rosette systems mis-tripped occasionally to frequently. Some of the Niskin bottles had stainless-steel lanyards which sometimes would not release.

All salinities (2305) were run on Autosal salinometers (serial # 52-530 and 57-524). 57-524 was used for all but about 5 boxes as it was new, and 52-530 exhibited filling problems. The temperature of the salt room ranged from 18 to 24 degrees C. The bath temperature was kept at 24 degrees C. No major problems were encountered.

Three areas of analysis were supported by the group from SIO. These consisted of: nutrient analysis, dissolved oxygen analysis and CTD data processing.

Nutrient concentrations were analyzed colorimetrically using a 4-channel Technicon auto-analyzer system, one channel for each of NO_2, NO_3, pO_4 and SIO_3. A total of 2267 nutrient samples were analyzed, from both CTD/rosette and Gerard casts. No major problems were encountered in the analyses.

Dissolved oxygen concentrations were analyzed using a modified Winkler titration method. A total of 2011 dissolved oxygen samples were analyzed from CTD/rosette casts. No major problems were encountered in the analyses.

CTD data processing was supported with software and a computer system run in parallel with the AWI system. Comparisons were made between the two groups CTD data processing techniques. 96 CTD/rosette casts were made at 79 stations. On 11 of these stations, two separate CTD/rosette systems were deployed. No major problems were encountered in the CTD data acquisition, rosette deployment, or data processing. Additionally, SIO performed the in situ calibration of CTD conductivity sensors to salinity check samples taken from the rosette.

The data set quality was monitored by cross-checking the independent measurements for consistency. Malfunctioning or leaking Niskin bottles were identified. The preliminary calibrated data were found to be consistent with the hydrography of the region.

CFM measurements:
The measuring system employed is an automated variety of the Bullister and Weiss (Deep Sea Res., 1988) design. Water samples are taken in the common way using glass syringes. The system contains calibrated 30 ml water sample containers (Hastalloy C) connected to a 2 x 8 multiposition GC valve (Vici-Valco), into which samples are introduced (upward displacement) through a regular GC valve manually. For measurement, container content is automatically transferred into the extraction burette by a flow of carrier gas (downward displacement). All valves are air- actuated. Temperature of the collection trap is forced by Peltier cooling/heating. Carrier gas purge (separately for GC and sample processing parts of the system) uses two lines each, of which one is back-flushed at higher temperature with a small flow of purified gas. System control and data handling is provided by a PC. It has peak integration installed for quick data inspection, but final peak evaluation occurred off-line by fitting Gaussians to the data. Calibration used compressed air from a tank, the CFM concentrations of which were later on calibrated by comparison with gas standards provided by R. F. Weiss, Scripps.

This was the first time that the system was used at sea, which led to some modification of procedures during the cruise. In general, the system and in particular the automation operated well. Some outliers (more than we had hoped) were observed, the cause of which was not always clear. A substantial blank was encountered in the beginning. However, the sample preparation line blank was quite stable and indistinguishable between water sample containers, as well as from the lowest values obtained in sample measurement. This showed that a sampling blank was negligible within errors, and at the same time gave proof of vanishingly low concentrations. A special cast was made early on into supposedly CFM-free water to compare different sets of Niskin bottles available, of which one was found contaminated. To monitor detection efficiency, gas standards were run regularly, and full calibration runs repeatedly (non-linearity was rather larger than usual). Sta. 145 was omitted, and four stations (Sta. 162 -165) were missed when water accidentally went beyond the extraction burette. The calibration curve was substantially different after this incident.

The data have been post-processed carefully and an error analysis has been made. The data blank was taken to be the sample preparation line blank, agreement between which and the lowest-concentration samples (see above) being found both at the beginning of the cruise (Drake Passage section) and towards the end (Cape Basin stations). Precision/accuracy estimates (standard errors throughout) were made considering the following error contributions (found to be similar for CFM 11 and 12):

- blank uncertainty (± 0.01 pmol/kg);
- sample replicate precision (about ± 1% for high concentrations);
- standard interpolation uncertainty (about ± 1.5%);
- uncertainty of calibration curve (<- ± 0.5%);
- uncertainty by drift in non-linearity (<- ± 0.5%);
- calibration uncertainty relative to the Scripps CFM scale (± 0.3%; ignoring any drift between the time of measurements at sea and the calibration later on).

By error propagation, the overall accuracy (relative to Scripps) is obtained as ± 2% or 0.01 pmol/kg, whichever is greater.

The calibration data points were fitted by a third order polynomial. The highest CFM 11 concentrations were outside the calibration range (by at most 40%). The polynomial was extrapolated towards higher concentrations and the uncertainty of the extrapolation was calculated from the fit. The added uncertainty due to the extrapolation is calculated to be ±2% for the maximum CFM 11 concentrations (about 6 pmol/kg), for which the total error thus becomes ± 3%.

Gas standard runs (temperature and pressure corrected) were fitted (in sections) by a straight line, and the standard interpolation uncertainty (apparently the largest error contribution, see above) is the standard deviation around such fit. Standard deviation among gas standards run consecutively was much smaller (about ±0.3%). This suggests that detection efficiency varies substantially on a time scale of several hours. Had gas standard runs been made somewhat more often and more regularly, it might have been possible to monitor these variations and reduce the overall error substantially.

The CFM 11 and 12 errors transform into a CFM 11/12 ratio error of ±3% for large concentrations, rising to about 3.5% for CFM 11 approaching 6 pmol/kg. As a consequence of the blank uncertainty (±0.01 pmol/kg), at 0.05 pmol/kg in CFM 12 the ratio error exceeds ±20%.

The data were screened as follows. Firstly, those data were removed for which samples or handling were considered faulty (e.g. samples from contaminated Niskins, see above). Secondly, CFM station profiles were inspected and compared to those of other properties, which led to rejection of just a few data considered as clearly unreasonable judging from the hydrographic structure. Thirdly, measurements were checked for CFM 11/12 ratio consistency. Those data that have ratios that differ significantly from a reasonable value (estimated from the general distribution of ratios), have been flagged in the data tables; the flag means that we believe one of the two CFM numbers to be faulty.

The CFM data of Stas. 122 to 139 have larger uncertainties and contain more outliers. The suspected cause of this is a leak in the 2 x 8 multiposition valve. It looks as if some sample degassing in the water sample containers may have occurred, effected by a small amount of carrier gas leaking through. If this interpretation is correct, measured concentrations should be on the low side for these stations, and, due to different solubility, more so for CFM 12 than for CFM 11. Such interpretation is supported by a comparison of surface water concentrations with values corresponding to solubility equilibrium with atmospheric concentrations, as wen as by profile information (i.e., high-ratio values tend to be low in the profiles). The flagged data for these stations may be low in CFM 12 by up to about 25% (10% for CFM 11), and there may be a general bias towards low values believed to be at most about 10% in CFM 12 (5% in CFM 11).

Tracer Measurements
(Birgit Klein)
1999 MAR 10

CFCs
CFCs are measured directly on the ship using a electron capture detector (ECD) packed column gas chromatograph. The column was filled with Porasil C and Porapak T.

Only f11 and f12 have been measured during the cruise. Part of the original documentation as been lost, information on system blanks and air measurements is unfortunately not available. The original measurements have been recorded on the sio86 scale and have latter been converted to sio93. Contamination problems and calibration problems are reflected in the relatively high errors. Quality flag for CFCs follow woce standards:

2: good measurement
3: questionable measurement
4: bad measurement
5: not reported
6: replicate sample
9: no sample drawn

errors:

sta.	f11	F12
102-117	2% or 0.01 pmol/kg	2% or f120.01 pmol/kg
118-161	3% or 0.01 pmol/kg	2% or 0.01 pmol/kg
166-179	2% or 0.01 pmol/kg	2% or 0.01 pmol/kg

Tritium:

Tritium is sampled in 1 l glass bottles which are analyzed after the cruise in the laboratory at Bremen. Tritium is measured through the in-growth of helium3 from the radioactive decay. For the procedure the water samples are degassed and transferred to special glas containers which are sealed off and placed into freezers. After a storage time of 6 month to about a year to allow the in- growth of sufficient amounts of helium3 the samples are measured with the noble gas spectrometer described below.

A large number of tritium samples have been contaminated on the ship and could not be recovered. They have been identified by quality flag 5. A smaller number of samples had been contaminated during measurement procedures in the lab and has been retrieved through a second extraction. These samples have been assigned quality flag 6 although they are not strictly replicate samples. Each measurement has been assigned an individual error.

Tritium concentrations are scaled to 15 February 1990.

Helium and Neon:

40 ml water samples are filled into copper tubes at sea which are pinched off. In the laboratory the gas amount is vacuum extracted from the sample and transferred to a specialized helium/ neon isotope mass spectrometer.

The noble gas mass spectrometer is no commercial unit but has been specially designed at the University of Bremen. It contains two commercial units: a quadro-pole mass spectrometer (Balzer QMG 112) and a sector field (Mass Analyzer Products, type 215).

Two helium isotopes 3He, 4He and two Neon isotopes 20Ne, 22Ne are measured. Air aliquots provide the instrument calibration and monitor sensitivity changes. An internal standard filled with regular air has been used for the helium isotope and neon measurements at the lab in Bremen to make all measurements internally self-consistent. An external standard does not exist.

Helium data have been corrected for tritium decay during storage although the correction is very small due to the low tritium concentrations in the southern ocean. It is at maximum 0.5% and effects mostly upper waters.

Helium and neon measurements have been assigned individual errors.

Acknowlements:

Funding: Deutsche Forschungsgemeinschaft
Bundesministerium fur Forschung und Technologie,
Bonn, Germany

References:

Bullister, J.L., and R.F. Weiss (1988): Determination of CCl3F and CCl2F2 and air. Deep-Sea Res., 35,839-853.

Huber, B.A., et al. (1989): ANT V/2 CTD and Hydrographic Data, LDGO-89-3, Lamont-Doherty Geological Observatory of Columbia University, Palisades New York, 1989.

Roether, W., M. Sarnthein, T.J. Muller, W. Nellen and D. Sahrhage (1990): Sudatlantik-Zirkumpolarstrom, Reise Nr. 11, 3. Oktober 1989 -11. Marz 1990. METEOR-Berichte, Universitat Hamburg, 90-2, 169 p.

Sievers, H.A., and W.D. Nowlin (1984): The stratification and water masses at Drake Passage. J. Geophys. Res., 89, 10,489-10,514.

Witworth, T., III, and W.D. Nowlin (1987): Water masses of the Southern Ocean at the Greenwich Meridian. J. Geophys. Res., 92, 6462-6476.

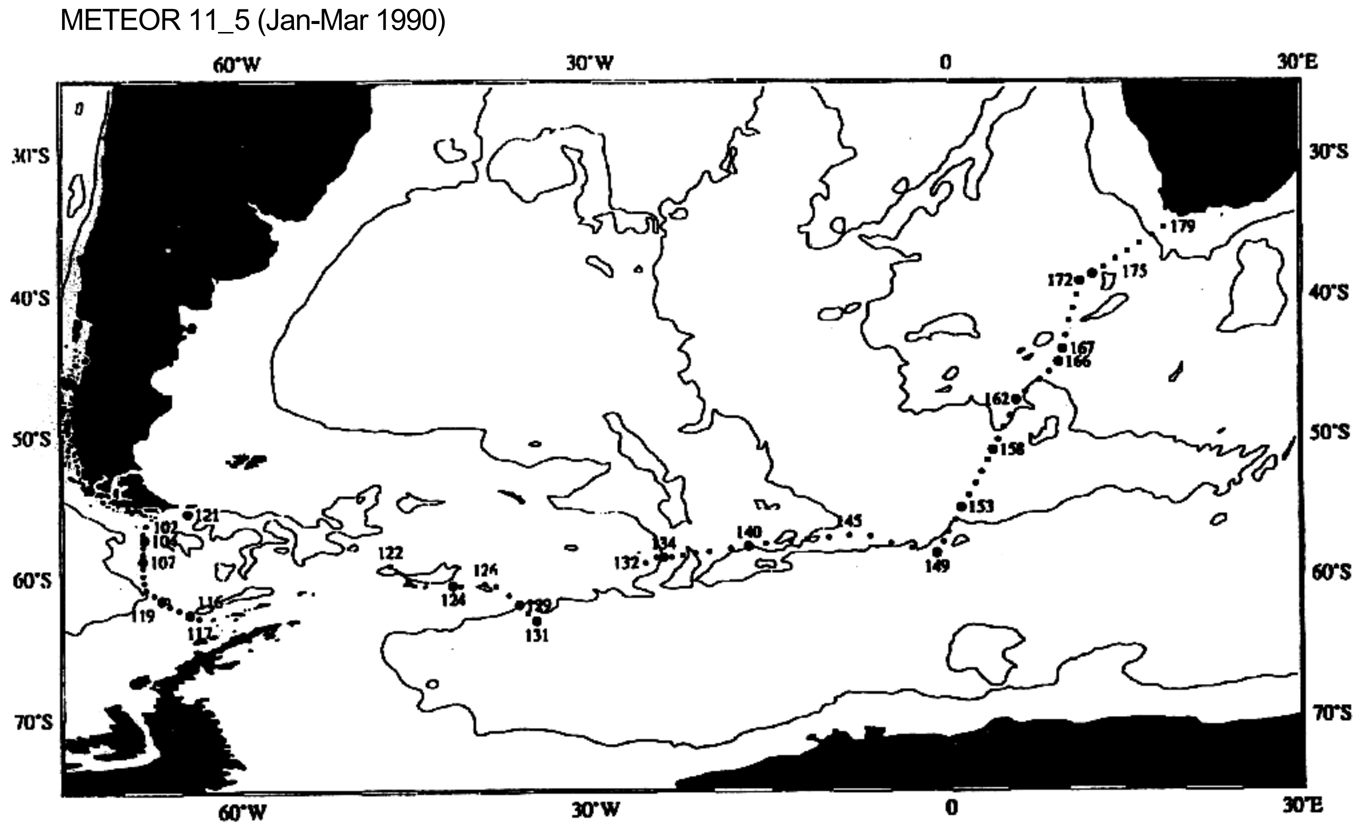


Figure 1: Cruise track and stations (large dots: large volume stations), METEOR cruise 11_5

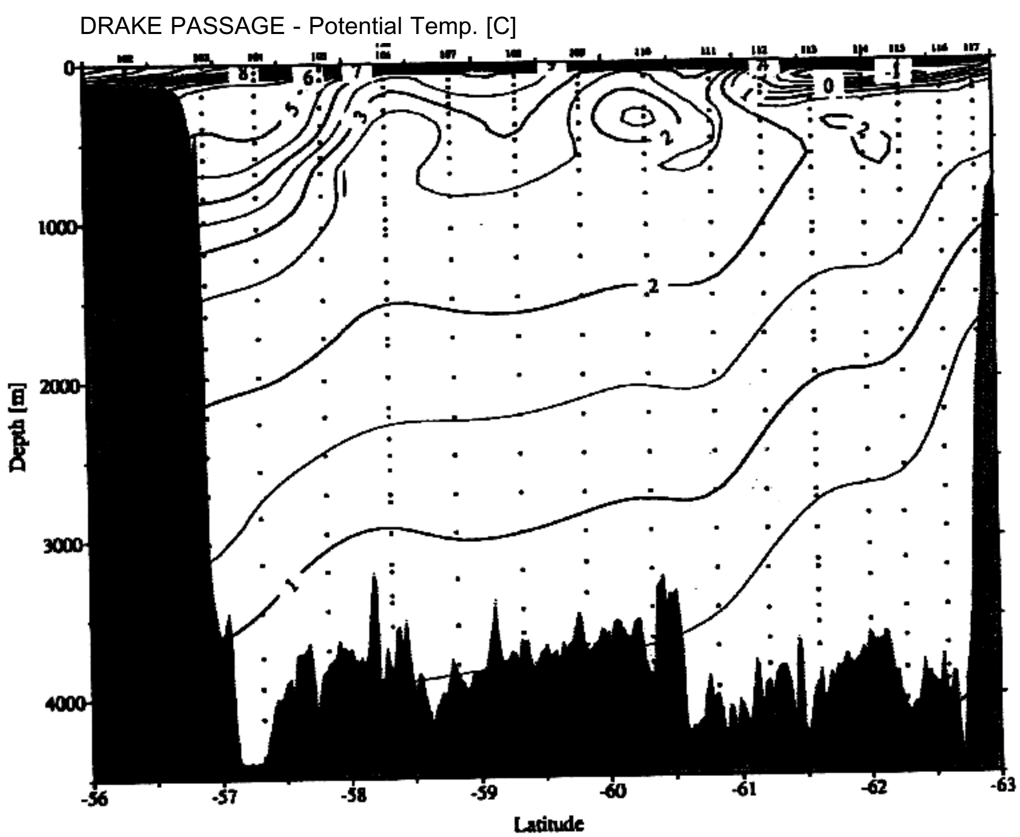


Figure 2: Potential temperature section, Drake Passage, METEOR 11_5 (WOCE A21). Station positions see Fig. 1 and Table 4. Isolines by objective analysis of original data (indicated by dots) by R. Schlitzer. Bottom depth from ships recordings.

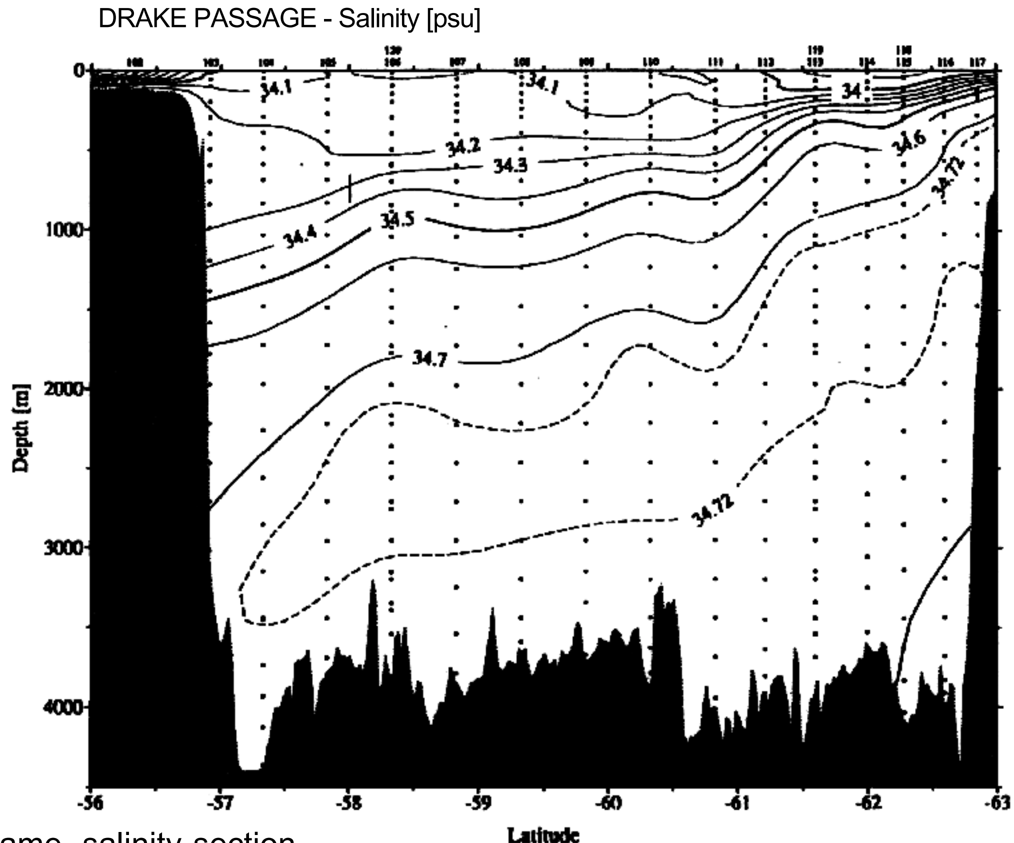


Fig. 3: same, salinity section.

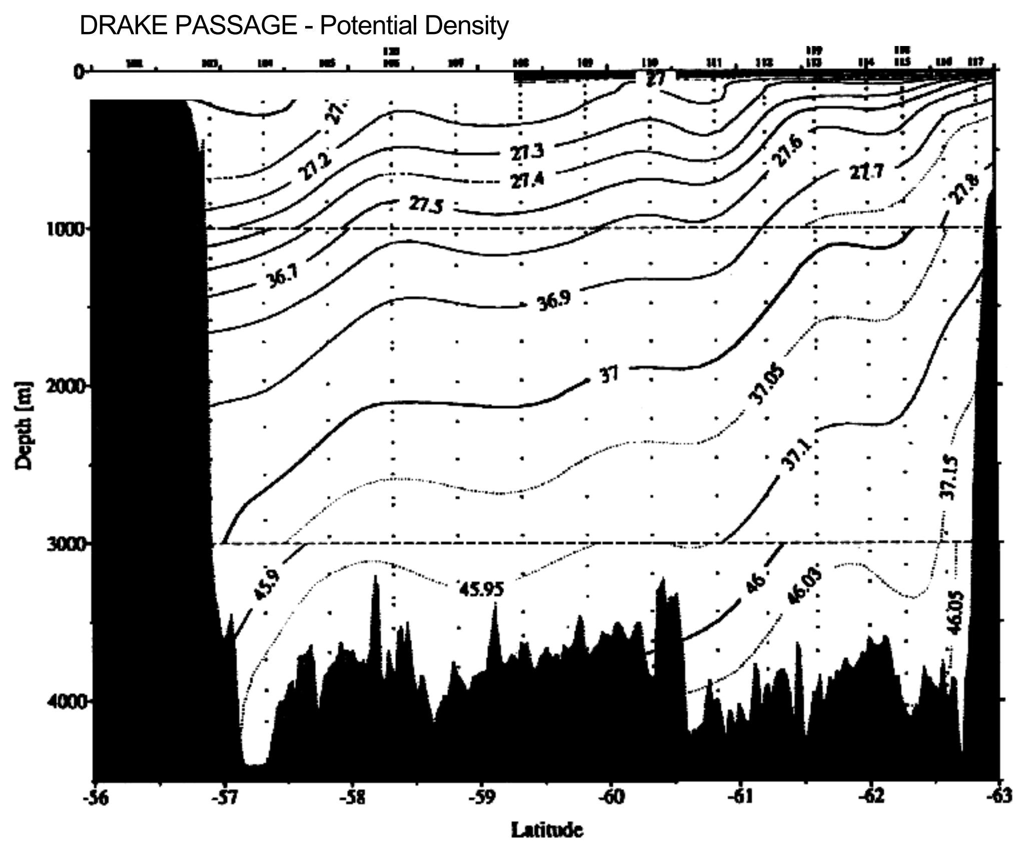


Fig. 4: same, density parameter, $\sigma 0$ (0 - 1000 M), $\sigma 2$ (1000 - 3000 m); $\sigma 4$ (3000 - bottom)

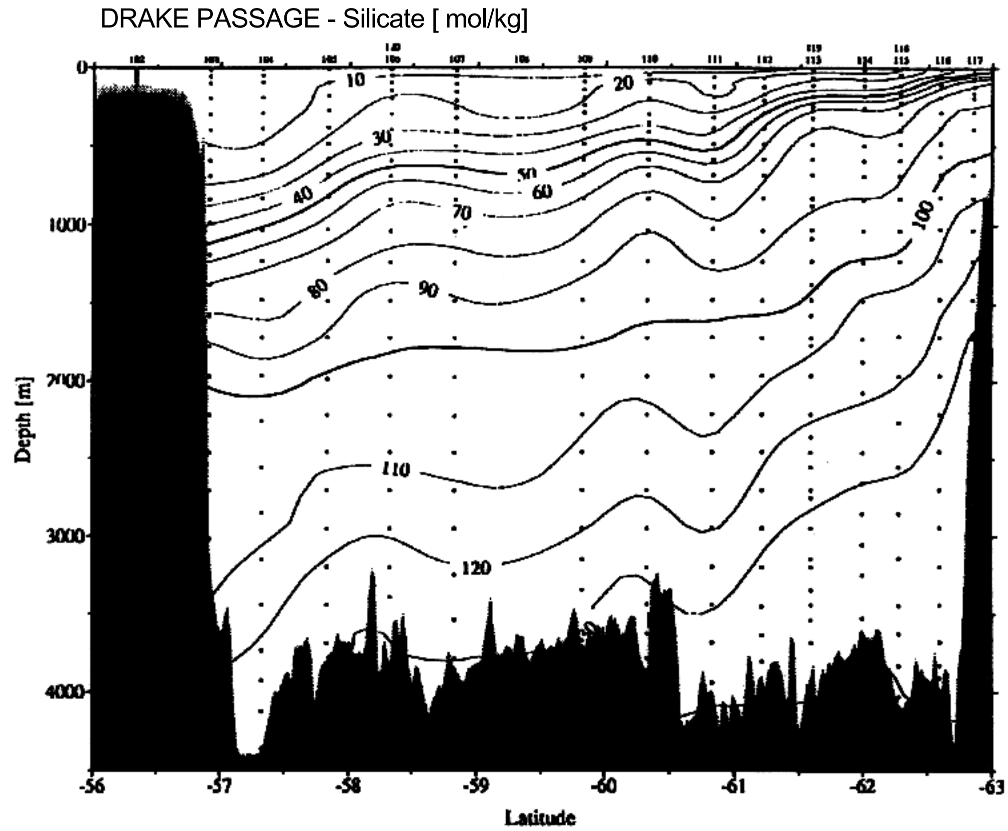


Fig. 5: same, silicate section.

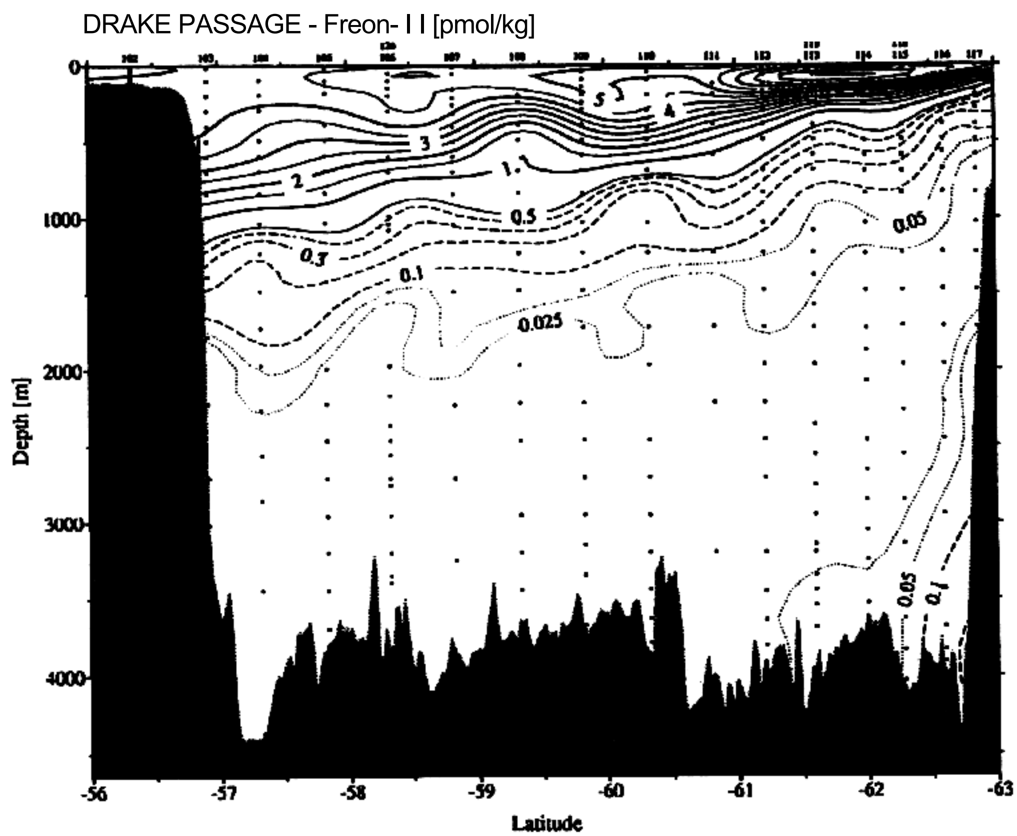


Fig. 6: same, CTM 11 section. The position of the lowest isoline, 0.025 pM, is somewhat uncertain, for being near to the data error of about 0.01 pmol/kg.

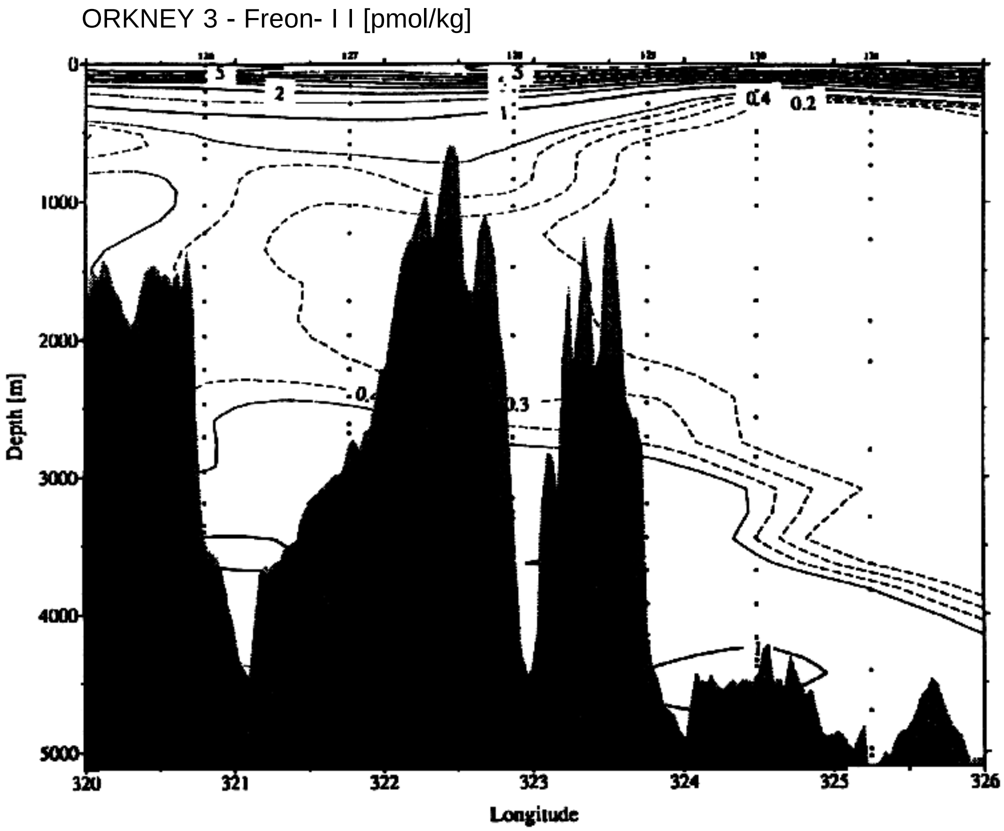


Fig. 7: CFM 11 section, Orkney Stas. (Fig. 1), for explanation see Fig. 2.

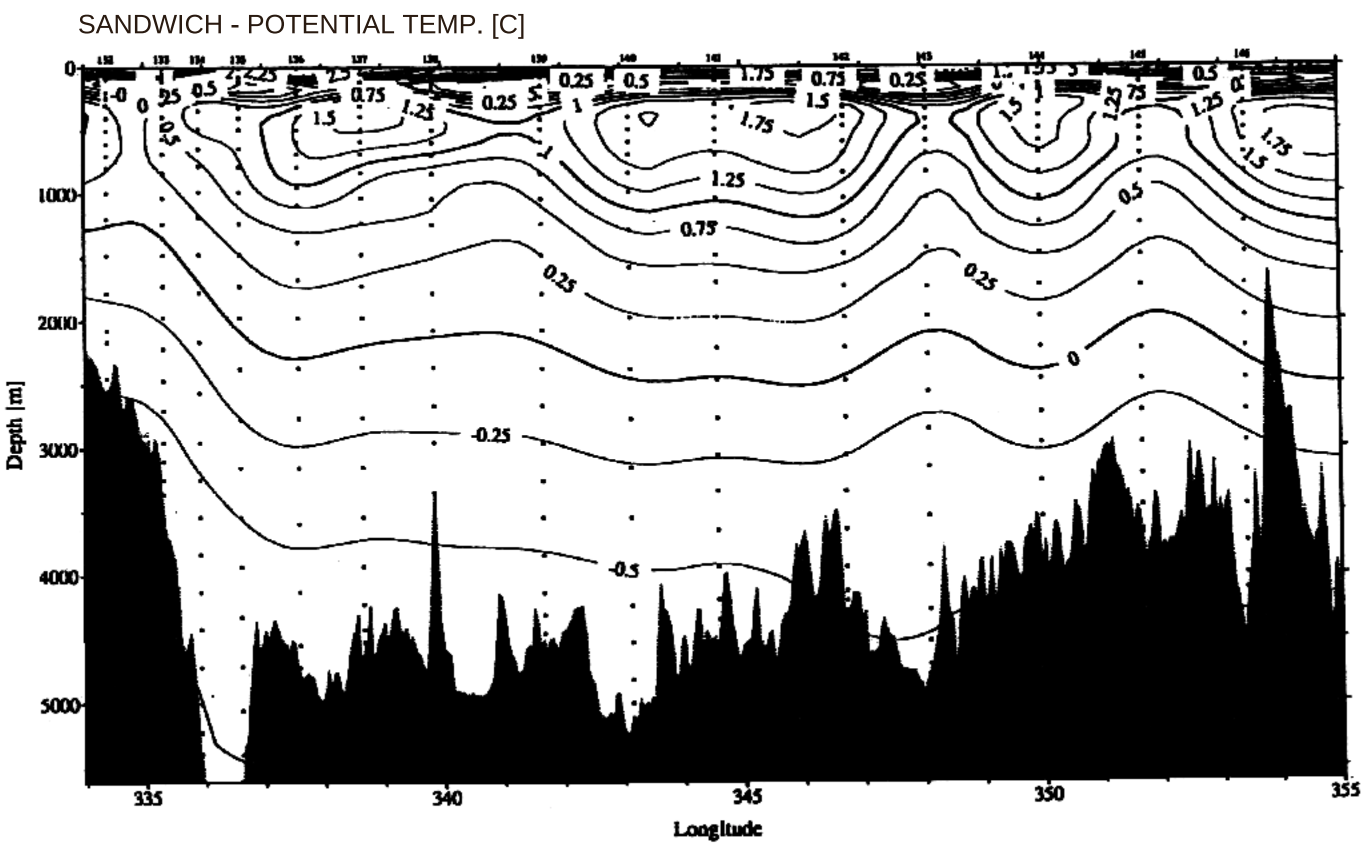


Fig. 8: South Sandwich trench and east, potential temperature section.
Stations: see Fig. 1. For explanation see Fig. 2.

SANDWICH - Oxygen [pmol/kg]

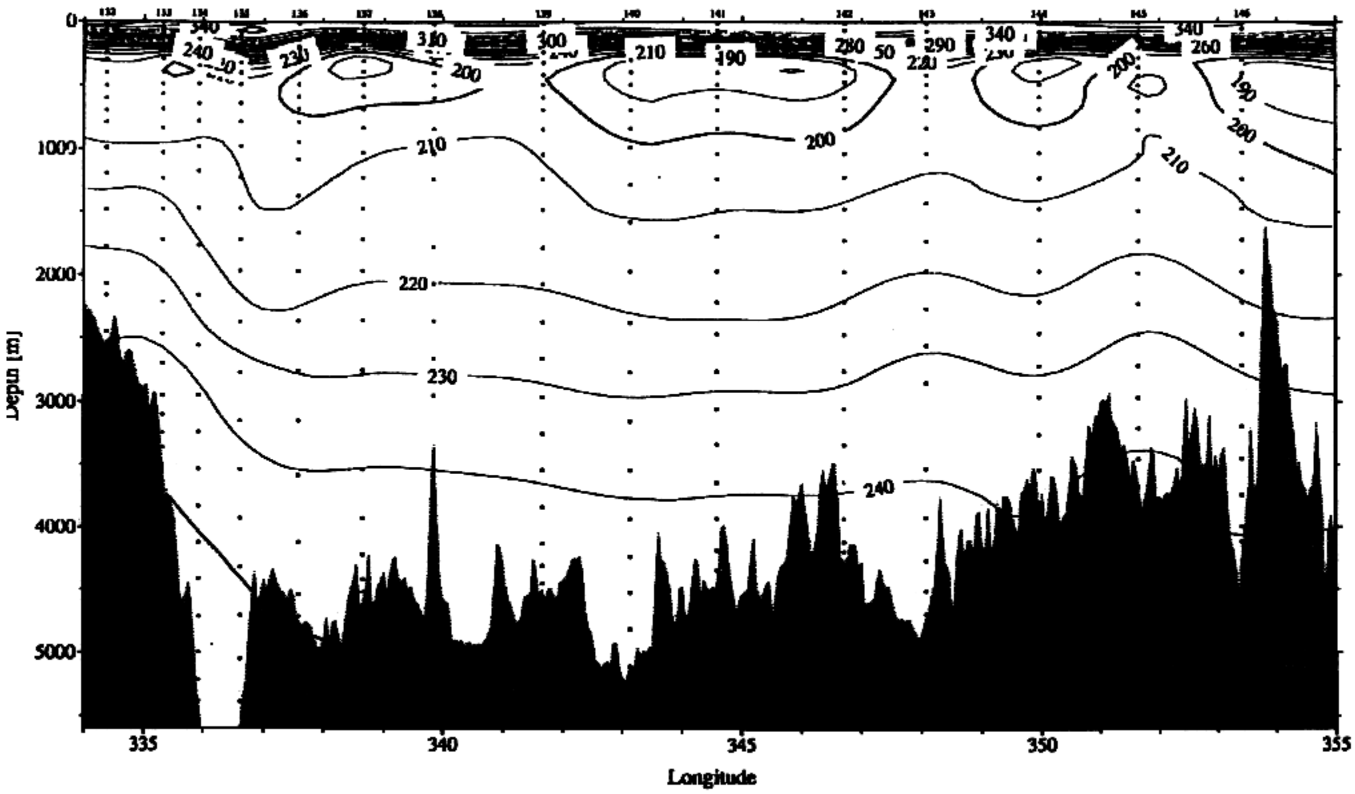


Fig. 9: same, oxygen section.

SANDWICH - Silicate [gmol/kg]

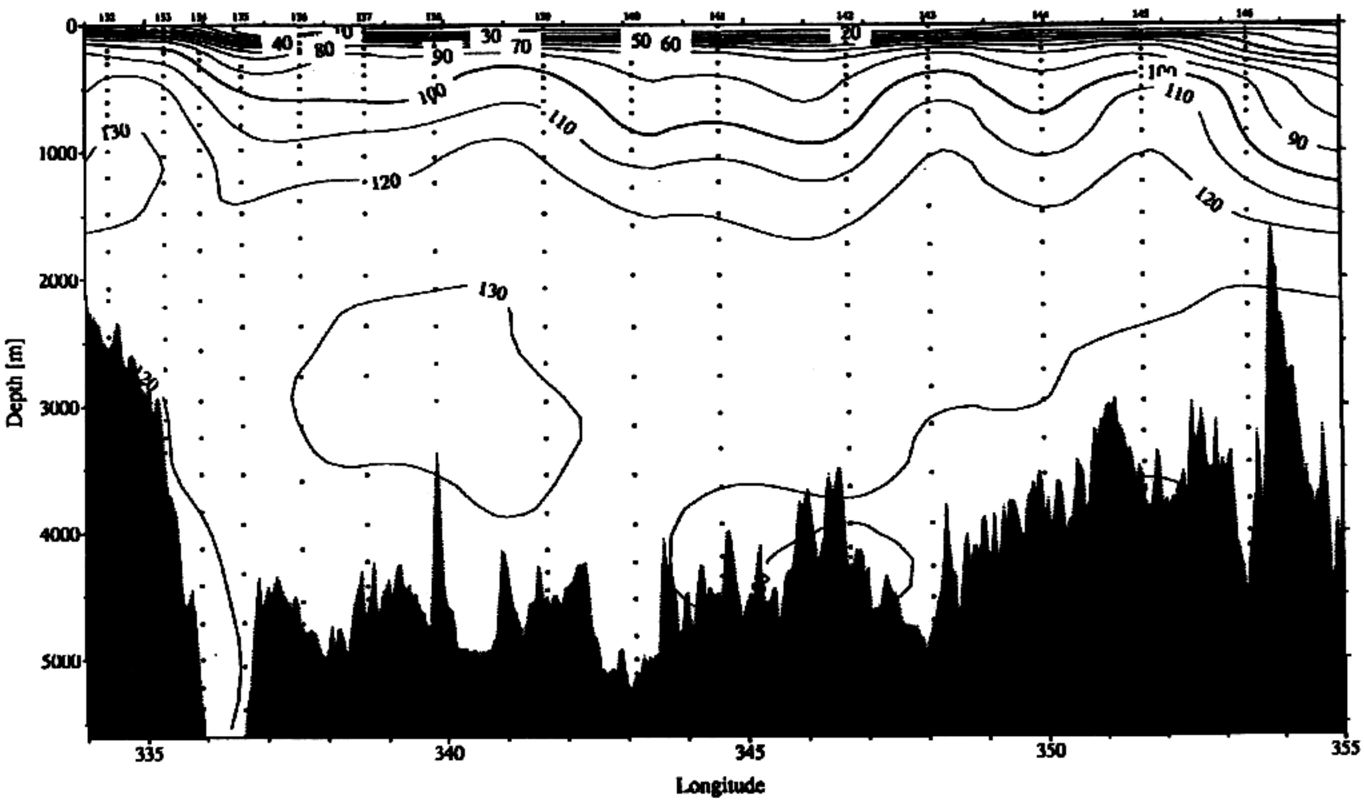


Fig. 10: same silica section.

CIRCUM - Potential Temp. [C]

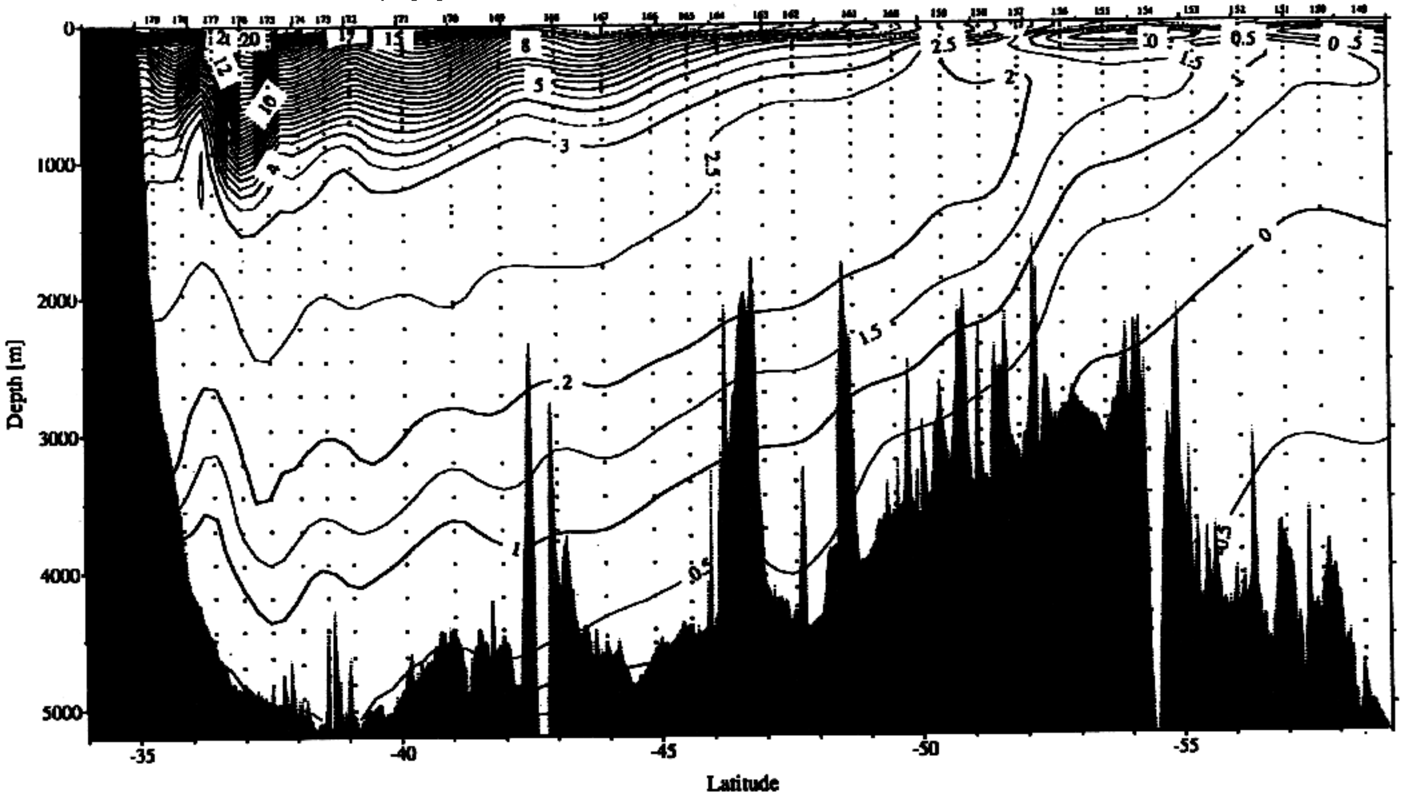


Fig. 11: African Passage section (WOCE SR02), potential temperature. Stas. see Fig. 1, for explanation see Fig. 2.

CIRCUM - Salinity [psu]

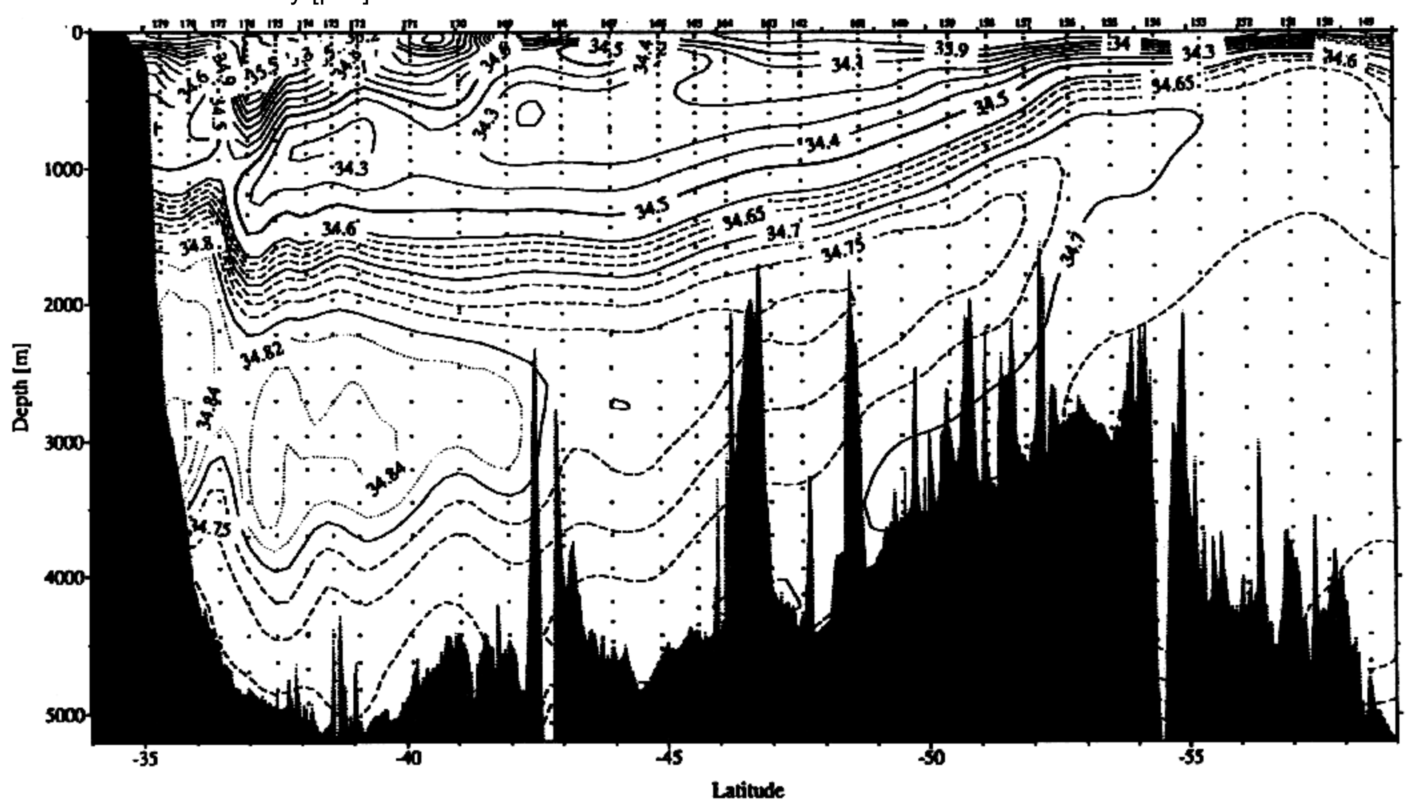


Fig. 12: same, salinity section.

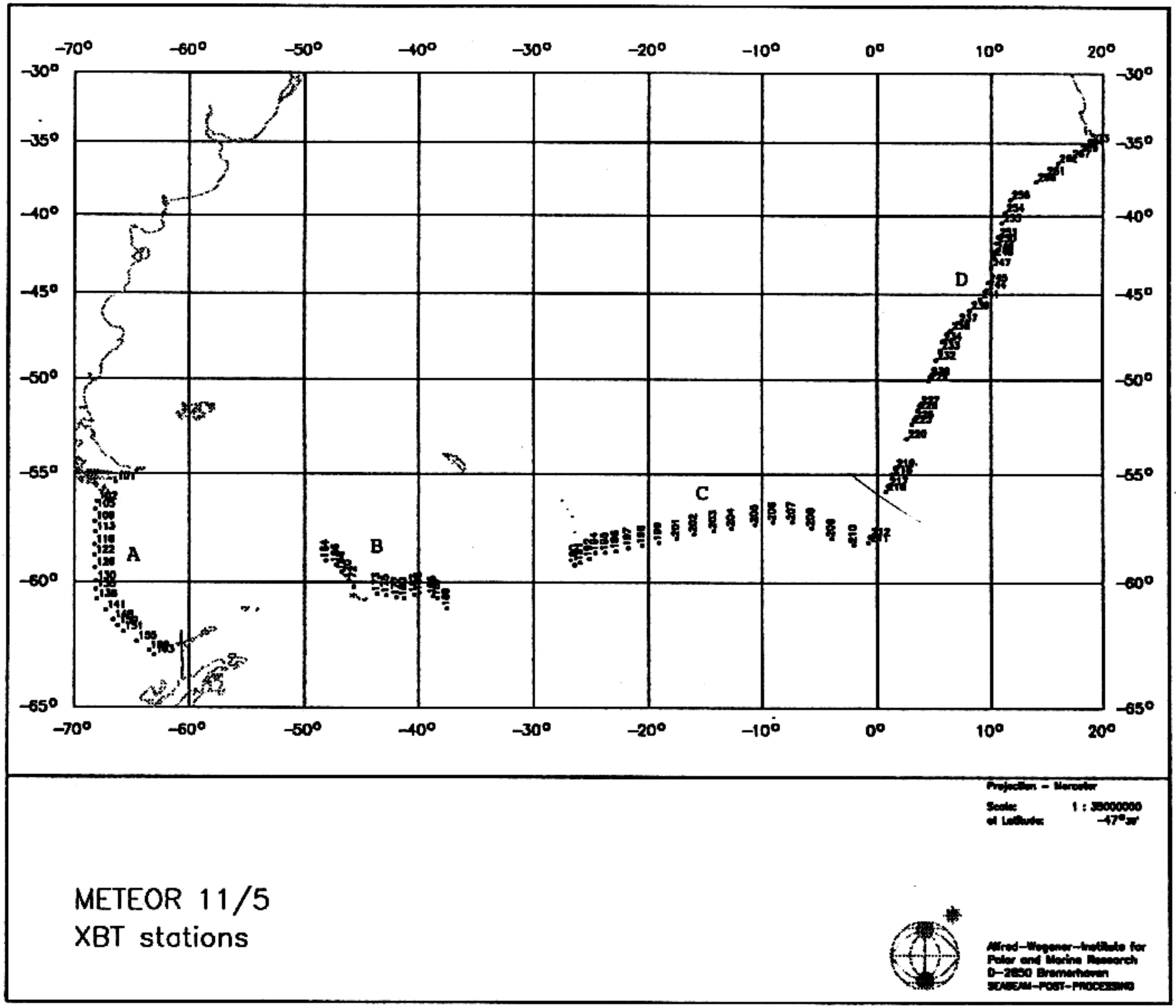
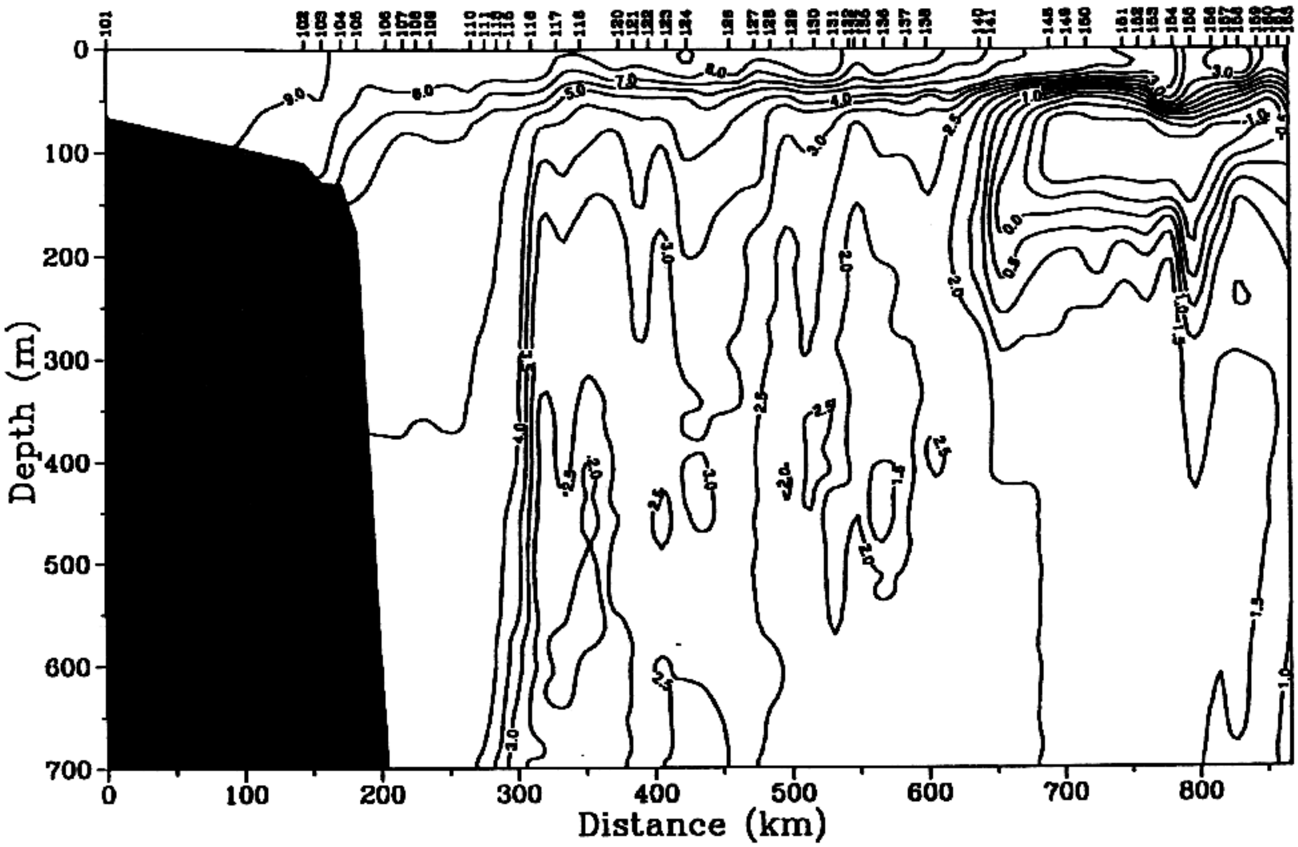


Fig. 13: Map of XBT drops, some numbers are omitted for clarity.

XBT - Section Meteor 11_5 (A)



XBT - Section Meteor 11_5 (B)

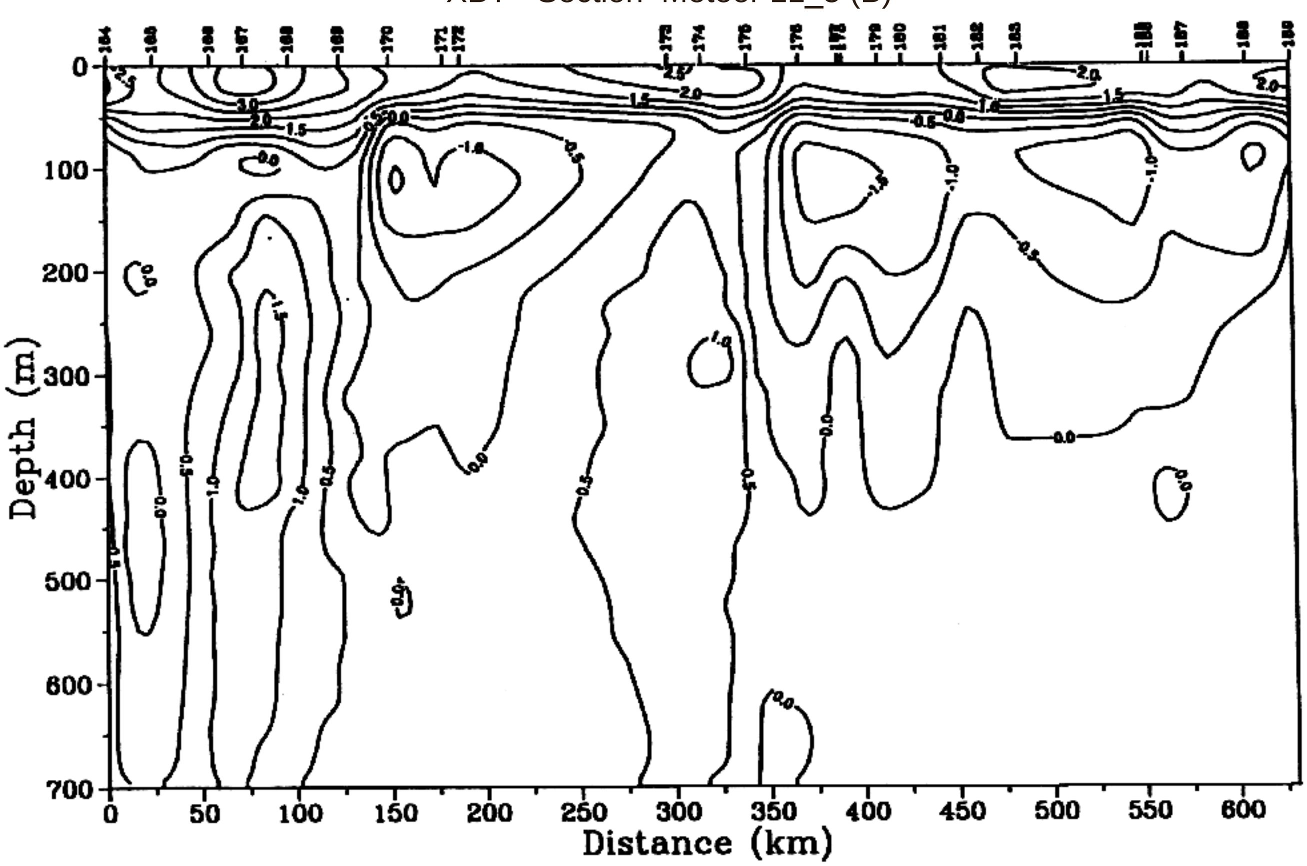
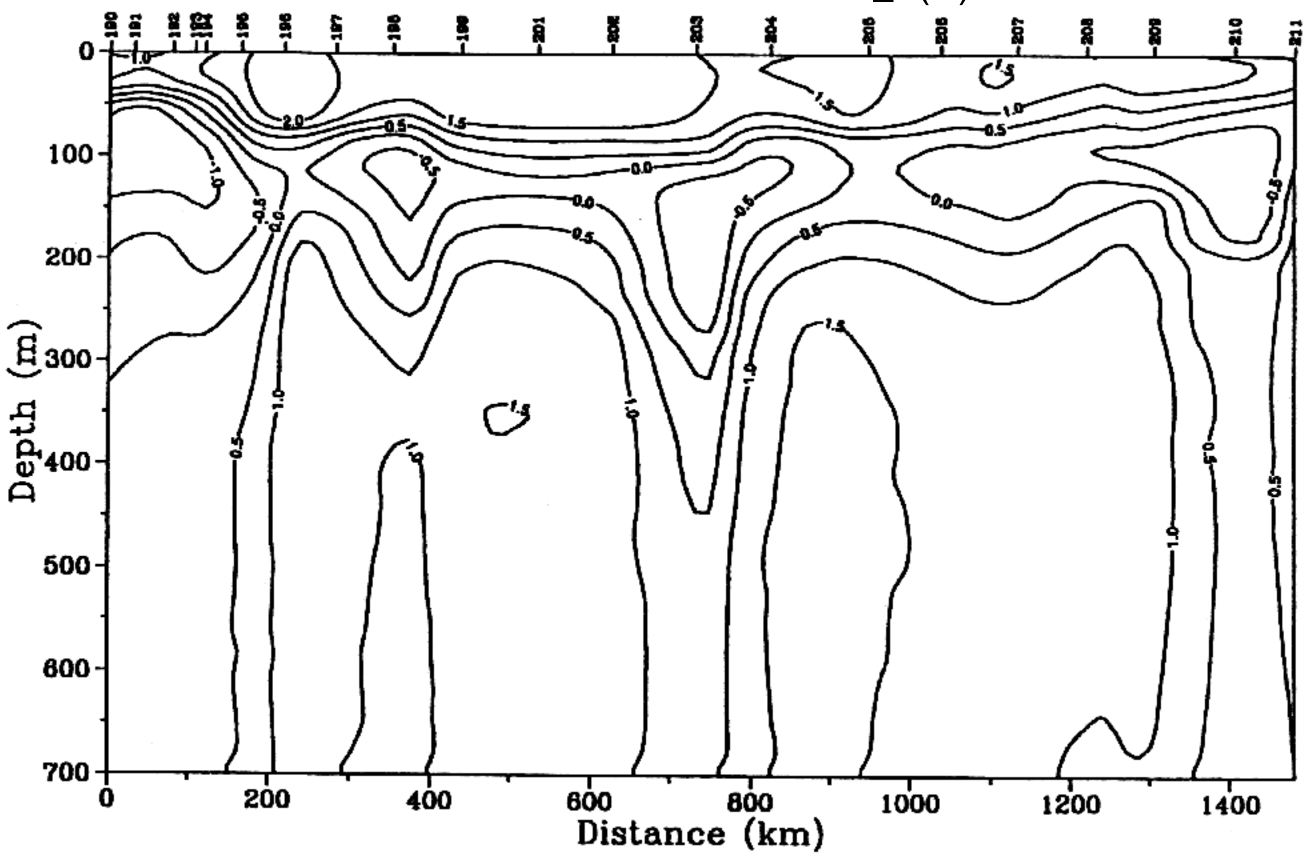


Fig. 14: XBT section, 0 to 700 m, in four parts as indicated in Fig. 13.

XBT-Section METEOR 11_5(C)



XBT-Section METEOR 11_5(D)

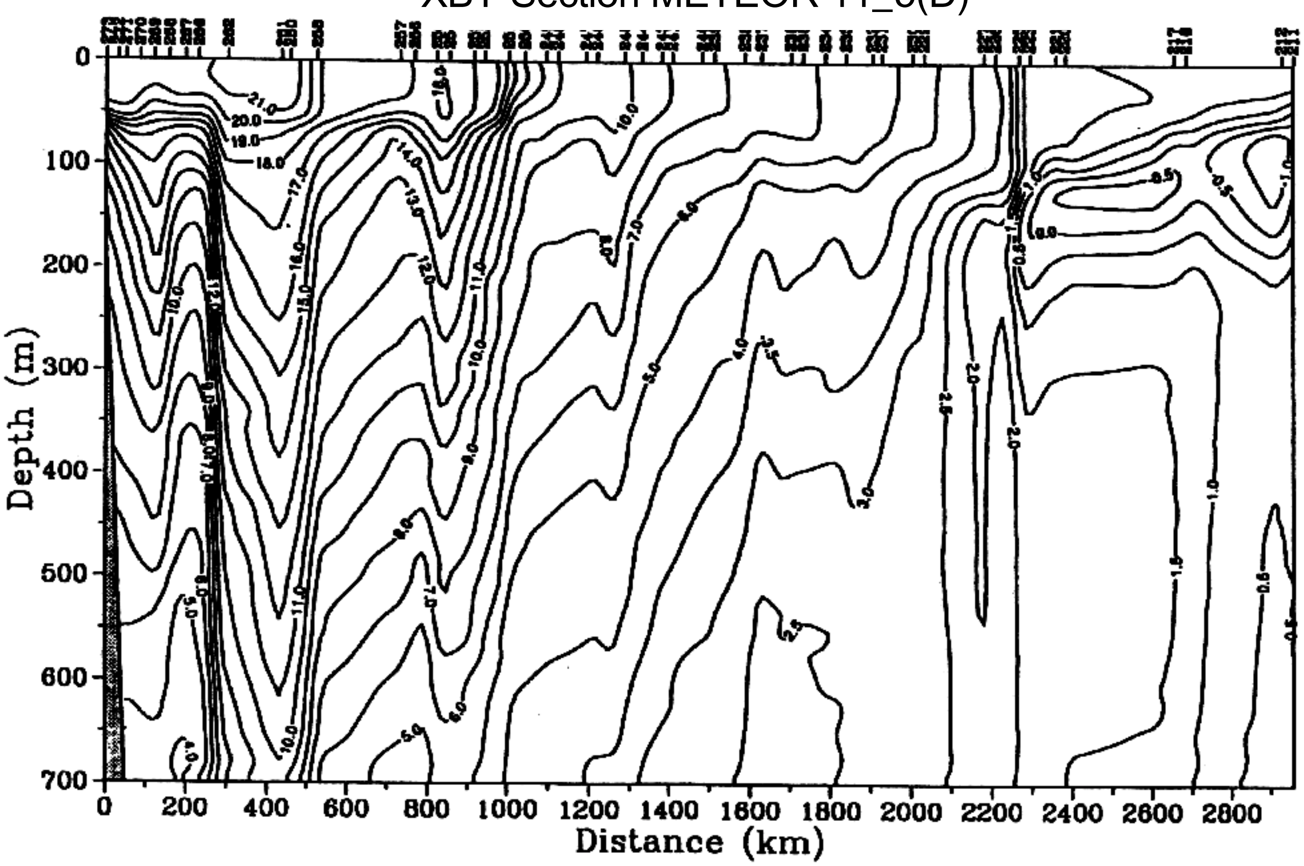


Fig. 14 (continued)

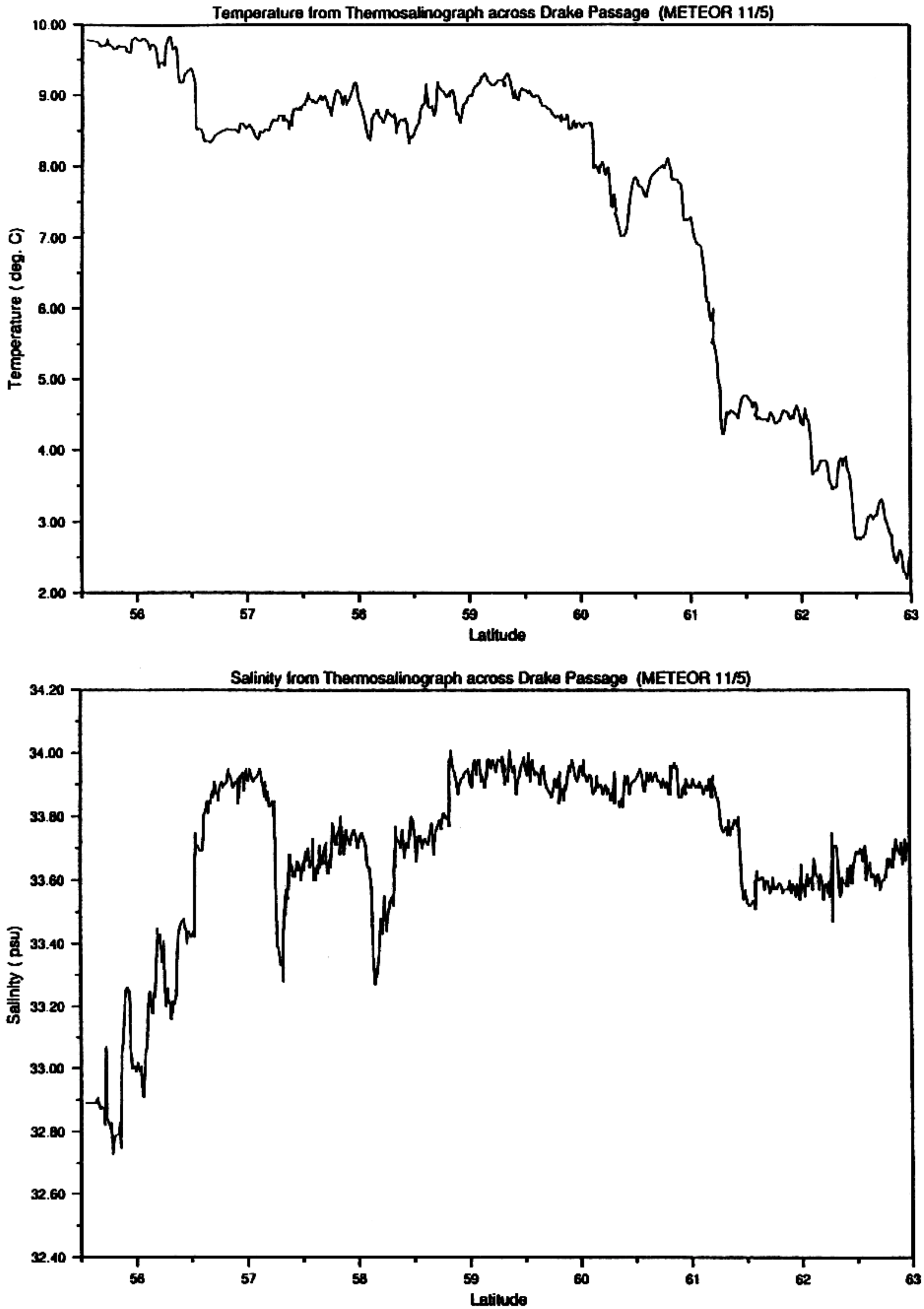
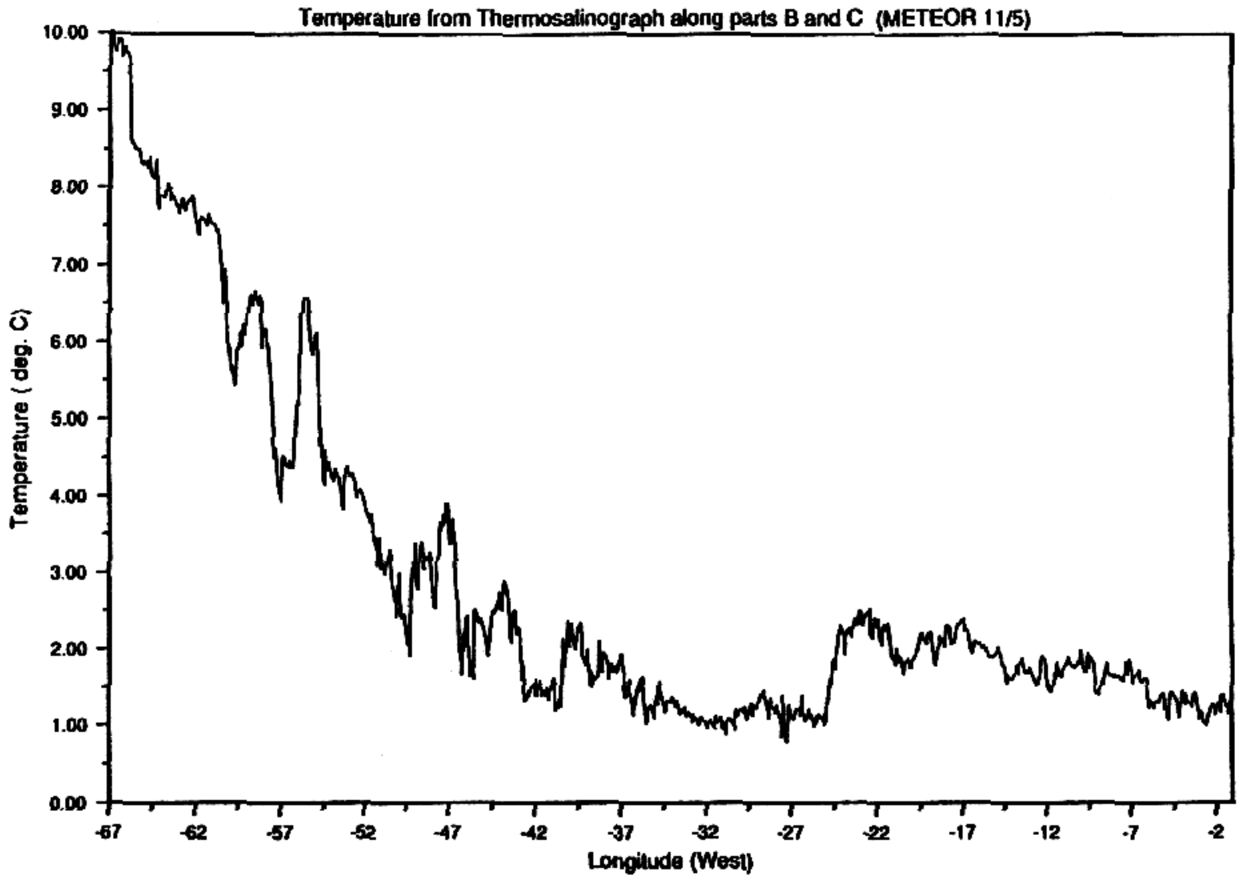


Fig. 15: Thermosalinograph section, in three parts as indicated in Fig. 13.



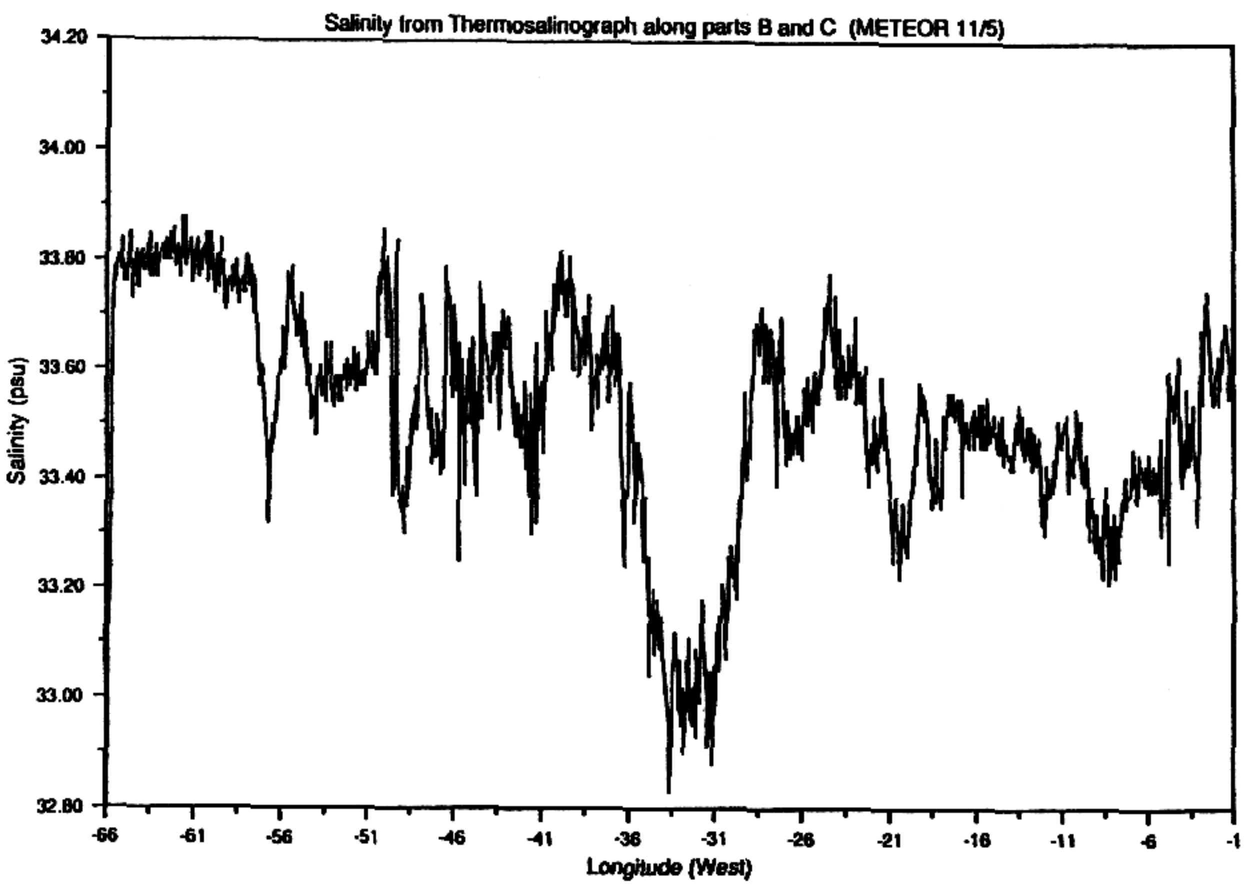
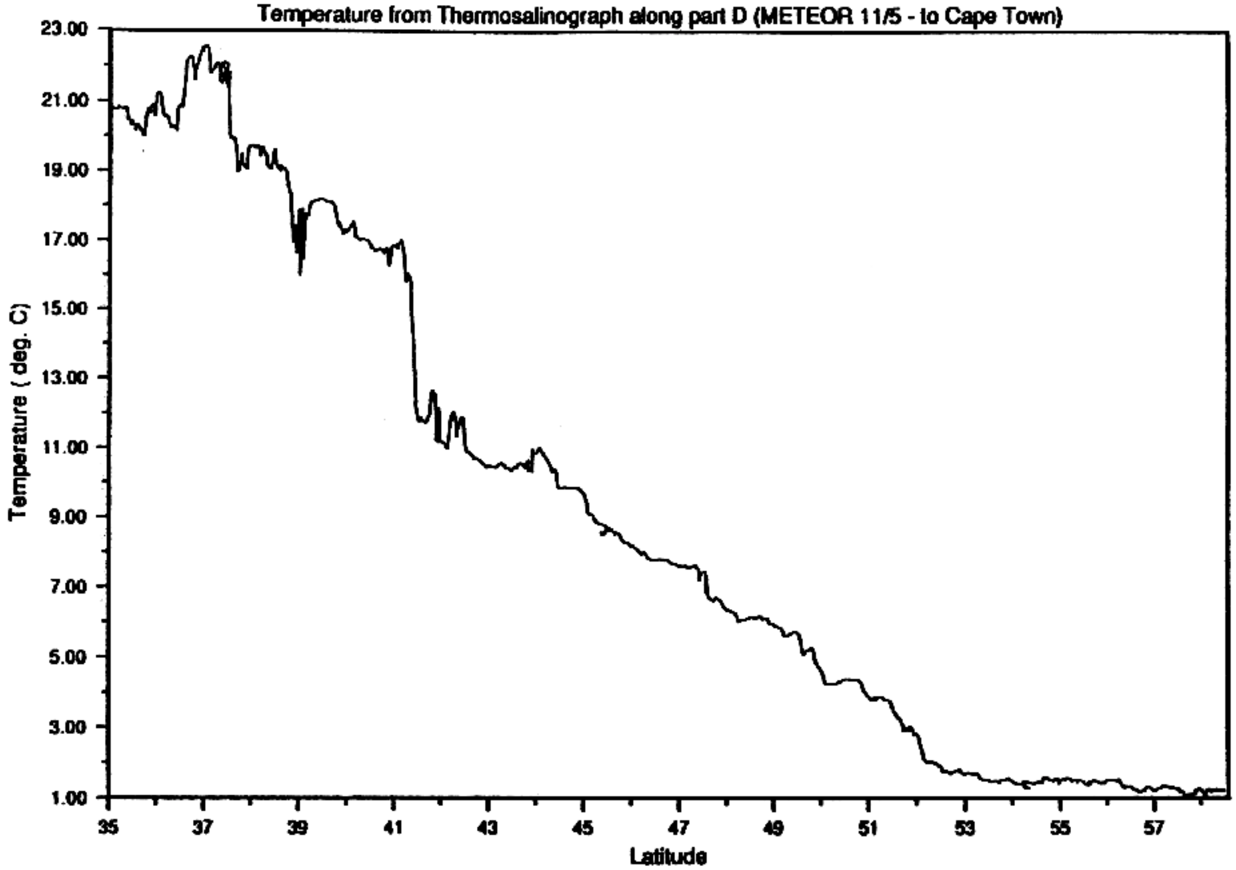


Fig. 15 (continued)



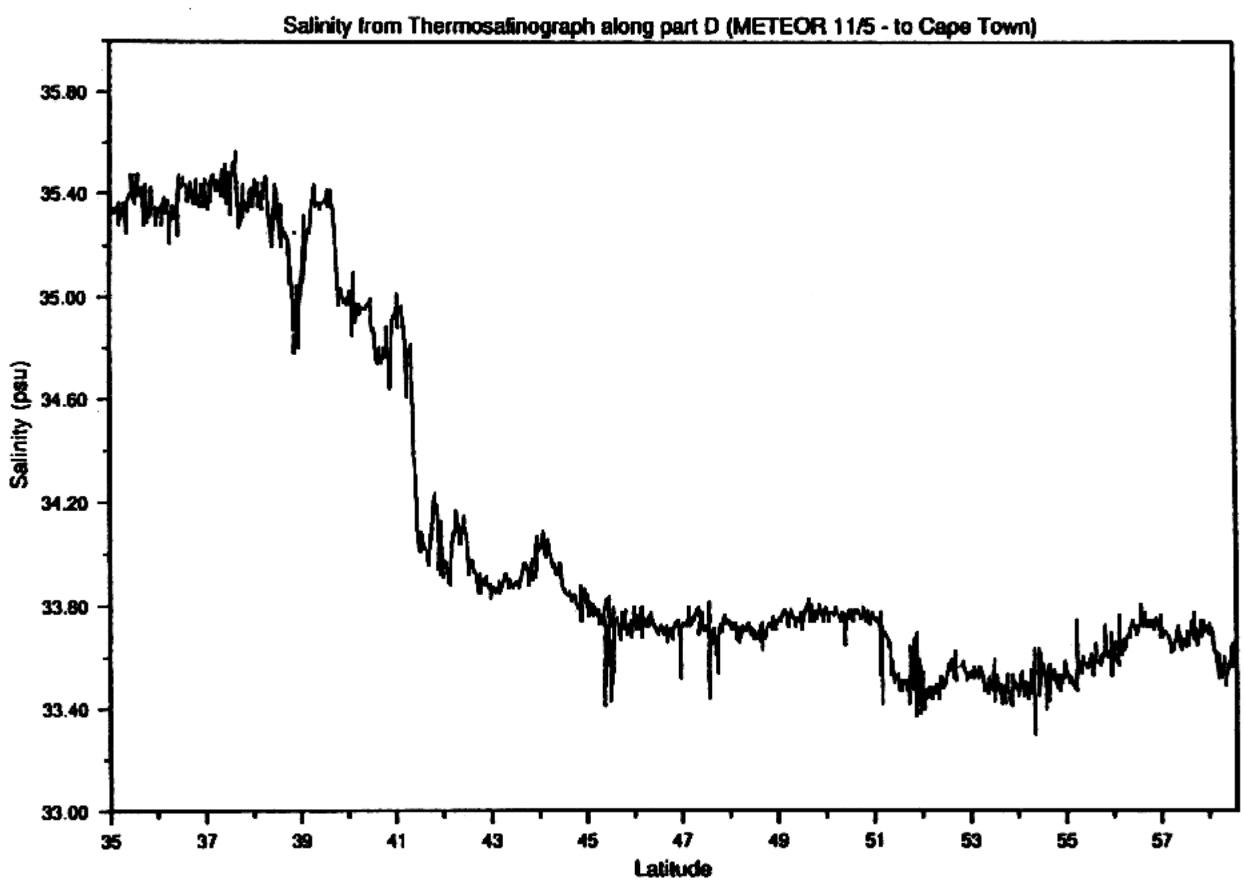


Fig. 15 (continued)

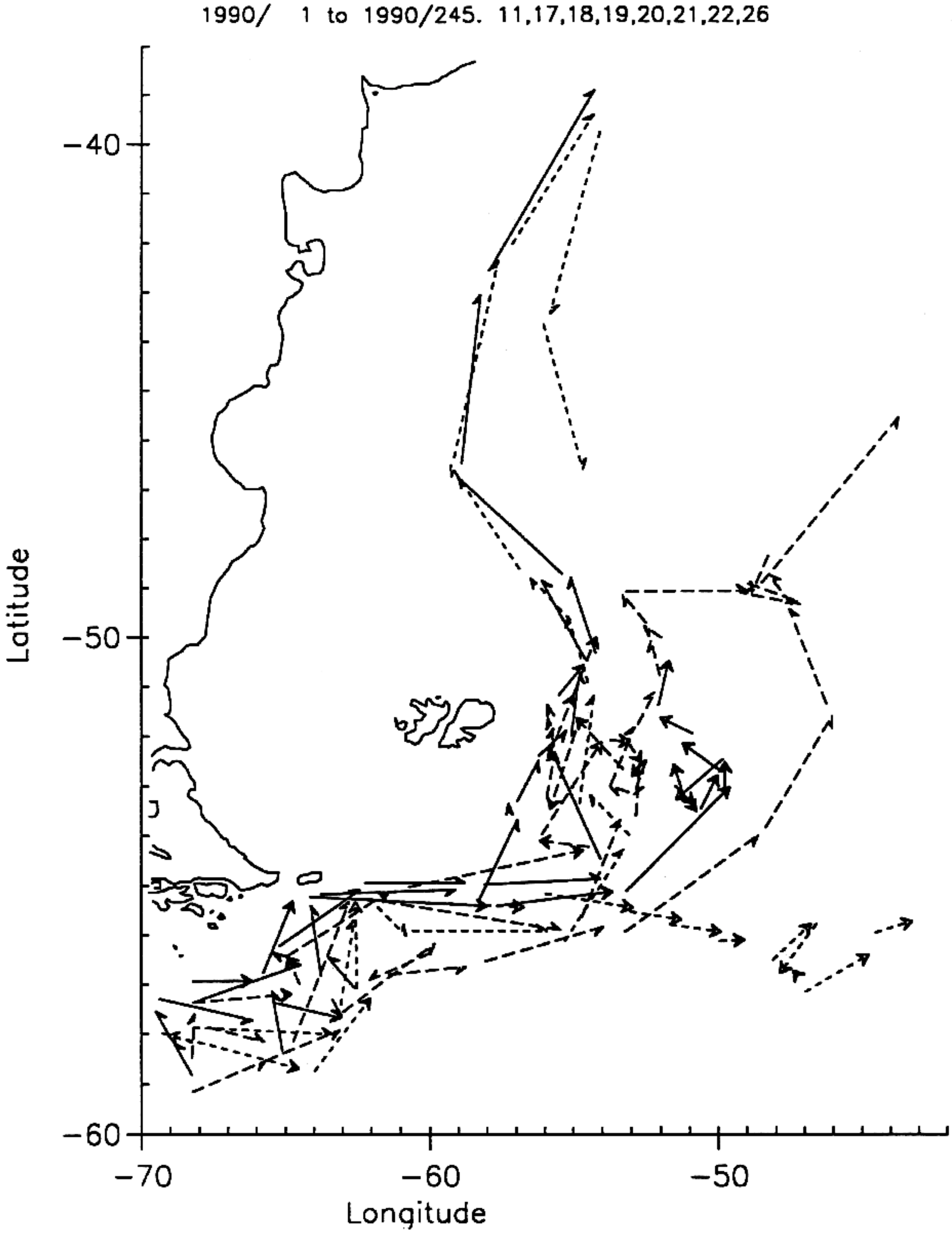


Fig. 16: Alace float trajectories, Jan. to end of August 1990. Vector displacements for 14 day period between dive and surfacing position are shown, coded for the individual floats; gap between vectors is surface time (24 h). Float rise velocity exceeds 1 km/h, descent starts at 700 m/h approaching zero at equilibrium depth.

Table 4: Tracer samples taken for shore-based analysis

The number of samples for each station is given.
Columns (1) to (5): sampled by rosette;
Columns (6) to (10): sampled by Gerards

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Sta#	**He**	**Tri**	**13C/18O**	**Ba**	**^{14}C**	**^{14}C**	**228Ra**	**226Ra**	**85Kr**	**39Ar**
101			2	2	3					
102	4	3								
103	12	11								
104	24	24	18	24		16	16	16	13	
105										
106	14	13								
107	25	24	20	20		18	18	18	13	1
108										
109	14	13								
110	13	12								
111	13	14			24					
112	6	6								
113	25	24		19						
114					11					
115	8	8								
116	24	24			6	15	15	16	14	
117	12	12		19						
118	10	9								
119						17	17	17	9	1
120										
121						1				1
122	23	22								
123	7	7								
124	24	24		24		16	16	16	2	1
125										
126	13	13								
127	21	21								
128										
129	24	24		24		16	16	16	13	
130	8	7								
131	23	23	23	23		14	15	15	11	1
132	16	15								
133	5	5								
134	24	24	24	24		18	18	17	14	1
135										
136	24	24								
137										
138	22	22								
139										
140	25	24		24		18	18	18	14	

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Sta#	**He**	**Tri**	**13C/18O**	**Ba**	**^{14}C**	**^{14}C**	**228Ra**	**226Ra**	**85Kr**	**39Ar**
141	9	9								
142	25	24	24							
143										
144	24	24								
145										
146	24	24								
147	15	15								
148										
149	24	24	24	24	11	9	5	9	4	
150										
151	24	24								
152										
153	24	24	24	24		18	18	17	13	
154	7	7								
155	12	12								
156										
157	12	12								
158	18	13	24	24		16	16	16	13	
159										
160	25	24								
161										
162	30	30	22	30		16	16	16	12	
163										
164	31	30								
165										
166	31	30	22	30		18	18	18	8	
167						2				2
168	28	28								
169										
170	30	29								
171										
172	28	20	24	32		15	18	18	7	1
173						7				1
174	27	22								
175										
176	26	20								
177										
178	39	30								
179										

Table 5: Station Inventory

Ship: METEOR (06MT11_5)
WHP section A21: Stas. 102 - 120 (suppl. 39Ar Sta.: 121)
WHP section S04A: Stas. 121-148
WHP section SR02: Stas. 149-179

Salinity, nutrients and oxygen were measured on all samples, and CFM's (11 and 12) on most. For other properties see Table 4. CO_2 parameters (pCO_2, TCO_2) were measured on virtually all stations, but to varying degree.

Station/cast with non-normal operation (single bottle misfirings not noted):

101/1:	trial station only, no samples
102/1:	shelf station, some depth repeats
104/4:	CFM blank check only (3500 - 4000 m)
109/1:	winch computer breakdown followed after this cast
115/1:	top 8 bottles misfired
118/1:	at position of Sta. 115, to fill in above 1000 in depth; bottle-depth relation had to be rotated; CFM test 600 m
119/1+3:	Gerard casts at position of Sta. 109
119/2:	supporting rosette cast, samples below 500 m only; CFM test 2000 m
120/1:	at position of Sta. 106; CFM test 3400 m
121/1:	support for 39Ar cast, to 2400 m only
121/2:	39Ar cast to support Drake Passage section
122/1:	some firing problems
135/1:	bottle-depth relation had to be rotated
140/2:	bottle-depth relation had to be rotated
154/1:	very high sea
164/2:	only even rosette positions were sampled, mix-up 10 and 100 in possible
165/1+2:	delay between casts due to high sea
167/3:	39Ar cast in connection with L-V Sta. 166
173/3:	39Ar cast in connection with L-V Sta. 172
178/1:	CFM check 900 m

Table has one line per station, with data being arranged as follows:

- Sta. No.
- cast/date
- type/latitude
- longitude/time
- depth/CTD institution
- "CTD#1"
- no. of rosette bottles fired

Format of entries:

- latitude and longitude in the degrees/min.fraction of min, at beginning of cast
- time in UTC, beginning of cast
- depth in m
- AWI CTD #l: AWI instrument no. 1, ODF calibrated; AWI rosette 24 X 12 liter
- SIO CTD #l: ODF instrument no. 1, Bremen rosette 24 X 10 liter

streport

101	1230190	ROS5519.4S	6621.9W2021	71AWI	CTD	#1	24 bottles
102	1240190	ROS5619.8S	6759.7W0709	103AWI	CTD	#1	24 bottles
103	1240190	ROS5655.0S	6815.0W1232	3090AWI	CTD	#1	24 bottles
104	1240190	ROS5319.8S	6815.0W1900	4390AWI	CTD	#1	24 bottles
104	2250190	GER5720.8S	6804.7W0216	4391			
104	3250190	ROS5720.0S	6814.7W0919	4390AWI	CTD	#1	24 bottles
105	1250190	ROS5750.1S	6814.5W2330	3757AWI	CTD	#1	24 bottles
106	1260190	ROS5820.1S	6814.3W0519	3855AWI	CTD	#1	24 bottles
107	1260190	GER5850.4S	6815.8W1032	3866			
107	2260190	ROS5850.0S	6814.9W1443	3842AWI	CTD	#1	24 bottles
107	3260190	GER5849.8S	6815.3W1649	3823			
108	1260190	ROS5919.9S	6814.8W2323	3665AWI	CTD	#1	24 bottles
109	1270190	ROS5949.9S	6815.0W0527	3738AWI	CTD	#1	24 bottles
110	1270190	ROS6019.8S	6808.0W1921	3818AWI	CTD	#1	24 bottles
111	1280190	ROS6049.9S	6800.0W0112	3954AWI	CTD	#1	24 bottles
112	2280190	ROS6112.9S	6719.8W1257	3849AWI	CTD	#1	24 bottles
113	1280190	ROS6135.9S	6640.3W1837	4013AWI	CTD	#1	24 bottles
114	1290190	ROS6200.0S	6559.1W0446	3587AWI	CTD	#1	24 bottles
115	1290190	ROS6216.9S	6512.7W0959	4083AWI	CTD	#1	24 bottles
116	1290190	GER6236.4S	6404.9W1603	3859			
116	1290190	ROS6236.0S	6416.3W1920	4015AWI	CTD	#1	24 bottles
116	3290190	GER6235.8S	6406.7W2237	4025			
117	1300190	ROS6251.4S	6331.5W0517	2099AWI	CTD	#1	24 bottles
118	1300190	ROS6217.0S	6513.0W1300	3860AWI	CTD	#1	24 bottles
119	1300190	GER6136.0S	6639.0W2020	3974			
119	2010290	ROS6136.0S	6640.3W2353	3995AWI	CTD	#1	24 bottles
119	3310190	GER6136.2S	6640.5W0244	3760			
120	1010290	ROS5820.1S	6815.3W0037	3855AWI	CTD	#1	24 bottles
121	1030290	ROS5529.4S	6429.1W2313	3642AWI	CTD	#1	24 bottles
121	2040290	GER5528.7S	6427.0W0025	3635			
122	1060290	ROS5915.1S	4715.0W1233	3895AWI	CTD	#1	24 bottles
123	1060290	ROS6012.3S	4539.9W2203	3785AWI	CTD	#1	24 bottles
124	1070290	GER6041.7S	4153.9W1405	3946			
124	2070290	ROS6039.1S	4156.1W1715	3978AWI	CTD	#1	24 bottles
124	3070290	GER6039.5S	4155.9W1935	4170			
125	1080290	ROS6041.2S	4117.2W0344	2905AWI	CTD	#1	24 bottles
126	1080290	ROS6032.3S	3911.8W1211	3471AWI	CTD	#1	24 bottles
127	1080290	ROS6042.4S	3814.0W1701	2738AWI	CTD	#1	24 bottles
128	1080290	ROS6121.8S	3707.6W2336	3556AWI	CTD	#1	24 bottles

129	1090290	GER6123.9S	374.0W0232	4355			
129	2090290	ROS6202.6S	3614.3W1046	4264AWI	CTD	#1	24 bottles
129	3090290	GER622.5S	3614.5W1252	4198			
130	1090290	ROS6236.0S	3530.4W2003	4469AWI	CTD	#1	24 bottles
131	1100290	GER631.7S	3455.8W0137	4860			
131	2100290	ROS6309.9S	3444.8W0445	5098AWI	CTD	#1	24 bottles
131	3100290	GER6310.6S	3444.7W0822	5104			
132	1120290	ROS5906.6S	2537.2W0248	2524AWI	CTD	#1	24 bottles
133	1120290	ROS5843.0S	2440.9W0907	3448AWI	CTD	#1	24 bottles
134	1120290	GER5844.2S	243.8W1340	5464			
134	2120290	ROS5844.0S	2404.0W1555	5413AWI	CTD	#1	24 bottles
134	3120290	GER5844.5S	243.5W2024	5491			
135	1130290	ROS5842.6S	2322.7W0446	5551AWI	CTD	#1	24 bottles
136	1130290	ROS5835.5S	2224.7W1112	4769AWI	CTD	#1	24 bottles
137	1130290	ROS5827.0S	2120.5W1946	4580AWI	CTD	#1	24 bottles
138	1140290	ROS5822.1S	2009.2W0456	3420AWI	CTD	#1	24 bottles
139	1140290	ROS5808.2S	1819.9W1314	4485AWI	CTD	#1	24 bottles
140	1140290	GER5758.6S	1651.9W2049	5138			
140	2140290	ROS5759.4S	1651.3W2307	5143AWI	CTD	#1	24 bottles
140	3150290	GER5758.7s	1652.0W0307	5155			
141	1150290	ROS5748.1S	1524.9W1042	4541AWI	CTD	#1	24 bottles
142	1150290	ROS5739.1S	1317.6W1925	4235AWI	CTD	#1	24 bottles
143	1160290	ROS5731.9S	1155.5W0542	4766AWI	CTD	#1	24 bottles
144	1160290	ROS5723.4S	1002.4W1433	3949AWI	CTD	#1	24 bottles
145	1170290	ROS5714.9S	820.7W0022	3688AWI	CTD	#1	24 bottles
146	1170290	ROS5719.7S	635.4W0912	4225AWI	CTD	#1	24 bottles
147	1170290	ROS5749.1S	451.5W1708	4142AWI	CTD	#1	24 bottles
148	1180290	ROS5809.0S	306.2W0414	4321AWI	CTD	#1	24 bottles
149	1180290	ROS5829.9S	100.0W1301	4759AWI	CTD	#1	24 bottles
149	2180290	GER5829.8S	100.2W1745	4768			
150	1190290	ROS5742.0S	025.0W0309	4101AWI	CTD	#1	24 bottles
151	1190290	ROS5659.9S	000.0E1037	3849AWI	CTD	#1	24 bottles
152	1190290	ROS5607.9S	037.6E1931	4157AWI	CTD	#1	24 bottles
153	1200290	GER5514.5S	109.4E0615	3423			
153	2200290	ROS5515.2S	105.6E0757	4130AWI	CTD	#1	24 bottles
153	3200290	GER5514.4S	105.2E1216	4125			
154	1210290	ROS5421.7S	145.1E1940	4890AWI	CTD	#1	24 bottles
155	1220290	ROS5331.0S	220.1E0557	3002AWI	CTD	#1	24 bottles
156	1220290	ROS5242.1S	249.9E1448	2910AWI	CTD	#1	24 bottles
157	1230290	ROS5152.6S	320.9E1034	3116AWI	CTD	#1	24 bottles
158	1230290	GER5108.9S	346.5E1853	3200			
158	2230290	ROS5109.4S	347.1E2212	3170AWI	CTD	#1	24 bottles
158	3240290	GER5110.3S	346.6E0222	4139			
159	1240290	ROS5025.1S	414.8E0853	2902AWI	CTD	#1	24 bottles
160	1240290	ROS4929.9S	445.0E1540	3574AWI	CTD	#1	24 bottles
161	1240290	ROS4841.6S	515.7E2329	3067AWI	CTD	#1	24 bottles
162	1250290	ROS4735.0S	549.3E0900	4321AWI	CTD	#1	24 bottles
162	2250290	GER4734.5S	550.0E1044	4283			
162	3250290	ROS4734.2S	549.6E1153	4289AWI	CTD	#1	24 bottles

162	4250290	GER4735.0S	549.6E1610	4315			
163	1260290	ROS4700.0S	640.0E0021	4093AWI	CTD	#1	24 bottles
164	1260290	ROS4609.6S	751.3E0938	3352AWI	CTD	#1	24 bottles
164	2260290	ROS4609.6S	751.0E1450	4055SIO	CTD	#1	24 bottles
165	1270290	ROS4534.9S	840.9E0254	4396SIO	CTD	#1	12 bottles
165	2270290	ROS4535.0S	841.0E1103	4394AWI	CTD	#1	24 bottles
166	1270290	ROS4453.2S	929.8E1835	4562AWI	CTD	#1	12 bottles
166	2270290	GER4453.6S	929.2E2050	5132			
166	3270290	ROS4453.1S	930.1E2228	4563AWI	CTD	#1	24 bottles
166	4280290	GER4454.1S	930.3E0316	4562			
167	1280290	ROS4357.0S	950.1E1033	4529SIO	CTD	#1	12 bottles
167	2280290	ROS4356.9S	951.0E1116	4539AWI	CTD	#1	24 bottles
167	3280290	GER4356.4S	949.5E1536	4507			
168	1010390	ROS4301.7S	1007.6E0058	4047SIO	CTD	#1	12 bottles
168	2010390	ROS4300.0S	1007.3E0147	4091AWI	CTD	#1	24 bottles
169	1010390	ROS4157.9S	1025.1E0928	4448SIO	CTD	#1	12 bottles
169	2010390	ROS4156.9S	1023.4E1057	4534AWI	CTD	#1	24 bottles
170	1010390	ROS4103.0S	1044.0E2214	4417SIO	CTD	#1	12 bottles
170	2010390	ROS4103.1S	1044.6E2308	4420AWI	CTD	#1	24 bottles
171	1020390	ROS4006.9S	1103.8E0809	4727SIO	CTD	#1	12 bottles
171	2020390	ROS4006.6S	1103.2E0855	4731AWI	CTD	#1	12 bottles
172	1020390	ROS3907.0S	1119.8E1849	5051AWI	CTD	#1	24 bottles
172	2020390	GER3905.7S	1117.4E2219	5063			
172	3020390	ROS3906.6S	1118.4E2247	5045AWI	CTD	#1	24 bottles
172	4030390	GER3906.0S	1116.3E0409	5065			
173	1030390	ROS3837.2S	1222.2E1137	4838SIO	CTD	#1	12 bottles
173	2030390	ROS3837.1S	1222.9E1222	4764AWI	CTD	#1	24 bottles
173	3030390	GER3837.1S	1222.6E1258	4741			
174	1030390	ROS3807.4S	1320.2E2230	5035SIO	CTD	#1	12 bottles
174	2030390	ROS3807.2S	1321.6E2327	5036AWI	CTD	#1	24 bottles
175	1040390	ROS3732.2S	1421.1E0724	4958SIO	CTD	#1	12 bottles
175	2040390	ROS3732.1S	1420.8E0816	4963AWI	CTD	#1	24 bottles
176	1050390	ROS3659.8S	1523.1E0504	4804SIO	CTD	#1	12 bottles
176	2050390	ROS3700.0S	1522.8E0617	4803AWI	CTD	#1	24 bottles
177	1050390	ROS3626.8S	1624.8E1706	4506AWI	CTD	#1	12 bottles
177	2050390	ROS3626.8S	1624.8E1845	4507AWI	CTD	#1	24 bottles
178	1060390	ROS3552.2S	1727.2E0332	3891AWI	CTD	#1	12 bottles
178	2060390	ROS3552.1S	1727.5E0556	3869AWI	CTD	#1	24 bottles
179	1060390	ROS3519.9S	1827.0E1855	1794AWI	CTD	#1	24 bottles

Table 6: XBT-Stations METEOR 11/5

Date (1990)	Time (GMT)	Station	Latitude	Longitude
Drake Passage (part A)				
23.01.	2215	101	55 24.4 S	66 25.4 W
24.01.	0747	102	56 21.2 S	68 00.6 W
24.01.	0852	103	56 28.7 S	68 04.3 W
24.01.	0958	104	56 36.6 S	68 08.4 W
24.01.	1059	105	56 43.3 S	68 11.6 W
24.01.	1535	106	56 56.2 S	68 14.7 W
24.01.	1637	107	57 03.8 S	68 15.8 W
24.01.	1733	108	57 10.6 S	68 14.1 W
24.01,	1829	109	57 17.5 S	68 14.2 W
25.01.	1803	110	57 36.1 S	68 09.8 W
25.01.	1931	111	57 42.4 S	68 09.0 W
25.01.	2055	113	57 47.0 S	68 12.0 W
25.01.	2224	114	57 52.6 S	68 15.0 W
26.01.	0231	115	57 52.1 S	68 12.5 W
26.01.	0331	116	58 01.4 S	68 13.2 W
26.01.	0429	117	58 11.8 S	68 14.7 W
26.01.	0818	118	58 21.6 S	68 14.7 W
26.01.	0908	119	58 30.0 S	68 15.1 W
26.01.	0944	120	58 37.5 S	68 14.9 W
26.01.	1015	121	58 43.6 S	68 15.0 W
26.01.	1739	122	58 49.8 S	68 15.4 W
26.01.	2047	123	58 57.4 S	68 15.3 W
26.01.	2131	124	59 05.4 S	68 15.4 W
26.01.	2224	125	59 13.1 S	68 15.2 W
27.01.	0239	126	59 23.1 S	68 13.7 W
27.01.	0343	127	59 32.9 S	68 15.5 W
27.01.	0424	128	59 39.7 S	68 14.1 W
27.01.	0516	129	59 48.5 S	68 14.0 W
27.01.	1140	130	59 58.2 S	68 08.1 W
27.01.	1251	131	60 05.8 S	68 09.4 W
27.01.	1353	132	60 12.5 S	68 04.6 W
27.01.	1454	133	60 19.1 S	68 06.9 W
28.01.	0015	134	60 14.9 S	68 06.3 W
28.01.	0342	135	60 18.9 S	68 08.3 W
28.01.	0426	136	60 26.5 S	68 06.2 W
28.01.	0513	137	60 35.5 S	68 04.0 W
28.01.	0557	138	60 43.8 S	68 01.6 W
28.01.	1208	140	61 07.1 S	67 27.6 W
28.01.	1559	141	61 12.2 S	67 14.8 W
28.01.	1854	147	61 35.9 S	66 40.1 W
29.01.	0209	148	61 36.5 S	66 36.1 W
29.01.	0253	149	61 43.4 S	66 26.3 W
29.01.	0342	150	61 51.2 S	66 13.0 W
29.01.	0812	151	62 05.5 S	65 44.3 W
29.01.	0901	152	62 11.2 S	65 27.1 W

Date (1990)	Time (GMT)	Station	Latitude	Longitude
Drake Passage (part A)				
29.01.	1028	153	62 16.7 S	65 13.3 W
29.01.	1407	154	62 23.3 S	64 53.4 W
29.01.	1456	155	62 29.3 S	64 35.4 W
29.01.	2150	156	62 36.4 S	64 16.5 W
30.01.	0336	157	62 41.2 S	64 00.3 W
30.01.	0415	158	62 45.0 S	63 48.5 W
30.01.	0655	159	62 50.9 S	63 31.3 W
30.01.	0725	160	62 54.8 S	63 21.4 W
30.01.	0748	161	62 57.9 S	63 13.0 W
30.01.	0808	162	63 00.5 S	63 06.4 W
30.01.	0823	163	63 01.1 S	63 04.9 W
Date (1990)	**Time (GMT)**	**Station**	**Latitude**	**Longitude**
South Orkney (part B)				
6.02.	0918	164	59 04.1 S	48 08.4 W
6.02.	1057	165	59 09.6 S	47 45.2 W
6.02.	1243	166	59 15.2 S	47 14.8 W
6.02.	1626	167	59 22.3 S	47 00.6 W
6.02.	1745	168	59 34.0 S	46 44.5 W
6.02.	1853	169	59 45.1 S	46 25.2 W
6.02.	2000	170	59 56.3 S	46 06.6 W
6.02.	2116	171	60 09.1 S	45 47.8 W
6.02.	2210	172	60 12.3 S	45 40.0 W
6.02.	0940	173	60 29.9 S	43 37.8 W
6.02.	1032	174	60 31.6 S	43 17.7 W
6.02.	1141	175	60 33.9 S	42 50.0 W
6.02.	1257	176	60 37.4 S	42 20.1 W
6.02.	1722	177	60 39.1 S	41 56.3 W
7.02.	2336	178	60 38.9 S	41 53.2 W
8.02.	0146	179	60 42.0 S	41 33.0 W
8.02.	0402	180	60 41.5 S	41 16.8 W
8.02.	0735	181	60 36.3 S	40 48.0 W
8.02.	0839	182	60 32.3 S	40 22.4 W
8.02.	0946	183	60 27.4 S	39 56.8 W
8.02.	0958	184	60 27.4 S	39 56.8 W
8.02.	1534	185	60 36.3 S	38 44.9 W
8.02.	1541	186	60 36.9 S	38 41.3 W
8.02.	1642	187	60 40.6 S	38 21.7 W
8.02.	2025	188	60 56.0 S	37 51.7 W
8.02.	2152	189	61 07.2 S	37 30.8 W

Date (1990)	Time (GMT)	Station	Latitude	Longitude
American-Antarctic Ridge (part C)				
11.02.	2315	190	59 15.5 S	26 29.0 W
11.02.	0114	191	59 09.3 S	26 00.0 W
11.02.	0625	192	58 59.1 S	25 12.7 W
11.02.	0815	193	58 49.1 S	24 49.7 W
11.02.	0924	194	58 43.1 S	24 41.1 W
12.02.	0211	195	58 42.6 S	23 49.3 W
12.02.	0947	196	58 37.7 S	22 53.1 W
12.02.	1700	197	58 29.9 S	21 47.8 W
14.02.	0239	198	58 23.5 S	20 34.9 W
14.02.	1101	199	58 15.4 S	19 06.4 W
14.02.	1846	201	58 03.2 S	17 31.6 W
15.02.	0851	202	57 51.7 S	16 00.0 W
15.02.	1640	203	57 42.0 S	14 15.0 W
16.02.	0116	204	57 35.4 S	12 41.1 W
16.02.	1225	205	57 25.1 S	10 35.9 W
16.02.	2009	206	57 18.1 S	09 03.3 W
16.02.	0628	207	57 17.5 S	07 24.4 W
16.02.	1443	208	57 34.1 S	05 41.9 W
17.02.	2346	209	58 03.4 S	03 55.4 W
18.02.	1016	210	58 20.6 S	01 59.9 W
18.02.	2144	211	58 14.5 S	00 43.8 W

Date (1990)	Time (GMT)	Station	Latitude	Longitude
NS-Section to Cape Town (part D)				
19.02.	0026	212	57 58.1 S	00 37.0 W
20.02.	0030	216	55 50.5 S	00 45.4 E
20.02.	0301	217	55 33.6 S	00 56.4 E
20.02.	1605	218	54 58.6 S	01 17.8 E
20.02.	1843	219	54 40.0 S	01 32.6 E
22.02.	1140	220	53 10.2 S	02 33.1 E
22.02.	1304	221	52 57.8 S	02 40.2 E
22.02.	1304	222	52 57.8 S	02 40.2 E
22.02.	1925	223	52 23.2 S	03 01.9 E
22.02.	1925	224	52 23.2 S	03 01.9 E
22.02.	2108	225	52 08.6 S	03 11.3 E
23.02.	1422	226	51 38.8 S	03 32.3 E
23.02.	1557	227	51 23.2 S	03 41.2 E
24.02.	1239	228	50 03.4 S	04 28.2 E
51.02.	5003	229	50 03.4 S	04 28.2 E
24.02.	1407	230	49 48.1 S	04 36.2 E
24.02.	2016	231	49 06.2 S	04 59.8 E
24.02.	2124	232	48 54.2 S	05 07.8 E
25.02.	0351	233	48 20.2 S	05 30.2 E
25.02.	0705	234	47 49.7 S	05 42.2 E
25.02.	2033	235	47 20.1 S	05 59.2 E
25.02.	2243	236	47 12.4 S	06 22.9 E
26.02.	0507	237	46 43.7 S	07 03.5 E

Date (1990)	Time (GMT)	Station	Latitude	Longitude
NS-Section to Cape Town (part D)				
26.02.	0717	238	07 25.5 S	46 27.6 E
26.02.	2039	239	45 59.1 S	08 06.8 E
26.02.	2340	240	45 47.6 S	08 24.0 E
27.02.	1557	241	45 17.4 S	09 01.9 E
27.02.	1706	243	45 05.8 S	09 14.3 E
27.02.	0720	244	44 43.5 S	09 36.8 E
27.02.	0851	245	44 16.6 S	09 43.1 E
27.02.	2158	246	43 35.9 S	09 56.6 E
28.02.	2321	247	43 19.3 S	10 00.9 E
1.03.	0601	248	42 37.2 S	10 14.5 E
1.03.	0734	249	42 18.5 S	10 18.7 E
1.03.	1727	251	41 45.7 S	10 29.1 E
1.03.	1932	251	41 21.9 S	10 37.6 E
2.03.	0415	252	40 44.0 S	10 51.6 E
2.03.	0606	253	40 26.7 S	10 57.5 E
2.03.	1447	254	39 46.7 S	11 13.6 E
2.03.	1706	255	39 26.0 S	11 21.3 E
3.03.	0830	256	38 55.8 S	11 41.6 E
3.03.	0959	257	38 46.7 S	12 02.9 E
4.03.	0536	258	37 43.4 S	14 01.1 E
4.03.	0536	259	37 43.4 S	14 01.1 E
4.03.	2109	260	37 27.0 S	14 41.7 E
4.03.	2318	261	37 17.1 S	14 51.6 E
5.03.	1253	262	36 14.8 S	15 47.0 E
5.03.	1253	263	36 14.8 S	15 47.0 E
5.03.	1438	264	36 26.9 S	15 57.6 E
5.03.	1515	265	36 26.3 S	16 06.0 E
5.03.	2330	266	36 15.4 S	16 46.1 E
6.03.	0113	267	36 06.9 S	17 06.4 E
6.03.	0356	268	35 53.2 S	17 27.4 E
6.03.	0955	269	35 42.5 S	17 48.9 E
6.03.	1246	270	35 29.9 S	18 07.1 E
6.03.	1904	271	35 20.0 S	18 27.1 E
6.03.	2225	272	35 12.6 S	18 35.9 E

Figures Legends

Fig. 1: Cruise track and stations (large dots: large volume stations), METEOR cruise 11/5

Fig. 2: Potential temperature section, Drake Passage, METEOR 11/5 (WOCE S1/A21). Station positions see Fig. 1 and Table 4. Isolines by objective analysis of original data (indicated by dots) by R. Schlitzer. Bottom depth from ships recordings.

Fig. 3: same, salinity section.

Fig. 4: same, density parameter, sigma-0 (0-1000 m),sigma-2 (1000-3000 m); sigma- 4 (3000-bottom)

Fig. 5: same, silicate section.

Fig. 6: same, CFM 11 section. The position of the lowest isoline, 0.025 pM, is somewhat uncertain, for being near to the data error of about 0.01 pmol/kg.

Fig. 7: CFM 11 section, Orkney Stas. (Fig. 1), for explanation see Fig. 2.

Fig. 8: South Sandwich trench and east, potential temperature section, Stas. see Fig. 1, for explanation see Fig. 2.

Fig. 9: same, oxygen section.

Fig. 10: same silica section.

Fig. 11: African Passage section (WOCE S2/A12), potential temperature. Stas. see Fig. 1, for explanation see Fig. 2.

Fig. 12: same, salinity section.

Fig. 13: Map of XBT drops, some numbers are omitted for clarity.

Fig. 14: XBT section, 0 to 700 m, in four parts as indicated in Fig. 13.

Fig. 15: Thermosalinograph section, in three parts as indicated in Fig. 13.

Fig. 16: Alace float trajectories, Jan. to end of August 1990. Vector displacements for 14 day period between dive and surfacing position are shown, coded for the individual floats; gap between vectors is surface time (24 h). Float rise velocity exceeds 1 km/h, descent starts at 700 m/h approaching zero at equilibrium depth.

CARBON DIOXIDE, HYDROGRAPHIC, AND CHEMICAL DATA
(A. Kozyr and A.F. Gaslightwala)
July 1994

Exerpted from Carbon Dioxide report ORNL/CDIAC-55
NDP-045

Chipman, D. W., T. Takahashi, D. Breger, and S. C. Sutherland. 1994. Carbon Dioxide, Hydrographic, and Chemical Data Obtained During the R/V Meteor Cruise 11/5 in the South Atlantic and Northern Weddell Sea Areas (WOCE sections A-12 and A-21). ORNL/CDIAC-55, NDP-045. Carbon Dioxide Information Analysis Center, Oak Ridge National Laboratory, Oak Ridge, Tennessee.

ABSTRACT

This document presents the procedures and methods used to obtain carbon dioxide (CO_2), hydrographic, and chemical data during the R/V Meteor Expedition 1115 in the South Atlantic Ocean, including the Drake Passage (Section A-12); the Northern Weddell Sea; and the Eastern South Atlantic Ocean (Section A-21). This cruise was conducted as part of the World Ocean Circulation Experiment (WOCE).

The cruise started from Ushuaia, Argentina, on January 23, 1990, and ended at Capetown, South Africa on March 8, 1990. Samples were collected at 78 stations that covered the Drake Passage (56-63° S); the Northern Weddell Sea (45-35° W); a section along the 58° W parallel (25° W-prime meridian); and two segmented S-N sections between the Northern Weddell Sea and Capetown, South Africa. Measurements taken at WOCE sections A-12 and A-21 included pressure, temperature, salinity measured by the Conductivity, Temperature and Depth sensor (CTD); bottle salinity; oxygen; phosphate; nitrate; nitrite; silicate; total carbon concentration (TCO_2); and partial pressure Of CO_2 (pCO_2) measured at 20°C. In addition, potential density at 0 decibar (dbar) and potential temperature were calculated from the measured variables.

The TCO_2 concentration in seawater samples was measured using a coulometer with an estimated precision of approximately ±1 µmol/kg. The coulometer was calibrated frequently at sea by using a high-precision gas pipette and CO_2 gas (99.998%). The pCO_2 value in seawater samples was measured at 20°C by means of a constant volume (500 ml seawater) equilibrator and a gas chromatograph. CO_2 in equilibrated gas was first converted to methane, by using a ruthenium catalyst, and then measured by a flame-ionization detector. The precision of pCO_2 measurements has been estimated to be approximately ±0.1%.

The CO_2 investigation during the R/V Meteor Cruise 11/5 was supported by a grant from the U.S. Department of Energy (No. DE-FG02-90ER60943).

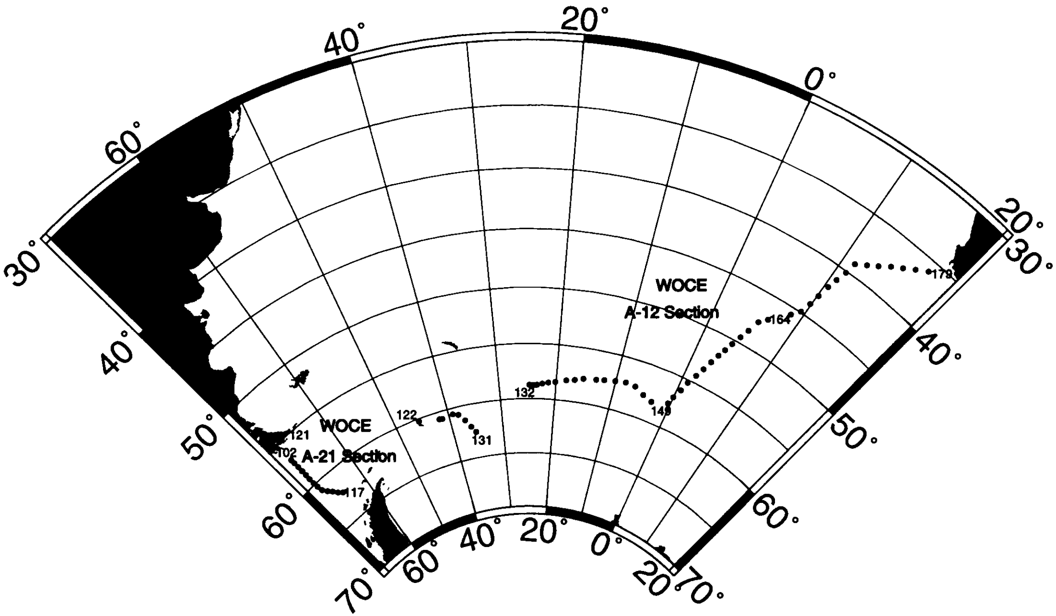
The data set is available, free of charge, as a Numeric Data Package (NDP) from CDIAC. The NDP consists of seven data files and this printed documentation, which describes the contents and format of all data files as well as the procedures and methods used to obtain these data during the R/V Meteor Cruise 11/5.

1. BACKGROUND INFORMATION

The World Ocean plays a dynamic role in the Earth's climate: it captures heat from the sun, transports it, and releases it thousands of miles away. These oceanic-solar-atmospheric interactions affect winds, rainfall patterns, and temperatures on a global scale. The oceans also play a major role in global carbon cycle processes. Carbon in the oceans is unevenly distributed because of complex circulation patterns and biogeochernical cycles, neither of which is completely understood. In addition to circulation patterns, biological processes (i.e., photosynthesis and respiration) play a crucial role in the carbon cycle. The oceans are estimated to hold 38,000 gigatons of carbon, which is 50 times more carbon than that in the atmosphere and 20 times more carbon than that held by plants, animals, and the soil (Williams 1990). Thus, if only 2% of the carbon stored in the oceans is released, the level of atmospheric carbon dioxide (CO_2) would double (Williams 1990). Furthermore, every year more than 15 times as much CO_2 is exchanged across the sea surface than the amount produced by the burning of fossil fuels, deforestation, and other human activities (Williams 1990).

Several large experiments were conducted in the past, and others are currently under way, attempting to better understand the oceans and their role in climate and the global carbon cycle. One of the earliest large-scale oceanographic projects was the Geochernical Ocean Section Study (GEOSECS). The goal of GEOSECS was to study geochernical properties of the oceans with respect to large-scale circulation problems. The project, which covered the Atlantic (1972-73), Pacific (1973-74), and Indian (1977-78) oceans, officially started in 1971 and was noted for its use of equipment and techniques that were at the forefront of modem technology and knowledge. The Transient Tracers in the Ocean (TTO) project (1982) was designed to measure the distribution of CO_2 and hydrographic properties in the North Atlantic Ocean. The World Ocean Circulation Experiment (WOCE) started in 1990 and is currently under way. WOCE is the first research program of sufficient scope to mount a true global study of the ocean. WOCE brings together the expertise of scientists and technicians from many nations in an oceanographic experiment that is larger than any ever attempted. Another multinational program currently under way is the Joint Global Ocean Flux Study (JGOFS). The purpose of JGOFS is to investigate the processes controlling marine biogeochernical cycles, specifically carbon and nutrient cycles.

Seventy-eight stations were occupied along the WOCE sections A-21 and A-12 (Fig. 1).



CO_2 Figure 1: Station locations during the R/V Meteor Cruise 11/5.

3. DESCRIPTION OF VARIABLES

Data file m115.dat (see description on pp. 26-28*) in this numeric data package contains the following variables: station numbers; cast numbers; sample numbers; bottle numbers; CTD pressures; CTD temperatures; CTD salinities; potential temperatures; bottle salinities; concentrations of dissolved oxygen, silicate, nitrate, nitrite, phosphate; total CO_2 concentrations; partial pressures of CO_2 at 20°C; potential densities at 0 dbar; and quality flags. Station inventory file mll5sta.inv (pp. 24-25) contains section numbers; station numbers; latitude, longitude, sampling date (i.e., day, month, and year), and bottom depth for each station.

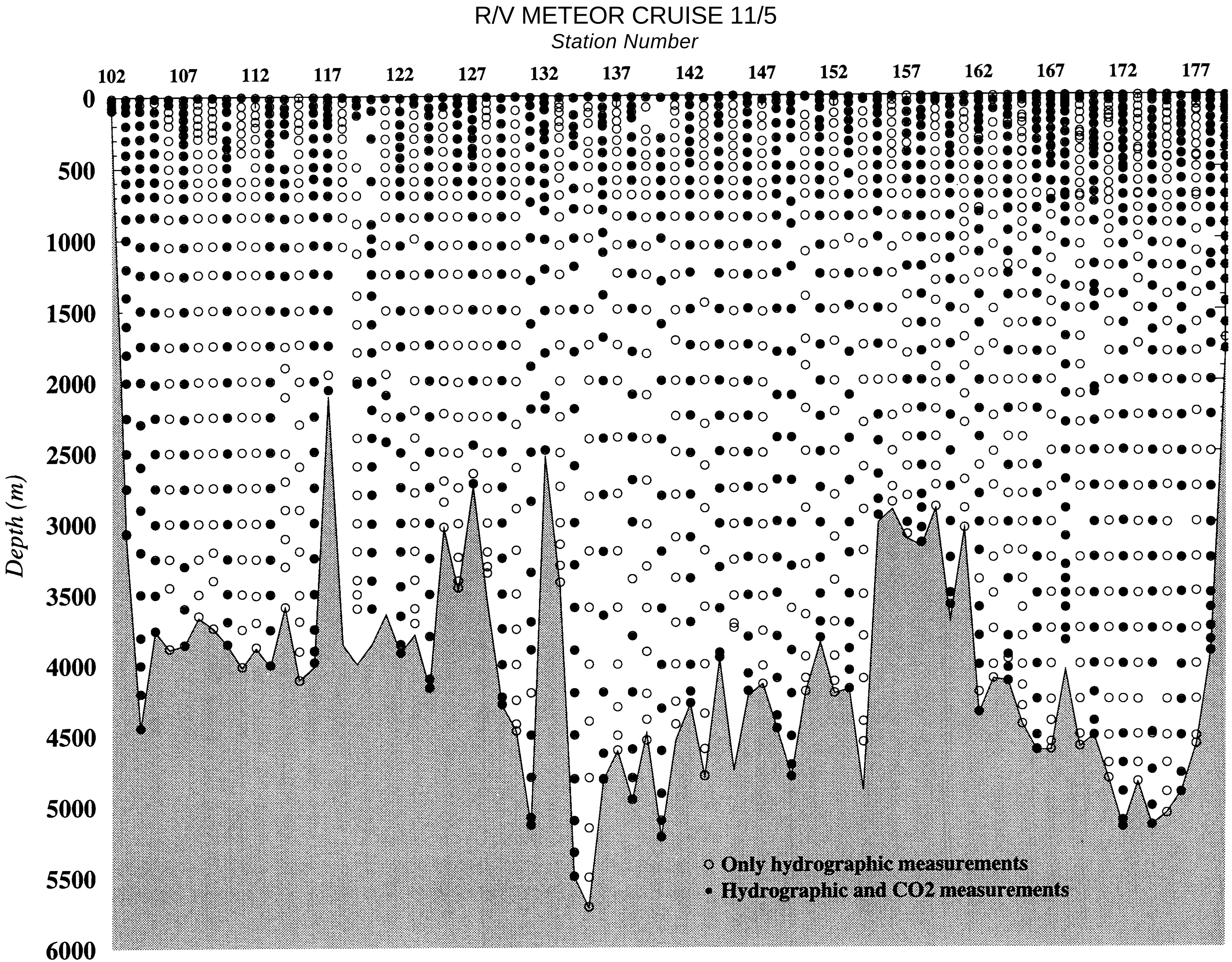
In accordance with WOCE data management policies, which stipulate that WOCE data are not final until designated as such by the chief scientist, we have rounded the CTD salinity, CTD temperature, potential temperature, and density values to two decimal places. If the chief scientist designates these parameters as final, these variables will be restored to their original precision.

The temperature and pressure readings of the Neil Brown IIIB CTD unit were corrected through the use of 4-6 pairs of reversing thermometers; the electrical conductivity readings were corrected by using the salinity values determined aboard the ship for all 24 Niskin samplers. A Guildline® Autosal 8400A salinometer and the Wormley Salinity Standards were used for the determination of salinity in the discrete water samples. The precision of the measurements obtained by the CTD unit has been estimated to be ±0.002°C for temperature and ±0.002‰ for salinity. Potential temperature (θ) and potential density (σ_0) values were computed through the use of the potential temperature algorithm of Fofonoff (1980), the International Equation of State for Seawater (Millero et al. 1980), and Bryden's (1973) formulation for the adiabatic temperature gradient.

The concentration of dissolved oxygen was determined by means of the Winkler titration method. A molar volume at STP of 22.385 liter/mole (Kester 1975) was used to convert oxygen concentrations from milliliter per liter to micromoles per kilogram of seawater at the in situ temperature.

The concentrations of nitrate, nitrite, phosphate, and silicate dissolved in the seawater samples were determined through the use of standard calorimetric methods with an Auto-Analyzer. Determinations were generally made within 6 hours of collection. The water samples were stored in a refrigerator at 4°C before analysis.

All of the concentration values are expressed in units of per kilogram of seawater, although analytical samples were isolated by volumetric means. For the conversion from the volume to the mass of seawater sample, the density of each water sample was computed by using the International Equation of State for Seawater (Millero et al. 1980) and the measured salinity and the temperature at which the volumetric measurements were made.



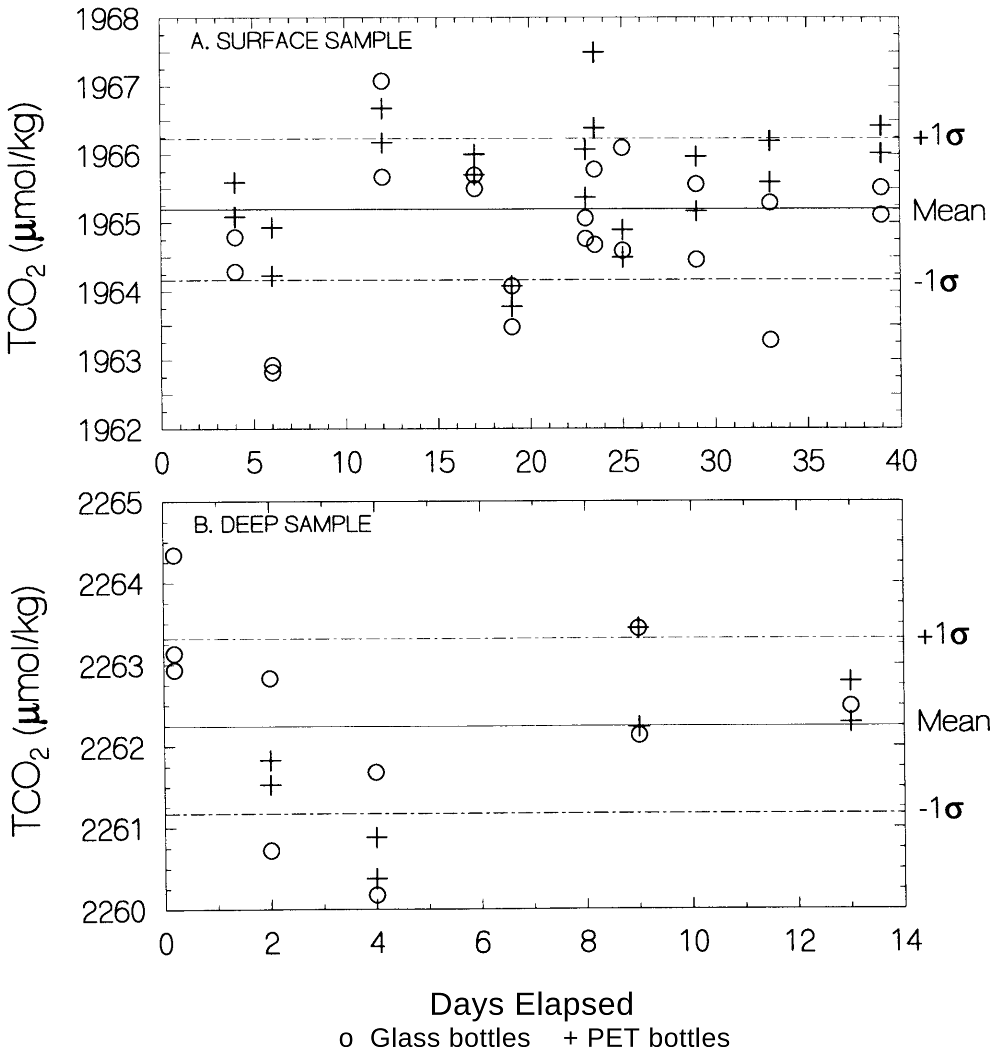
CO_2 Figure 2: Sampling depths at the 78 hydrographic stations occupied during the R/V METEOR Cruise

The total CO_2 concentration in approximately 1300 seawater samples and the CO_2 partial pressure in approximately 870 seawater samples collected at 76 stations (Fig. 2) were determined aboard the ship. The TCO_2 concentration in seawater samples was determined by the use of a coulometric system, which was modified from that described by Johnson et al. (1985).

For analysis, the seawater was introduced into the stripping chamber using fixed-volume syringes. The sample was acidified with 1 ml of 8.5% phosphoric acid while it was in the stripping chamber, where the evolved CO_2 gas was swept from the sample and transferred with a stream of CO_2-free air into the electrochemical cell of the CO_2 coulometer (UTC-Coulometric Model-5011). In the coulometer cell, the CO_2 was quantitatively absorbed by a solution of ethanolamine in dimethylsulfoxide (DMSO). Reaction between the CO_2 and the ethanolamine formed the weak hydroxyethylcarbamic acid. The pH change of the solution associated with the formation of the acid resulted in a color change of the thymophthalein pH indicator in the solution. The color change, from deep blue to colorless, was detected by a photodiode, which continually monitored the transmissivity of the solution. The electronic circuitry of the coulometer, on detecting the change in the color of the pH indicator, caused a current to be passed through the cell generating hydroxyl (OH_-) ions from a small amount of water in the solution. The 0H- that was generated titrated the acid, returning the solution to its original pH (and hence color); the circuitry then interrupted the current flow. The product of current passed through the cell and time was related by the Faraday constant to the number of moles of OH^- generated to titrate the acid and hence to the number of moles of CO_2 absorbed to form the acid.

The volumes delivered by the constant-volume syringes were determined by repeatedly weighing distilled water dispensed in the same manner as a sample; the volume was calculated from the delivered weight by using the density of pure water at the temperature of the measurement and a buoyancy correction for the air displaced by the water (amounts to approximately 0.1% of the weight of the water). The density of the seawater in the pipet was calculated at the temperature of injection by using the International Equation of State (Millero et al. 1980).

The coulometer was calibrated by introducing research-grade CO_2 gas (99.998%) into the carrier gas line upstream of the extraction tube, using a pair of fixed-volume sample loops on a gas-sampling valve and measuring the gas pressure in the loops as the gas was vented to the ambient atmosphere, and determining the barometric pressure by means of the electronic barometer used with the pCO_2 system. The loop temperature was measured to ±0.05°C with a thermometer calibrated against one traceable to the National Institute of Standards and Technology (NIST), and the non-ideality of CO_2 was incorporated in the computation of the loop contents. The volume of the calibration loop had previously been determined by weighing empty loops and then loops filled with mercury. The volumes of these loops have additionally been checked by comparing the amount Of CO_2 introduced by them with the amount derived from gravimetric samples of calcium carbonate and sodium carbonate. They were found to be accurate to within 0.1%.



CO_2 Figure 3: Repeated measurements of the total CO2 concentration in sea surface (A)and in deep water (B) samples. About 50 sample bottles were analyzed over a 50-day period during the expedition. Only 20 bottles were filled with a homogenized deep water sample and analyzed subsequently over a period of 13 days. The analyses of these samples yield a mean value of 1965.2±1.0 for the surface samples and 2262.2±1.0 for the deep water samples.

During the expedition, the coulometer was calibrated several times daily by using the calibrated loop and pure CO_2 gas.

In order to evaluate the long-term reproducibility and precision of the coulometric determination Of CO_2 in seawater, a number of sample bottles were filled with a homogeneous sample of surface water and deep water. Bottles made of Pyrex glass and PET plastic (500 ml and 1000 ml, respectively) were used. Bottled samples were poisoned with mercuric chloride solutions (200 µl for each 500-ml water sample) and analyzed for total CO_2 during the expedition. On the basis of these measurements (Fig. 3), the precision of TCO_2 measurements during this expedition was estimated to be approximately ±1 µmol/kg. Additional details on the TCO_2 measurements are discussed in Chipman et al. (1992).

A fully automated equilibrator-gas chromatograph system was used during the expedition to determined the pCO_2 exerted by the seawater samples. Prior to analysis, the sample flasks were brought to 20°C in the thermostated water bath, and approximately 45 ml of seawater was displaced with air that had a known CO_2 concentration. The air in the flasks and in the tubing connecting the flasks to the sample loop of the gas chromatograph was recirculated continuously for approximately 20 minutes; the gas disperser about 1 cm below the water surface provided a large contact area between the water and air bubbles. At the end of the equilibration period, the circulation pump was switched off, and the air pressure throughout the system was allowed to equalize. A 1-ml aliquot of the equilibrated air was isolated from the equilibration subsystem and injected into the carrier gas stream of the gas chromatograph by cycling the gas sampling valve to which the sample loop was attached. After chromatographic separation, the CO_2 was converted into methane and water vapor through a reaction with the hydrogen carrier in the catalytic converter. The methane produced by this reaction was then measured with a precision of ±0.05% (one standard deviation) by the flame ionization detector. The concentration of CO_2 in the sample was determined through comparison with the peak areas of known amounts of CO_2 from injections of three reference gas mixtures, which were calibrated against the World Meteorological Organization standards created by C. D. Keeling. The reference gas mixtures were injected into the gas chromatograph by means of the same sample loop used for the equilibrated air samples; the pressure of the gas in the sample loop at the time of injection was determined by venting the loop to atmospheric pressure and measuring that pressure by means of a high-accuracy electronic barometer (Setra Systems, Inc., Model 270, accuracy ±0.3 millibar; calibration traceable to the NIST provided by the manufacturer). The sample loop was located within the well-controlled temperature environment of the column oven of the gas chromatograph; hence, all injections were made at a constant temperature.

The equilibrated air samples were saturated with water vapor at the temperature of equilibration and had the same pCO_2 as the water sample. By injecting the air aliquot without removing the water vapor, the partial pressure of CO_2 was determined directly, without the need to know the water vapor pressure (Takahashi et al. 1982). However, was necessary to know the pressure of equilibration, which was controlled by keeping the equilibrator flask at atmospheric pressure. The atmospheric pressure was, in turn, measured with the electronic barometer at the time each equilibrated air sample was injected into the gas chromatograph. Corrections were required to account for the change in pCO_2 of the sample water as a result of the transfer of CO_2 to or from the water during equilibration with the recirculating air. The overall precision of the pCO_2 measurement is estimated to be about ±0.10%, based on the reproducibility of replicate equilibrations. Greater details on the pCO_2 measurements are discussed in Chipman et al. (1992).

4. DATA CHECKS PERFORMED BY CDIAC

An important part of the numeric data package (NDP) process at the Carbon Dioxide Information Analysis Center (CDIAC) involves the quality assurance (QA) of data before distribution. Data received at CDIAC are rarely in a condition that would permit immediate distribution, regardless of the source. To guarantee data of the highest possible quality, CDIAC conducts extensive QA reviews. Reviews involve examining the data for completeness, reasonableness, and accuracy. Although they have common objectives, these reviews are tailored to each data set, often requiring extensive programming efforts. In short, the QA process is a critical component in the value-added concept of supplying accurate, usable data for researchers. The following summarizes the checks performed by CDIAC on the data obtained during the R/V Meteor 11/5 Expedition in the South Atlantic Ocean and Northern Weddell Sea areas.

1. These data were provided to CDIAC in three files: CO_2 measurements, along with downgraded hydrographic and chemical data, provided by Taro Takahashi and David Chipman from Lamont-Doherty Earth Observatory; hydrographic and chemical measurements, and station information files provided by the WOCE Hydrographic Program Office (WHPO) after quality evaluation; FORTRAN 77 retrieval code written and used to merge and reformat the first two data files.

2. All data were plotted by using a PLOTNEST.C program written by Stewart C. Sutherland (LDEO) to check for obvious outliers. The program plots a series of nested profiles, using the station number as an offset; the first station is defined at the beginning, and subsequent stations are offset by a fixed interval (Figs. 4 and 5). Some outliers were identified and removed after consultation with the principal investigators.

3. Property-property plots for all parameters were generated (Fig. 6), carefully examined, and compared with plots from previous expeditions in the South Atlantic Ocean to identify "noisy" data and possible systematic, methodological errors.

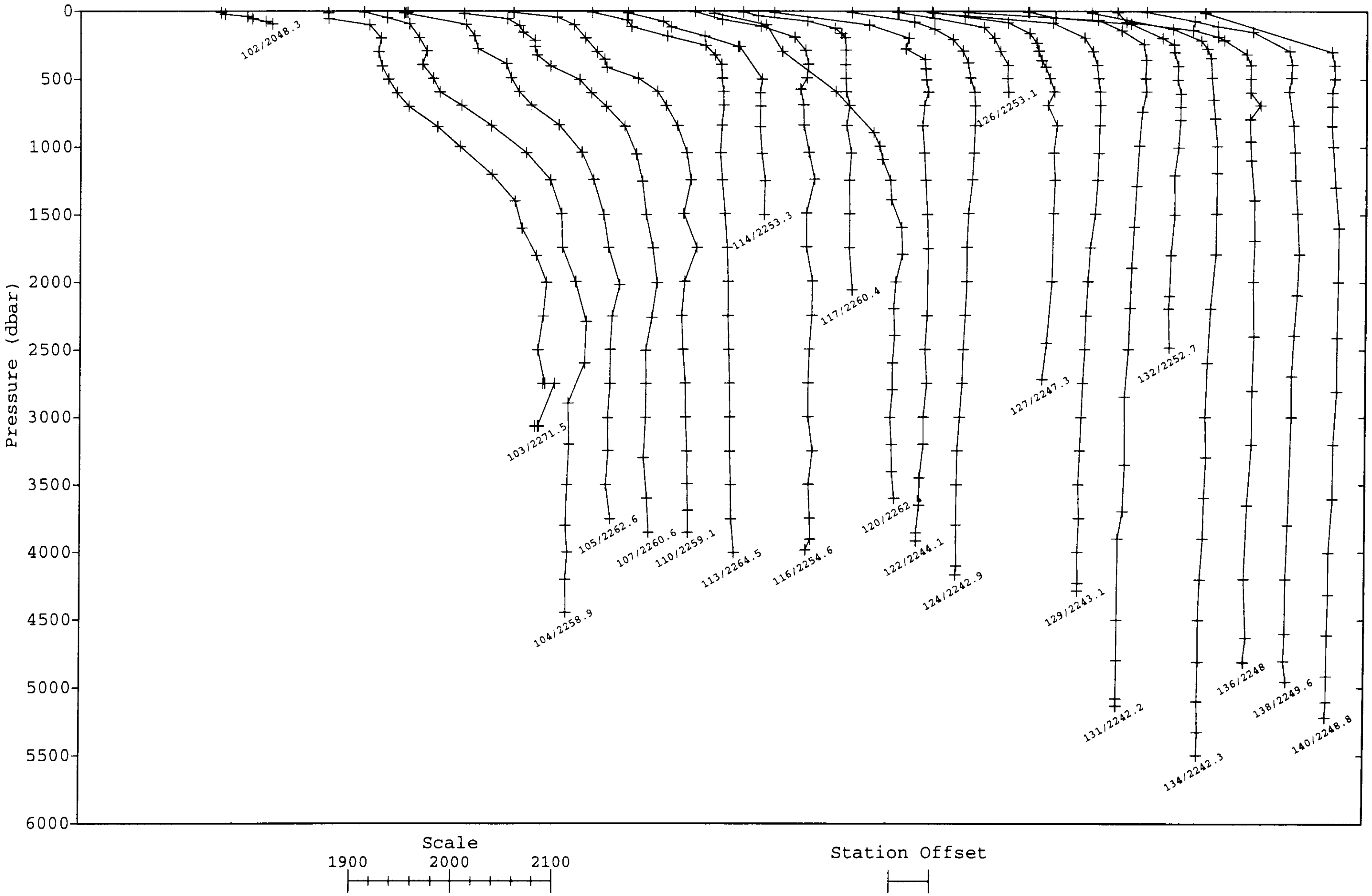
4. All variables were checked for values exceeding physical limits, such as sampling depth values that are greater than the given bottom depths.

5. Station locations (latitudes and longitudes) and sampling times were examined for consistency with maps and with cruise information supplied by Chipman et al. (1992).

6. CTD salinity, CTD temperature, potential temperature, and density have been downgraded to two decimal places in accordance with WOCE data management policies, which stipulate that data are not final until designated as such by the chief scientist. If the chief scientist designates these parameters as final, these values will be restored to their original precision.

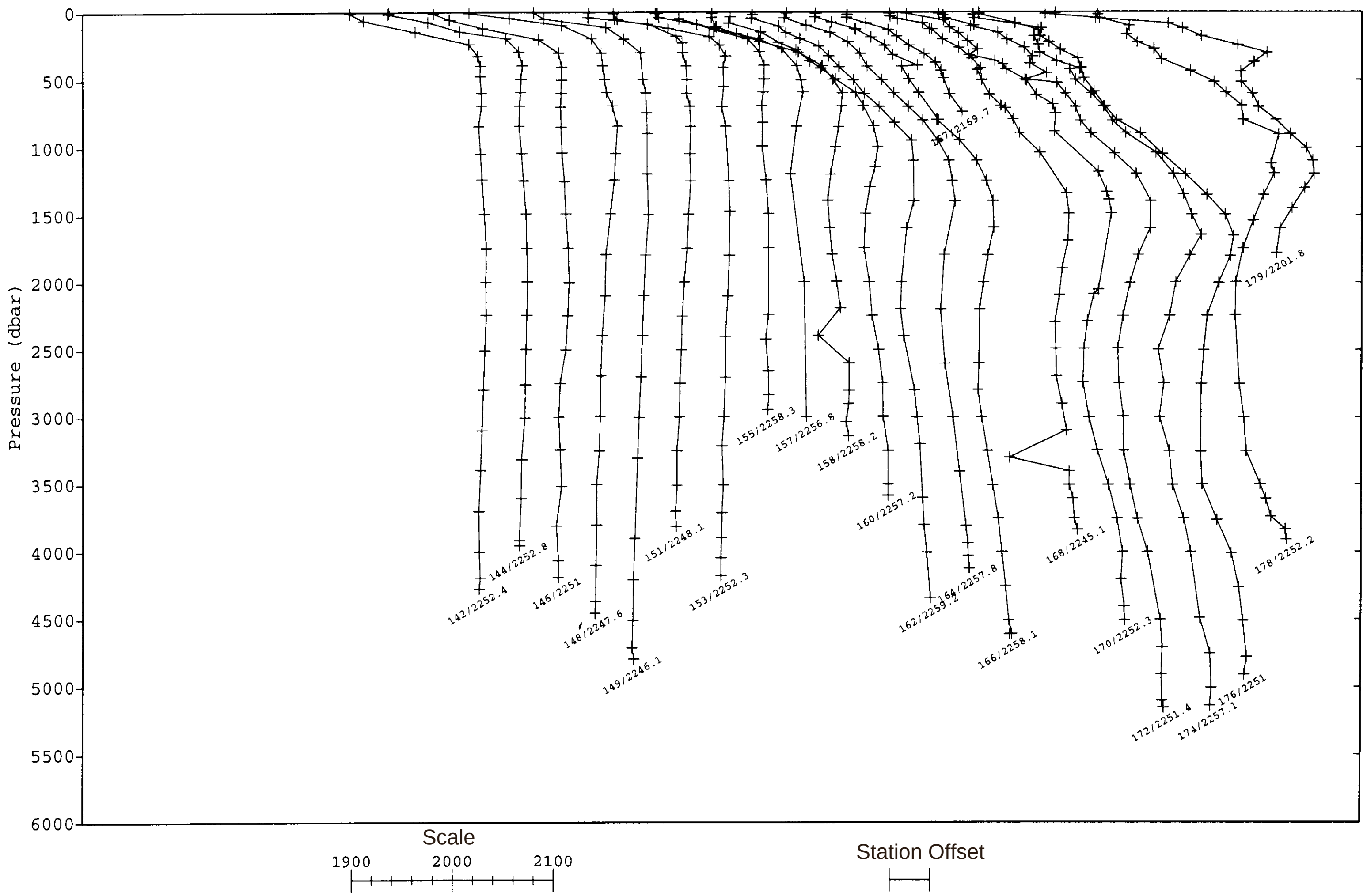
7. The designation for missing values, given as -9.0 in the original files, was changed to -999.9.

R/V METEOR *Cruise 11/5. South Atlantic Ocean.*
only profiles which exist in this Pressure (dbar) range are plotted
Plotted parameter ranges from 1900 to 2300.

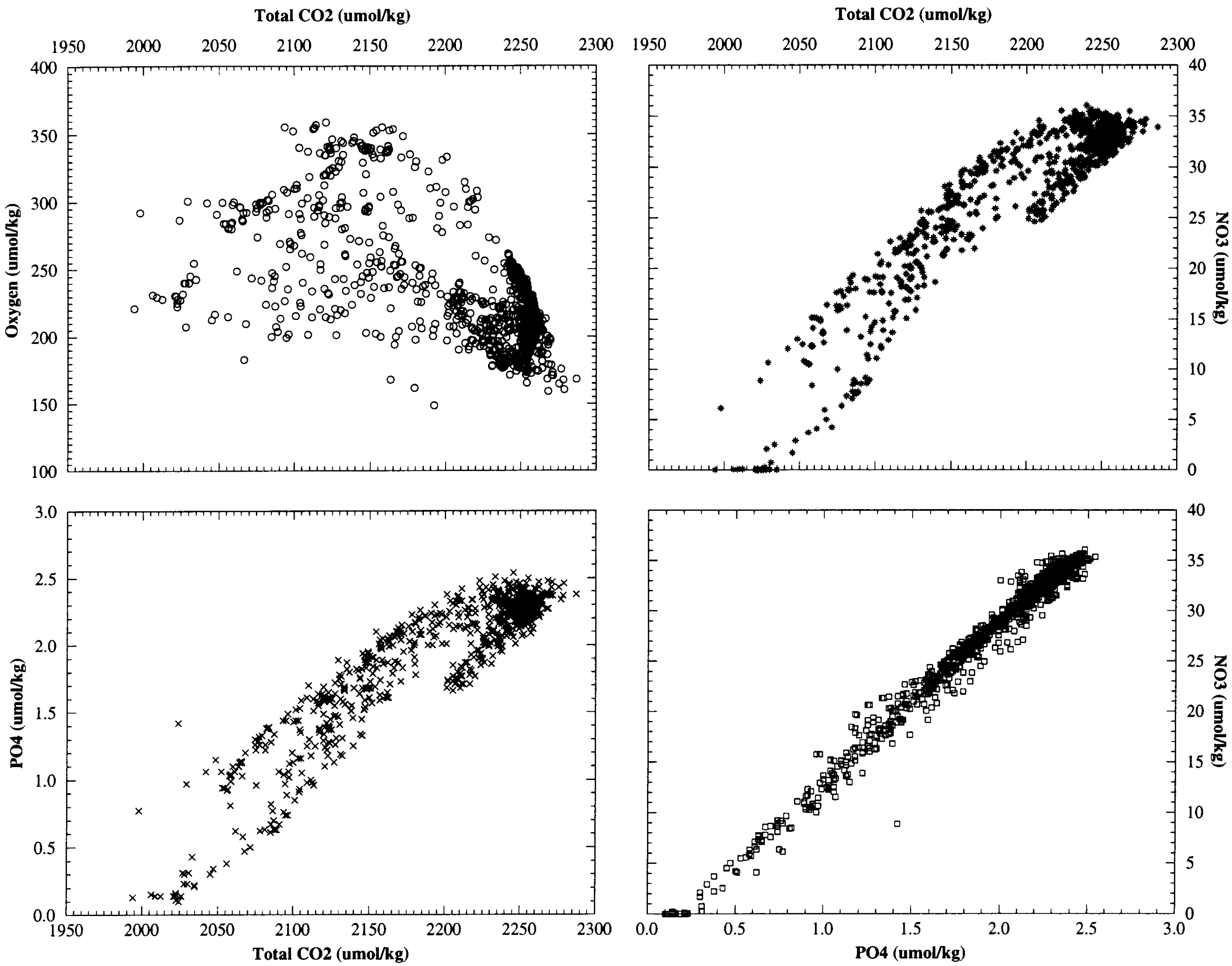


CO_2 Figure 4: Nested profiles: Total carbon (µmol/kg) vs pressure (dbar) for stations 102-141.

R/V METEOR Cruise 11/5. South Atlantic Ocean.
Only profiles which exist in this Pressure (dbar) range are plotted
Plotted parameter ranges from 1900 to 2300



CO_2 Figure 5: Nested profiles: Total carbon (µmol/kg) vs pressure (dbar) for stations 142-179.



CO_2 Figure 6: Property-property plots for all stations occupied during the R/V *Meteor* Cruise 11/5.

6. REFERENCES

Bryden, H. L. 1973. New polynomials for thermal expansion, adiabatic temperature gradient and potential temperature of seawater. Deep-Sea Research 20: 401-08.

*Chipman, D., T. Takahashi, D. Breger, S. Sutherland. 1992. Investigation of carbon dioxide in the South Atlantic and Northern Weddell Sea Areas (WOCE Sections A-12 and A-21) during the Meteor Expedition 11/5, January-March 1990. Lamont-Doherty Geological Observatory of Columbia University, Palisades, N.Y.

Clark, W. C. 1982. Carbon dioxide review. Clarendon Press and Oxford Press, Oxford, England, and New York.

Fofonoff, N. P. 1980. Computation of potential temperature of seawater for an arbitrary reference pressure. Deep-Sea Research 24: 489-91.

Johnson, K. M., A. E. King, and M. Sirburth. 1985. Coulometric TCO_2 analyses for marine studies: An introduction. Marine Chemistry 16: 61-82.

Kester, D. R. 1975. Dissolved gases other than CO_2. pp. 497-556. In 2nd Edition, J.P. Riley, G. Skirrow (eds.), Chemical Oceanography. Academic Press, London. Vol.1.

Millero, F. J., C.-T. Chen, A- Bradshaw and K. Schleicher. 1980. A new high-pressure equation of state for seawater. Deep-Sea Research 27: 225-64.

Roether, W., M. Sarnthein, T. J. Miffler, W. Nellen und D. Sahrhage. 1990. SUDATLANTICZIRCUMPOLARSTORM, Reise Nr. 11. 3 October 1989 - 11 Mdrz 1990. Meteor-Berichte, Universität Hamburg.

Sievers, H. A., and W. D. Nowlin. 1984. The stratification and water masses at Drake Passage. Journal of Geophysics Research 89: 10489-514.

Takahashi, T., D. Chipman, N. Schechtman, J. Goddard, and R. Wanninkof. 1982. Measurements of the partial pressure of CO_2 in discrete water samples during the North Atlantic Expedition, the Transient Tracers of Oceans Project. Technical Report to NSF. Lamont-Doherty Earth Observatory, Palisades, N.Y.

U.S. WOCE Implementation Plan. 1991. U.S. Implementation Report No. 1, U.S. WOCE Office, College Station, Tex.

Williams, P. J. 1990. Oceans carbon, and climate change. Scientific Committee on Oceanic Research (SCOR), Halifax, Canada.

CTD calibration report 06MT11_5
(Ronala G. Patrick/SIO-ODF)
28 DEC 1989 (submitted to WHPO 16 JUL 1993)

CALIBRATION SUMMARY

Parameters:	Pressure and Temperature
Instruments:	1 ea NBIS Mark III CTD
Identification:	AWI CTD serial serial # 01-1069
Dates of calibration:	1989 DEC 13-19
By:	R.T.Williams

Sequence of events of calibration:
13 Dec 89: Temperature calibration started.
Corrections were determined from -2.5 to 25.0°C.
14 Dec 89: (Continue temperature calibration)
14 Dec 89: 0-8830 psi (0-6080 dbars) pressure calib at -1.00°C
14 Dec 89: 0-1730 psi (0-1190 dbars) pressure calib at 5.00°C
15 Dec 89: (Continue temperature calibration)
19 Dec 89: (Continue temperature calibration)
19 Dec 89: Calibrations complete.

Calibrations carried out by: Robert T. Williams
Oceanographic Data Facility
Scripps Institution of Oceanography
U.C. San Diego, A-014
La Jolla, California 92093
(619) 534-4426

CTD TEMPERATURE CALIBRATION REPORT

Temperature transfer standard:
Rosemount standard platinum resistance thermometer Model 162CE, serial no. 2544.
Most recent triple point:
19 September 1989.

Resesistance Bridge:
NBIS ATB-1250

Constant Temperature Water Bath:
375 liters volume, stirred with industrial stirrer moving 1500 liters/min. Controlled by Tronac PTC-41 temperature controller using 2 cooled heater units and 1 auxiliary cooling coil. Standard deviation was 0.0003°C or better during calibration.
Gradients in bath interior:
approx. 0.001°C/meter. The CTD was completely immersed in the bath.

Procedure:
The CTD was suspended on rails in the center of the bath. The Standard PRT (SPRT) was located as close as possible (less than 2 cm) to the CTD temperature sensor. At each temperature, 30-70 SPRT readings were taken, each reading being compared to an average of 15 frames of CTD data with a standard deviation of .0002. The time spent taking readings after the bath stabilized at each temperature varied from a few minutes to over an hour.

13 DEC 89
01-1069 POST-OFFSET, PRE-METEOR
in tank at 5 degrees at 1220

Time (hhmm)	Strt Tmp (deg.C)	CTD tmp (deg.C)	Correction (deg.C)	#of values IN AVERAGE
1327	5.0018	7.9990	-2.9972	10
1329	5.0024	7.9996	-2.9972	10
1339	5.0025	7.9998	-2.9973	10
1344	5.0028	8.0001	-2.9973	10
1347	5.0025	7.9998	-2.9973	10
1349-1353 Go to 1 degree				
1414	1.0066	4.0000	-2.9934	10
1437	1.0052	3.9987	-2.9935	10
1551	1.0036	3.9970	-2.9934	10
1557	1.0034	3.9969	-2.9935	10

	Time (hhmm)	Strt Tmp (deg.C)	CTD tmp (deg.C)	Correction (deg.C)	#of values IN AVERAGE
Go to -1 degree					
	1623	-1.0040	1.9876	-2.9916	10
	1626	-1.0032	1.9883	-2.9915	10
	1632	-1.0030	1.9885	-2.9915	10
	1716	-1.0030	1.9883	-2.9913	10
	1753	-1.0035	1.9880	-2.9915	10
14 DEC 89					
	0957	-1.0037	1.9881	-2.9918	10
	1042	-1.0039	1.9878	-2.9917	10
Go to -2.5 degree					
	1149	-2.5015	0.4887	-2.9902	10
	1159	-2.5014	0.4888	-2.9902	10
	1221	-2.5018	0.4889	-2.9907	10
	1231	-2.5014	0.4889	-2.9903	10
Go to -2.0 degree					
	1252	-1.9988	0.9921	-2.9909	10
	1257	-1.9982	0.9926	-2.9908	10
	1308	-1.9986	0.9923	-2.9909	10
Go to -1.0 degree					
	1320	-0.9999	1.9917	-2.9916	10
	1323	-1.0008	1.9910	-2.9918	10
	1333	-1.0009	1.9906	-2.9915	10
DO 0-8830 psi pressure calib. at -1 degrees					
	1446	-1.0009	1.9906	-2.9915	10
1452-1500 Go to 3.0 degrees					
	1503	3.0016	5.9977	-2.9961	10
	1628	3.0046	6.0006	-2.9960	10
	1630	3.0046	6.0006	-2.9960	10
1631-1637 Go to 5 degrees					
	1638	4.9965	7.9941	-2.9976	10
	1644	4.9970	7.9947	-2.9977	10
	1659	4.9972	7.9950	-2.9978	10
Do 0-1730 psi pressure calib. at 5 degrees					
	1725	4.9969	7.9948	-2.9979	10

Time (hhmm)	Strt Tmp (deg.C)	CTD tmp (deg.C)	Correction (deg.C)	#of values IN AVERAGE
1726-1732 Go to 10 degrees				
1736	9.9977	12.9987	-3.0010	10
1806	9.9986	13.0001	-3.0015	10
1812	9.9985	13.0000	-3.0015	10
1815	9.9983	12.9999	-3.0016	10
Go to 15 degrees				
1825	15.0026	18.0066	-3.0040	10
1831	15.0041	18.0085	-3.0044	10
1834	15.0046	18.0089	-3.0043	10
1924	15.0044	18.0087	-3.0043	10
2015	15.0051	18.0092	-3.0041	10
15 DEC 89				
1908	15.0050	18.0094	-3.0044	10
1918	15.0048	18.0092	-3.0044	10
Go to 20 degrees				
1934	20.0011	23.0072	-3.0061	10
1935	20.0013	23.0076	-3.0063	10
1942	20.0019	23.0083	-3.0064	10
1950	20.0001	23.0065	-3.0064	10
2006	19.9999	23.0063	-3.0064	10
Go to 25 degrees				
2025	25.0020	28.0094	-3.0074	10
2027	25.0020	28.0094	-3.0074	10
2117	25.0027	28.0099	-3.0072	10
2208	25.0024	28.0094	-3.0070	10
2259	25.0023	28.0091	-3.0068	10
19 Dec 89				
1539	25.0031	28.0097	-3.0066	10
1541	25.0030	28.0096	-3.0066	10
1546-1548 Go to 14+ degrees				
1551	14.4393	17.4447	-3.0054	5
1552	14.4388	17.4441	-3.0053	6
1554	14.4393	17.4441	-3.0048	10
1603	14.4384	17.4425	-3.0041	10
1640	14.4382	17.4420	-3.0038	10
1654	14.4378	17.4417	-3.0039	10
1718	14.4382	17.4422	-3.0040	10

End of Calibration

Pressure transfer standard: Ruska Model 2400 Piston Gage
Piston gage serial number: HC-792
calib date: 10 Jan 1985
Weight set serial number: 34221
calib date: 10 Jan 1985
Pressure range: 30 to 12000 psi.
CTD calibration date: 14 Dec 1989
Barometer: 1012.2 mbars

CTD pressure transducer 17.8 cm below standard reference plane

Bath temperature for this calibration: 5.00°C

The CTD was connected to the Ruska pressure standard in a closed loop to apply desired pressures. Pressure was applied via calibrated plates of known mass starting with atmospheric pressure, going to the maximum pressure, then back to atmospheric pressure. The beginning and ending "zero" pressures were obtained by opening the system to the atmosphere, effectively applying only the barometric pressure and oil head pressure in the standard system to the CTD. At each pressure, a minimum of three readings were taken, with each reading compared to an average of 10 frames of data, providing the standard deviation within the 10 frames of data did not exceed 0.1 decibar. The effects of physical parameters such as barometric pressure and head pressure of the oil were calculated and used to derive the correction values.

Standard Pres. (calibrated dbars)	CTD Pres. (uncorrected dbars)	Correction Needed (dbars, at 5.00°C)
0.2	5.1	-4.9
20.8	25.6	-4.8
89.6	94.1	-4.5
158.5	162.7	-4.2
227.3	231.3	-4.0
296.2	300.0	-3.8
365.0	368.8	-3.8
502.6	506.5	-3.9
640.3	644.5	-4.2
709.2	713.4	-4.2
846.8	851.4	-4.6
1053.3	1058.3	-5.0
1191.0	1196.3	-5.3
1053.3	1059.3	-6.0
846.8	853.8	-7.0
709.2	716.3	-7.1
640.3	647.6	-7.3
502.6	5,09.8	-7.2

Standard Pres. (calibrated dbars)	CTD Pres. (uncorrected dbars)	Correction Needed (dbars, at 5.00°C)
365.0	372.0	-7.0
296.2	303.0	-6.8
227.3	233.8	-6.5
158.5	164.6	-6.1
89.6	95.4	-5.8
20.8	26.0	-5.2
0.2	5.4	-5.2

Pressure transfer standard: Ruska Model 2400 Piston Gage
Piston gage serial number: HC-792
calib date: 10 Jan 1985
Weight set serial number: 34221
calib date: 10 Jan 1985
Pressure range: 30 to 12000 psi.
CTD calibration date: 14 Dec 1989
Barometer: 1012.2 mbars

CTD pressure transducer 17.8 cm below standard reference plane

Bath temperature for this calibration: -1.00°C

Standard Pres. (calibrated dbars)	CTD Pres. (uncorrected dbars)	Correction Needed (dbars, at -1.00°C)
PRL		
0.2	5.1	-4.9
20.8	25.7	-4.9
158.5	162.8	-4.3
365.0	369.0	-4.0
709.2	713.8	-4.6
1053.3	1058.8	-5.5
1397.6	1403.4	-5.8
2086.0	2090.9	-4.9
2774.4	2777.6	-3.2
3463.0	3464.1	-1.1
4151.5	4151.0	0.5
4840.0	4838.6	1.4
5528.6	5526.9	1.7
6079.5	6078.8	0.7

Standard Pres. (calibrated dbars)	CTD Pres. (uncorrected dbars)	Correction Needed (dbars, at -1.00°C)
PRN		
5528.6	5527.0	1.6
4840.0	4838.5	1.5
4151.5	4151.0	0.5
3463.0	3464.4	-1.4
2774.4	2778.4	-4.0
2086.0	2092.8	-6.8
1397.6	1406.8	-9.2
1053.3	1063.1	-9.8
709.2	718.6	-9.4
365.0	373.1	-8.1
158.5	165.2	-6.7
20.8	26.4	-5.6
0.2	5.6	-5.4

APPENDIX H
PRESSURE AVERAGING

Pressure Averaging converts the raw time series instrument data from the CTD to a uniform pressure averaged series. Time lags between sensors are corrected before pressure averaging and the sensor calibrations are applied to convert the pressure averaged data to engineering units after pressure averaging. Any erroneous observations must be corrected using the manual editor before pressure averaging. The conversion of conductivity and temperature to engineering units and the computation of salinity according to the 1978 practical salinity scale is done on the pressure averaged data to reduce the number of calculations. Calculated data are stored in the output file in ASCII.

Sensor time lag corrections:
Because the output file is no longer a uniform time series, corrections for time lags between. sensors, particularly temperature and conductivity, must occur prior to carrying out the pressure averaging. The platinum temperature sensor has a time constant which has been observed to vary by a factor of three among sensors. The nominally mid-range time constant is .06 seconds. Note that some Mark III CTD's have summed platinum and thermistor temperature probes with a faster nominal thermal response but a more complex transfer function (reference 17). The flushing length of the 3 centimeter conductivity sensor depends on lowering rate but is short (Approximately .03 seconds at I meter/sec lowering rates) compared to the thermal response of the temperature probe. To slow the conductivity cell down to match the temperature probe, an exponential recursive filter is applied to the conductivity sensor to give the conductivity a response closely approximating the temperature sensor (see Millard 1982).

$C(t) = C(t\text{-}\delta t)*W_1\ Ci(t)*W_0$

where

$W_0 = e^{-\delta t/\tau}$

$W_1 = 1\text{-}W_0$

τ is the platinum thermometer time constant.
δt is the time between CTD observations.
The temperature probe time constant τ is stored in the instrument calibration file.

Pressure is treated similarly:

$P(t) = P(t\text{-}\delta t)*W_1\ \ Pi(t)*W_0$

Ci and Pi are the raw conductivity and pressure.
C and P is output lagged conductivity and pressure

Although the shift in amplitude and phase of pressure is small from filtering, the resultant pressure is smoother varying and better behaved for differentiating to compute the lowering rate to look for pressure reversals.

The pressure averaging to create a uniform pressure series is broken into two steps. First, the time average of pressure, temperature, conductivity, and other parameters is performed between the starting pressure P_0 and $P_0 +\ \delta P$. Depending on whether the instrument spends more or less time above the center pressure value P_0 + 1/2δ, the time averaged pressure will be less or greater than the center value. Secondly, a pressure interpolation is made to adjust the time weighted average of temperature, salinity, oxygen, etc. to the center pressure. The difference between mean pressure P and the center pressure of the interval P_0 + 1/2δP is used together with temperature and salinity gradient to adjust these properties to the center of the interval.

A detailed description of the pressure averaging method is now. presented. As described earlier, the sensor time lag corrections are applied to the data **prior** to the pressure averaging so the pressure P(t), and conductivity C(t) values employed are lag corrected.

δt is the CTD instrument sampling interval which can vary with instrument set up.
δt = .128 sec for a standard Mark III B.
δP is the pressure averaging interval and the output pressure sampling interval.

j^{th} refers to the j^{th} pressure interval
P_0 is the starting pressure of the interval.
m is the number of observations averaged in the pressure interval.

The time averaged pressure P(1/2mδt) is computed while pressure lies between $P_0 < P(t) < P_0 + \delta p$.

$$P(1/2 m\delta t) = \frac{1}{m\delta t} \sum_{0}^{m\delta t} P(t)\ \delta t = P_j$$

P(1/2 mδt) is the time averaged pressure position of the CTD sensors within the pressure interval $P_0 + 1/2\delta p$.

The lowering rate δP/δt must also be positive for data to be included in the above time average. This screens out data occurring during instrument reversals, when the CTD sensors are in the wake of the fish and lack of flushing of the conductivity cell make this measurement unreliable. Otherwise the previous value is substituted in order to preserve the time sequence.

When $\delta P(k)/\delta t < 0$ then:

$$P(k) = P(k-1)$$
$$T(k) = T(k-1)$$
$$C(k) = C(k-1)$$

The temperature and conductivity are averaged over the pressure interval (δP), also applying the lowering rate constraint. The temperature and conductivity averages are located at the time averaged instrument position. These averages are carried out on the raw uncalibrated observations, which are scaled to physical units after the average is formed but prior to the calculation of salinity. The output pressure averaged data file is stored in ASCII, in physical units of decibars, degrees celsius, and salinity on PPS78.

$$T_j = T(P_j) = \frac{1}{m\delta t} \sum_{P_0}^{P_0+\delta P} T(P(t))\ \delta t$$

$$C_j = C(P_j) = \frac{1}{m\delta t} \sum_{P_0}^{P_0+\delta P} C(P(t))\ \delta t$$

$\#_j = \#(P_j) = m$: number of observations in pressure bin δP.

The number of observations in each pressure average interval is carried along as a crude time base (mδt) and also to allow the lowering rate $\delta P/\delta t = \delta P/m\delta t$ to be calculated.

APPENDIX H (CON'T)

Before computing salinity the conductivity in engineering units is adjusted for conductivity cell distortions with temperature α and pressure β following Fofonoff, Hayes, and Millard *(1973).*

$$C_j = C_j\ (1+\alpha\{T_j - T_0) + \beta(P_j - P_0)\}$$

where α and β for a Mark III CTD alumina conductivity cell are stored in the calibration file together with T_0 and P_0.

α = -6.5 E-6
β = 1.5 E-8
T_0 = 24°C
P_0 = 0 dB

Salinity is computed from the time averaged values of pressure, temperature and conductivity before these observations are interpolated to the center pressure described next.

The temperature and conductivity averages T_j and C_j are located at the time averaged position within P_j, which is not necessarily the center of the pressure interval P_0+1/2δP and interpolation to the center pressure is performed to create a uniform pressure series. The gradients of temperature, salinity, and oxygen are estimated from neighboring pressure. intervals as follows.

For temperature:

$$T_j(P_0 + 1/2\delta P) = T(P_j)+[T(P_{j-1})-T(P_{j+1})](P_0+1/2\delta P-P_j)/(P_{j-1}-P_{j+1})$$

For salinity:

$$S_j(P_0+1/2\delta P) = S(P_j)+[S(P_{j-1})-S(P_{j+1})](P_0+1/2\delta P-P_j)/(P_{j-1}-P_{j+1})$$

The oxygen sensor requires lag correction as described by Owens & Millard (1985). This lag correction of the oxygen current is done after the pressure averaging using the time information stored in the number of observations $\#_j$ as follows.

Oc = oxygen current with lag correction.
Oc_j = measured oxygen current.
τ_0 = oxygen sensor lag approximately 5 - 8 seconds.
$Oc = Oc_j + \tau_0(\delta\ Oc/\delta t)$

where the derivative of oxygen current is estimated as follows:

$$\delta 0c/\delta t = [Oc_{j-1}-0c_{j+1}]/(1/2\{\#_{j-1}+\#_{j+1}\}+\#_j)$$

It should be noted that adding the derivative of oxygen current with τ_0 larger than unity causes resultant oxygen values to have a somewhat higher noise level. Lag corrected oxygen values are best smoothed over 10 to 15 decibars. This smoothing is currently not performed by the pressure averaging program.

Oxygen is computed from oxygen current as follows from Owens and Millard (1985).

$$Ox = Oc\ e^{\{tcor(Tj+W(Tj-otj)+pcor\ P\}}\ Oxsat\ (T,S)$$

where Oc has been converted to physical units and lagged corrected as described before and Oxsat(T,S) is the oxygen saturation value after Weiss (1973).

The coefficients tcor, pcor and W are membrane diffusion parameters which are stored along with τ_0 and other oxygen current bias and slope parameters in the calibration file. A fitting procedure for obtaining these oxygen parameters is discussed in Owens and Millard (1985). Typical values are:

Tcor = -.036
Pcor = .00015
W = .75
τ_0 = 5 seconds

June 4, 1988

How to handle gaps in pressure in the time series (.EDT) input data file.

A gap is NβP pressure intervals $P_0 + NP_0$ for which no input time series pressure values P(t) exist. Currently the program stops output pressure averaged data at a gap although it continues searching
the input data.

The logic of the pressure interpolation used to center up the time averaged pressure, temperature, conductivity etc. formed as described below can be extended to interpolate gaps in pressure as is shown under pressure centering logic on the next page.

The time averaged pressure P(1/2δt) is computed while pressure lies between
$P_0 < P(t) < P_0 + \beta P$

$$P(1/2m\delta t) = \frac{1}{m\delta t} \sum_{0}^{m\delta t} P(t)\ \delta t = P_j$$

$P(1/2m\delta t)$ is the time averaged pressure position of the CTD sensors within the pressure interval $P_0 + 1/2\delta P$.

The temperature and conductivity are averaged over the pressure interval (δP), also applying the lowering rate constraint. The temperature and conductivity averages are located at the time averaged instrument position. These averages are carried out on the raw uncalibrated observations, which are scaled to physical units after the average is formed but prior to the calculation of salinity. The output pressure averaged data file is stored in ASCII in physical units of decibars, degrees celsius, and salinity on PPS78.

$$T_j = T(P_j) = \frac{1}{m\delta t} \sum_{P_0}^{P_0+\delta P} T(P(t))\delta t$$

$$C_j = C(P_j) = \frac{1}{m\delta t} \sum_{P_0}^{P_0+\delta P} C(P(t))\delta t$$

$\#_j = \#(P_j) =$ m : number of observations in pressure bin δP.

Salinity is computed from the time averaged values of pressure, temperature and conductivity before these observations are interpolated to the center pressure described next.

PRESSURE CENTERING LOGIC WITH EXTENSION TO GAPS

The temperature and conductivity averages T_j and C_j are located at the time averaged position within P_j which is not necessarily the center of the pressure interval $P_0 + 1/2\delta P$, and interpolation to the center pressure is performed to create a uniform pressure series. The gradients of temperature an salinity, and oxygen are estimated from neighboring pressure intervals as follows.

Pressure centering logic:

For temperature:

$$T_j(P_0 + 1/2\delta P) = T(P_j)+[T(P_{j-1})-T(P_{j+1})](P_0+1/2\delta P-P_j)/(P_{j-1}-P_{j+1})$$

For salinity:

$$S_j(P_0 + 1/2\delta P) = S(P_j)+[S(P_{j-1})-S(P_{j+1})](P_0+1/2\delta P-P_j)/(P_{j-1}-P_{j+1})$$

EXTENSION TO HANDLE GAPS

The logic used to interpolate to the center of the pressure interval $P_0 + 1/2\delta P$ can be extended to include the interpolation over gaps in data as follows.

Suppose the pressure interval $P_{\mathbf{j}}$ has just been calculated together with $T_{\mathbf{j}}$, etc. A further test is inserted in the Basic code.in which the next input pressure value P(t) is compared with $P_0 + N\delta P$

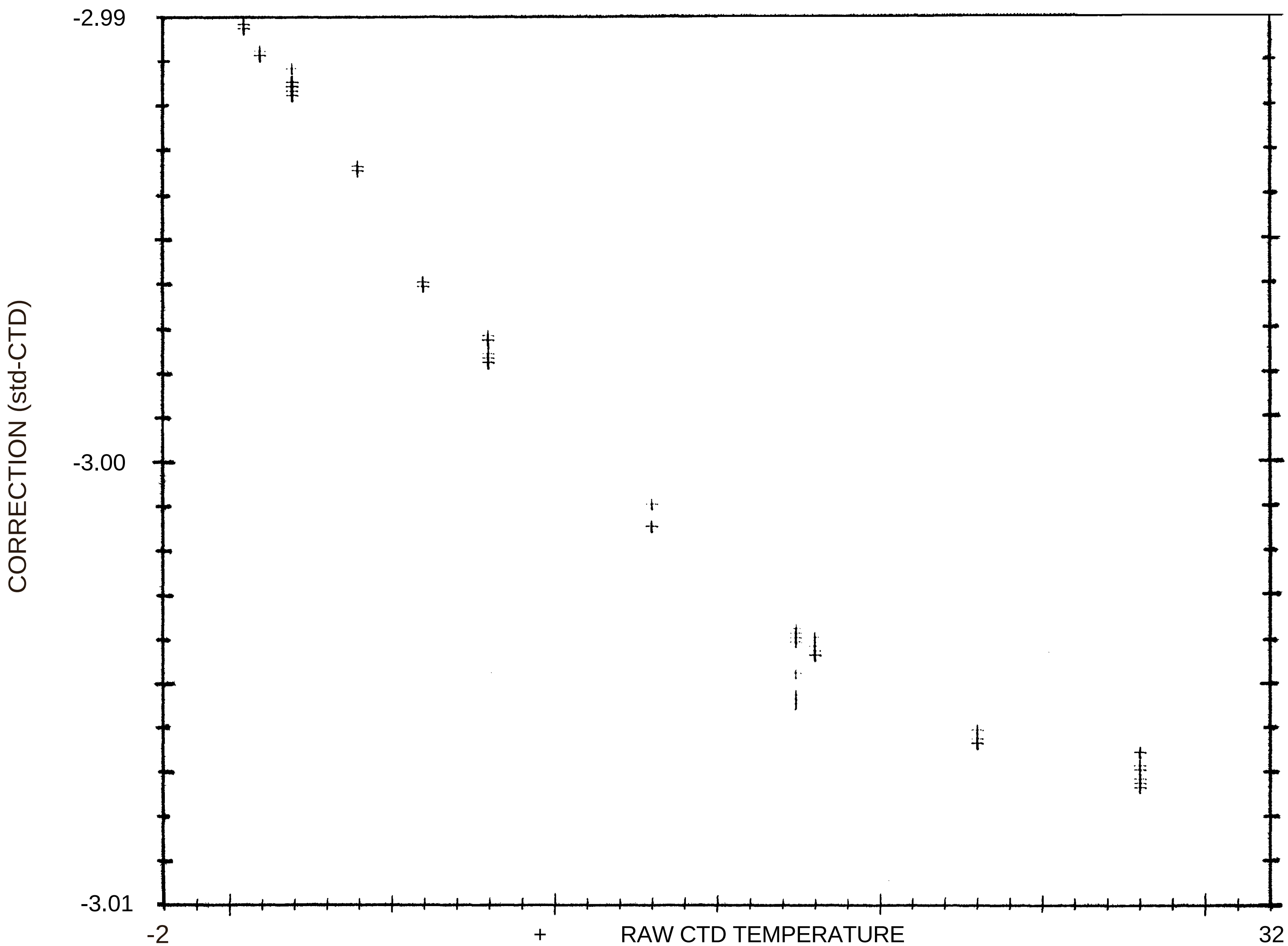
where N=1,2,3 …
If $P(t) > P_0 + N\delta P$ where N > 2 then increment N by 1 and retest until test is not true.

Next, form time averaged pressure, temperature, etc. for:
$P_{\mathbf{j}+n}$ $T_{\mathbf{j}+n}$ $C_{\mathbf{j}+n}$ and compute salinity.

Now we are ready to interpolate the last N missing pressure intervals for temperature, salinity, etc. using the pressure centering logic above.

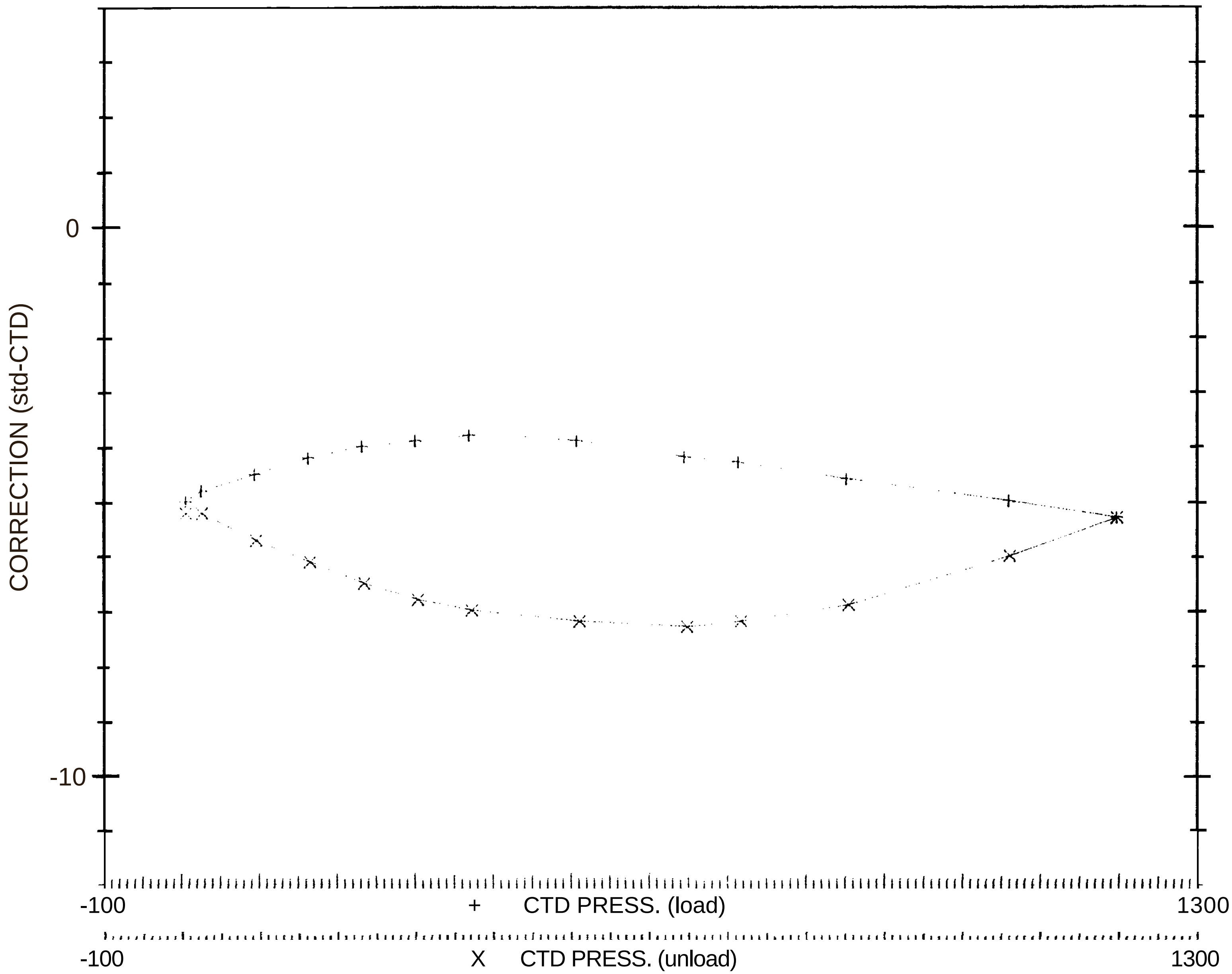
CDT CALIBRATION FIGURE

DEC-89 CTD-AWI-1069 T-sensor Temperature Calibration, after CTD PRT offset



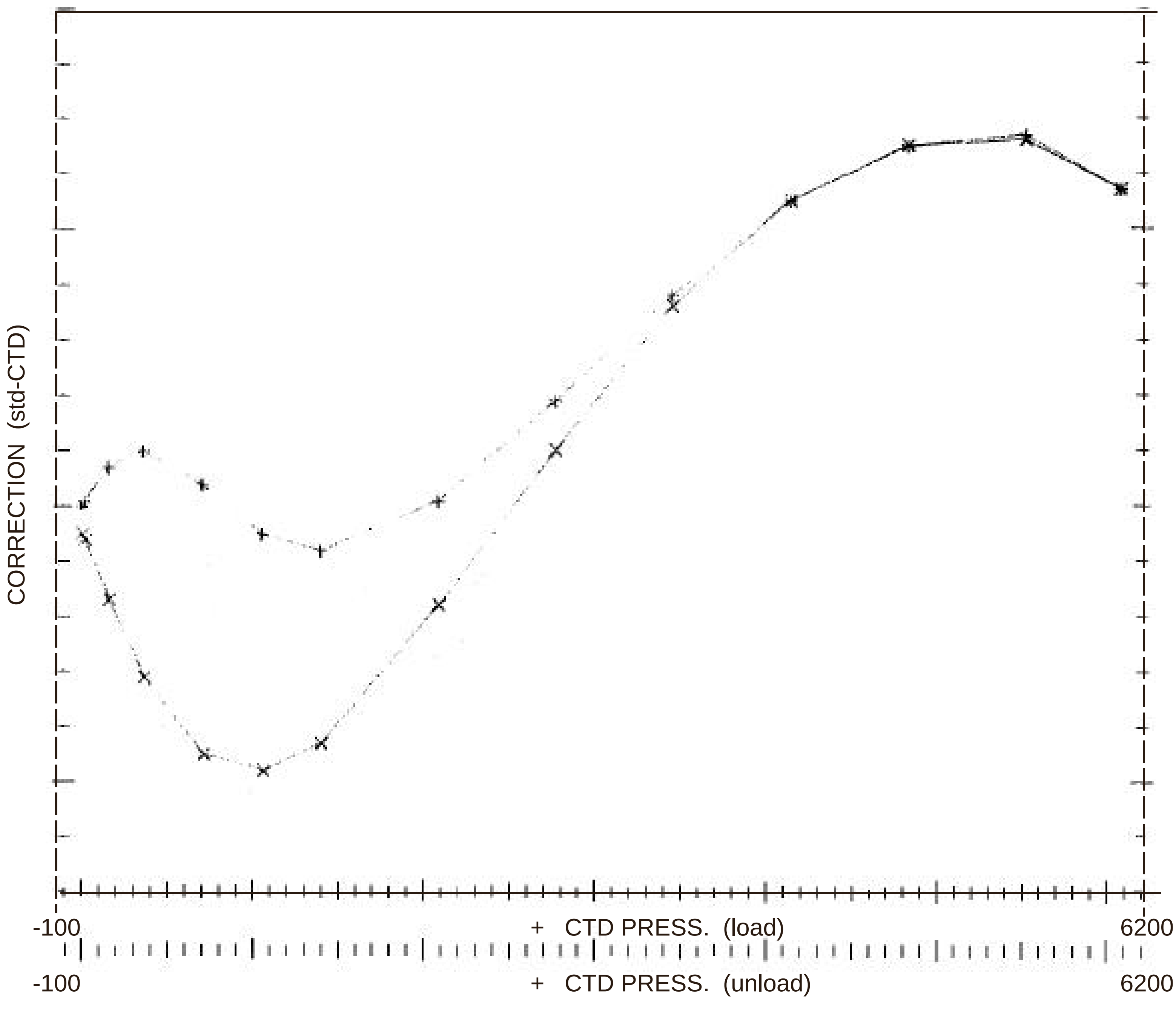
CDT CALIBRATION FIGURE

DEC-89 CTD-AWI-1069 0-1190 Pressure Calib. at 5.00 deg C, after CTD PRT offset at CTD PRT temperature ~ 7.99 °C



CDT CALIBRATION FIGURE

DEC-89 CTD-AWI-1069 0-6080 Pressure Calib. at -1.00 deg C, after CTD PRT offset
at CTD PRT temperature ~ + 1.99°C



CTD Data Quality Evaluation: Meteor 11/5
(Robert Millard)
May 6, 1993

Two data sources have been looked at in quality controlling the CTD data of this cruise. For the most part, I used the .HY2 combined water sample and CTD data file, and to a lesser degree the individual 2-decibar .WCT CTD data files. The cruise report has no information on laboratory and at sea calibrations performed on the CTD data set. Without this information there is no way to evaluate the quality of the CTD pressure and temperature. The method of matching the CTD to water sample data needs to be described. It would also be useful to have a reference on the data processing methodology (i.e. converting the time series CTD data to a uniform pressure series, edit procedures both data glitches and pressure reversals). No CTD oxygens were provided and therefore no assessment of CTD oxygens was performed.

The water sample data from the .HY2 file

The CTD and water sample salinity difference (CTD-WS) is calculated for all observation levels of the .HY2 file and they are plotted versus station in figure 1. Figure 1 shows several stations with salinity differences of .003-.004 psu (sta. 138, 149, & 154), These could be problems associated with water sample or CTD salinity, but no mention is made of this in the cruise report. A histogram of salinity differences is shown in figure 2 with a mean difference of -0.00027 psu and a standard deviation of .0038 psu. A plot of the salt differences versus pressure (figure 3) shows that the scatter decreases with depth, particularly below 800 decibars.

The least squares linear fit shows that mean difference is slightly greater than zero (~0.0005 psu) above 2000 dbars but approaches zero at the bottom. A plot of the salt differences below 2000 decibars (figure 4) shows the smaller scatter as does the histogram for P > 2000 dbars of figure 5. Again, several stations (sta. 138, 149, 154 and perhaps 103) show salinity differences as noted earlier. The standard deviation below 2000 dbars is reduced to .0021 psu and the mean salt difference is -0.00015 psu.

Generally the CTD salinity is very well matched to the bottle salinity and the deep water salinity difference scatter indicates high quality water sample salinity as well. Figure 6 is a potential temperature/salinity plot for pressures greater than 1700 dbars for stations 153, 154, & 155. The CTD salinity of station 154 seems anomalously low compared to both neighboring station data & water sample salts. The CTD conductivity (salinity) appears to be well matched to rosette water sample salinities for all but the few stations mentioned, and these could be water sample salt problems, except for station 154 which appears to have conductivity (salinity) miscalibrated.

The 2 decibar CTD profiles from the .WCT files

A mean profile was created on pressure surfaces for all stations and then individual profiles compared to the mean profile in order to identify questionable data values. The mean profile was formed from all cruise data and has a larger than normal standard deviation because the station data transects a strong frontal zone, as indicated in a plot of the potential temperature below 2000 dbars (figure 7), which shows stations 120 - 156: a group of somewhat colder stations.

Two edit criteria were used to flag questionable data:

1. Temperature and salinity variations whose difference from the mean profile exceeds 3.0 standard deviations (for all of the station data at that pressure level) or
2. density inversions where the stability parameter (E) exceeds -1.0 E-4 per meter.

Nearly all of the questionable data in the table below involve a few unstable regions that slightly exceed the E min = -1.0 E-04 edit criteria. A summary list of stations with questionable data follows below:

File name	Pmax	E_Tot	T_err	S_err	02_err	E_err	Sd fact	E Min
M101CO1.WCT;	60	4	0	4	0	0	3.00	-0.1000E-04
M102CO1.WCT;	92	0	0	0	0	0	3.00	-0.1000E-04
M103CO1.WCT;	3072	0	0	0	0	0	3.00	-0.1000E-04
M104CO1.WCT;	4442	0	0	0	0	0	3.00	-0.1000E-04
M104CO4.WCT;	4004	0	0	0	0	0	3.00	-0.1000E-04
M105CO1.WCT;	3786	0	0	0	0	0	3.00	-0.1000E-04
M106CO1.WCT;	3888	1	0	0	0	1	3.00	-0.1000E-04
M107CO2.WCT;	3858	0	0	0	0	0	3.00	-0.1000E-04
M108CO1.WCT;	3670	0	0	0	0	0	3.00	-0.1000E-04
M109CO1.WCT;	3742	0	0	0	0	0	3.00	-0.1000E-04
M110CO1.WCT;	3854	0	0	0	0	0	3.00	-0.1000E-04
M111CO1.WCT;	4028	1	0	0	0	1	3.00	-0.1000E-04
M112CO2.WCT;	3888	0	0	0	0	0	3.00	-0.1000E-04
M113CO1.WCT;	4020	0	0	0	0	0	3.00	-0.1000E-04
M114CO1.WCT;	3600	0	0	0	0	0	3.00	-0.1000E-04
M115CO1.WCT;	4118	1	0	0	0	1	3.00	-0.1000E-04
M116CO1.WCT;	4074	0	0	0	0	0	3.00	-0.1000E-04
M117CO1.WCT;	2056	0	0	0	0	0	3.00	-0.1000E-04
M119CO2.WCT;	3960	0	0	0	0	0	3.00	-0.1000E-04
M120CO1.WCT;	3650	0	0	0	0	0	3.00	-0.1000E-04
M121CO1.WCT;	2158	0	0	0	0	0	3.00	-0.1000E-04
M122CO1.WCT;	3926	1	0	0	0	1	3.00	-0.1000E-04
M123CO1.WCT;	3736	0	0	0	0	0	3.00	-0.1000E-04
M124CO2.WCT;	4174	1	0	0	0	1	3.00	-0.1000E-04
M12SCO1.WCT;	3048	0	0	0	0	0	3.00	-0.1000E-04
M126CO1.WCT;	3476	0	0	0	0	0	3.00	-0.1000E-04
M127CO1.WCT;	2724	1	0	0	0	1	3.00	-0.1000E-04
M128CO1.WCT;	3360	0	0	0	0	0	3.00	-0.1000E-04

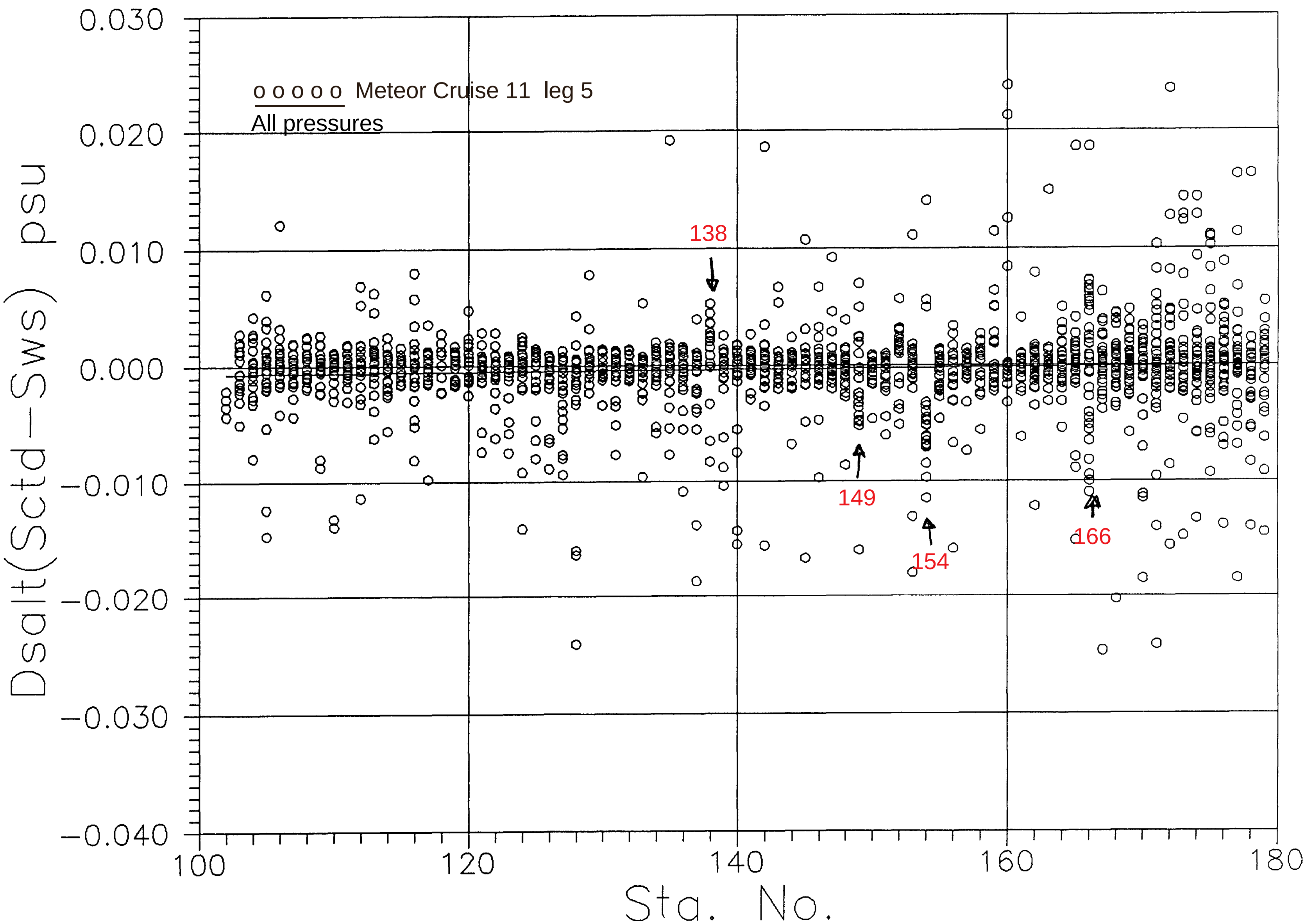
File name	Pmax	E_Tot	T_err	S_err	02_err	E_err	Sd fact	E Min
M129CO2.WCT;	4302	1	0	0	0	1	3.00	-0.1000E-04
M130CO1.WCT;	4478	0	0	0	0	0	3.00	-0.1000E-04
M131CO2.WCT;	5164	0	0	0	0	0	3.00	-0.1000E-04
M132CO1.WCT;	2496	0	0	0	0	0	3.00	-0.1000E-04
M133CO1.WCT;	3396	0	0	0	0	0	3.00	-0.1000E-04
M134CO2.WCT;	5494	0	0	0	0	0	3.00	-0.1000E-04
M135CO1.WCT;	5714	0	0	0	0	0	3.00	-0.1000E-04
M136CO1.WCT;	4832	0	0	0	0	0	3.00	-0.1000E-04
M137CO1.WCT;	4624	0	0	0	0	0	3.00	-0.1000E-04
M138CO1.WCT;	4966	0	0	0	0	0	3.00	-0.1000E-04
M139CO1.WCT;	4554	0	0	0	0	0	3.00	-0.1000E-04
M140CO1.WCT;	3244	0	0	0	0	0	3.00	-0.1000E-04
M141CO1.WCT;	4440	0	0	0	0	0	3.00	-0.1000E-04
M142CO1.WCT;	4284	0	0	0	0	0	3.00	-0.1000E-04
M143CO1.WCT;	4798	0	0	0	0	0	3.00	-0.1000E-04
M144CO1.WCT;	3964	0	0	0	0	0	3.00	-0.1000E-04
M145CO1.WCT;	3756	0	0	0	0	0	3.00	-0.1000E-04
M146CO1.WCT;	4200	0	0	0	0	0	3.00	-0.1000E-04
M147CO1.WCT;	4156	1	0	0	0	1	3.00	-0.1000E-04
M148CO1.WCT;	4464	1	0	0	0	1	3.00	-0.1000E-04
M149CO1.WCT;	4804	0	0	0	0	0	3.00	-0.1000E-04
M150CO1.WCT;	4208	0	0	0	0	0	3.00	-0.1000E-04
M151CO1.WCT;	3826	0	0	0	0	0	3.00	-0.1000E-04
M152CO1.WCT;	4216	0	0	0	0	0	3.00	-0.1000E-04
M153CO2.WCT;	4188	0	0	0	0	0	3.00	-0.1000E-04
M154CO1.WCT;	4528	0	0	0	0	0	3.00	-0.1000E-04
M156CO1.WCT;	2856	0	0	0	0	0	3.00	-0.1000E-04
M157CO1.WCT;	3086	0	0	0	0	0	3.00	-0.1000E-04
M158CO1.WCT;	3158	0	0	0	0	0	3.00	-0.1000E-04
M159CO1.WCT;	2882	0	0	0	0	0	3.00	-0.1000E-04
M160CO1.WCT;	3592	0	0	0	0	0	3.00	-0.1000E-04
M161CO1.WCT;	3026	0	0	0	0	0	3.00	-0.1000E-04
M162CO1.WCT;	794	0	0	0	0	0	3.00	-0.1000E-04
M162CO3.WCT;	4326	0	0	0	0	0	3.00	-0.1000E-04
M163CO1.WCT;	4100	0	0	0	0	0	3.00	-0.1000E-04
M164CO1.WCT;	4134	0	0	0	0	0	3.00	-0.1000E-04
M165CO2.WCT;	4430	0	0	0	0	0	3.00	-0.1000E-04
M166CO1.WCT;	1412	0	0	0	0	0	3.00	-0.1000E-04
M166CO3.WCT;	4616	0	0	0	0	0	3.00	-0.1000E-04
M167CO2.WCT;	4608	0	0	0	0	0	3.00	-0.1000E-04
M168CO2.WCT;	3848	0	0	0	0	0	3.00	-0.1000E-04
M169CO2.WCT;	4588	0	0	0	0	0	3.00	-0.1000E-04
M170C02.WCT;	4506	0	0	0	0	0	3.00	-0.1000E-04
M171CO2.WCT;	4810	0	0	0	0	0	3.00	-0.1000E-04
M172CO1.WCT;	1210	0	0	0	0	0	3.00	-0.1000E-04
M172CO3.WCT;	5150	0	0	0	0	0	3.00	-0.1000E-04
M173CO2.WCT;	4838	0	0	0	0	0	3.00	-0.1000E-04
M174CO2.WCT;	5144	0	0	0	0	0	3.00	-0.1000E-04

File name	Pmax	E_Tot	T_err	S_err	02_err	E_err	Sd fact	E Min
M175CO2.WCT;	5058	113	50	63	0	0	3.00	-0.1000E-04
M176CO2.WCT;	4914	505	480	234	0	0	3.00	-0.1000E-04
M177CO1.WCT;	706	1	0	0	0	1	3.00	-0.1000E-04
M177CO2.WCT;	4584	1	1	1	0	0	3.00	-0.1000E-04
M178CO1.WCT;	904	0	0	0	0	0	3.00	-0.1000E-04
M178CO2.WCT;	3926	60	0	60	0	0	3.00	-0.1000E-04
M179CO1.WCT;	1784	47	0	47	0	0	3.00	-0.1000E-04

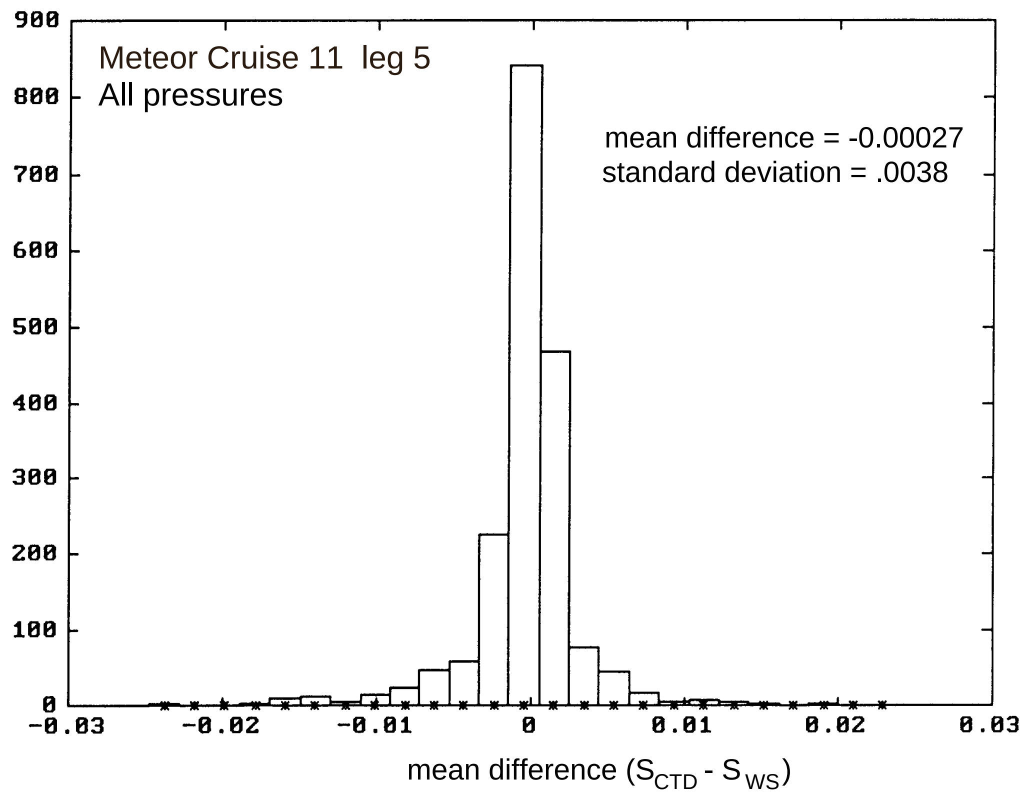
Only a few questionable data were located, and nearly all were in temperature and salinity and occurred at the extremes of the survey region (stations 1, 176, 176, 178 and 179), which contains a strong frontal zone at all depths. The flagged observations just exceed the 3 standard deviation edit criteria and most likely indicate the extreme variability of survey region (see figure 7) rather than questionable data.

Overall, the CTD data of Meteor cruise 11 leg 5, in both the water sample file and CTD data files, appear to be of good quality, both with respect to calibration of salinity and removal of erroneous data. A report addressing the laboratory calibration of pressure and temperature, together with a statement of the accuracy of these data, are necessary in order to complete the CTD data assessment.

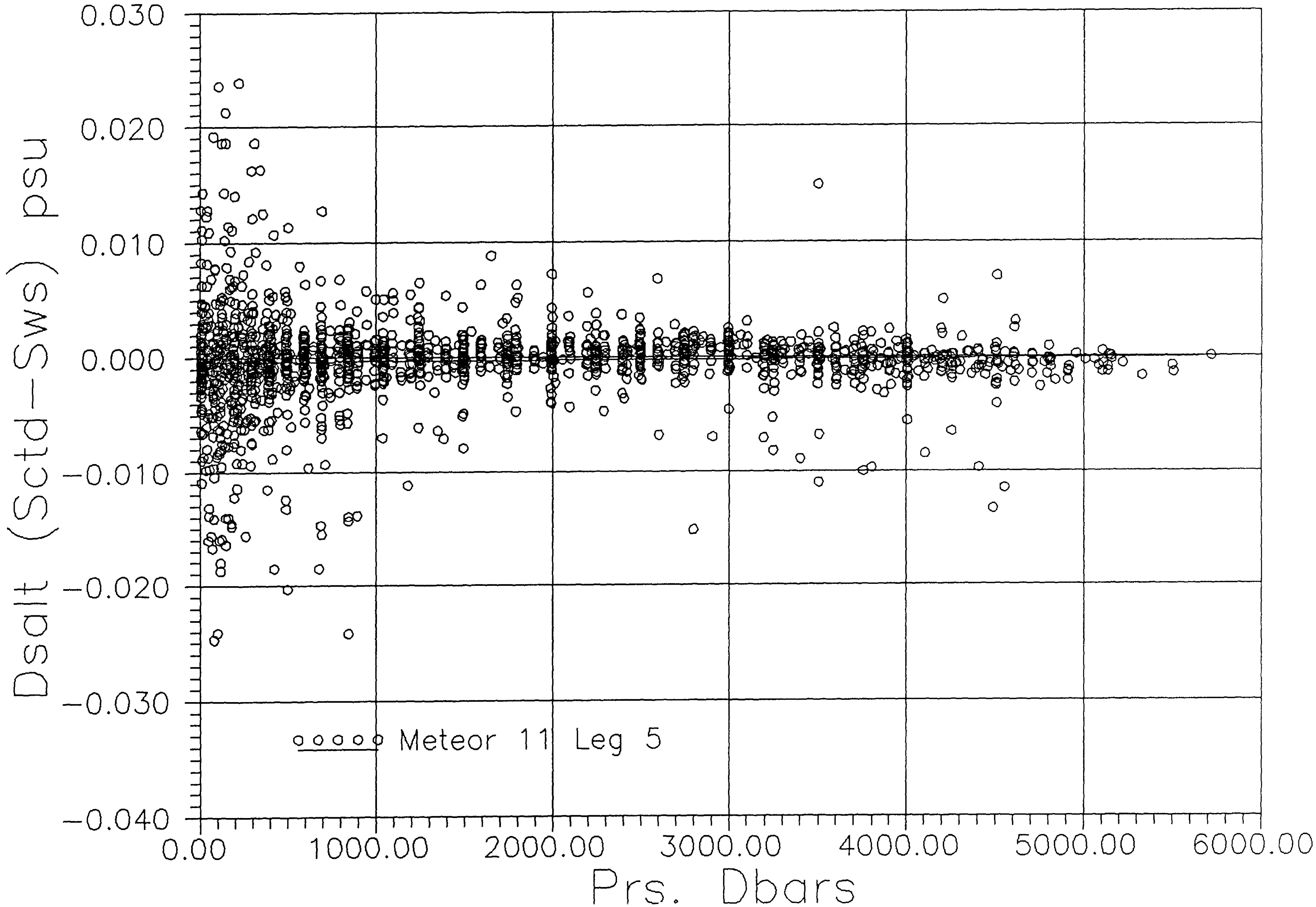
CTD DQE: Figure 1



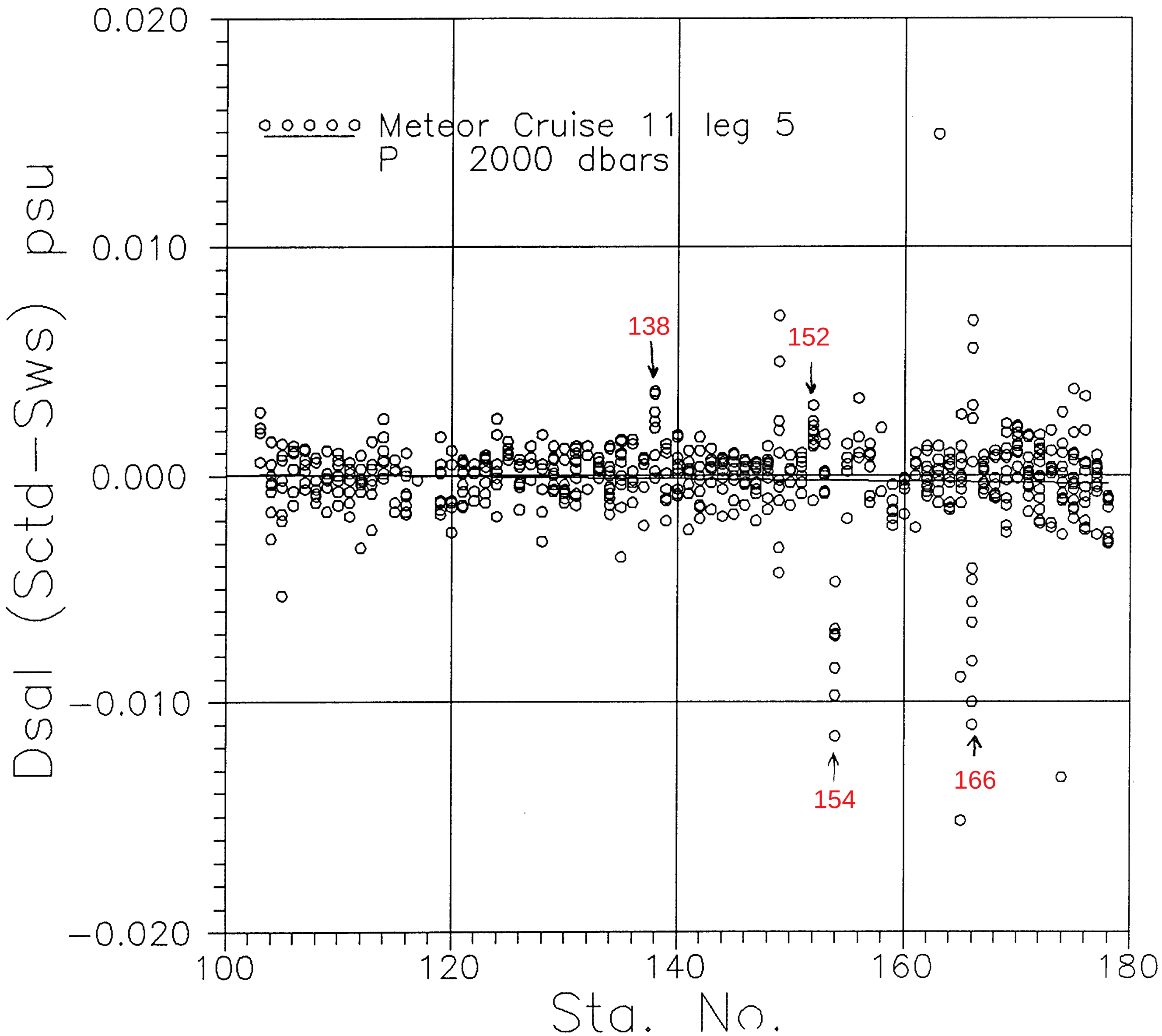
CTD DQE: Figure 2



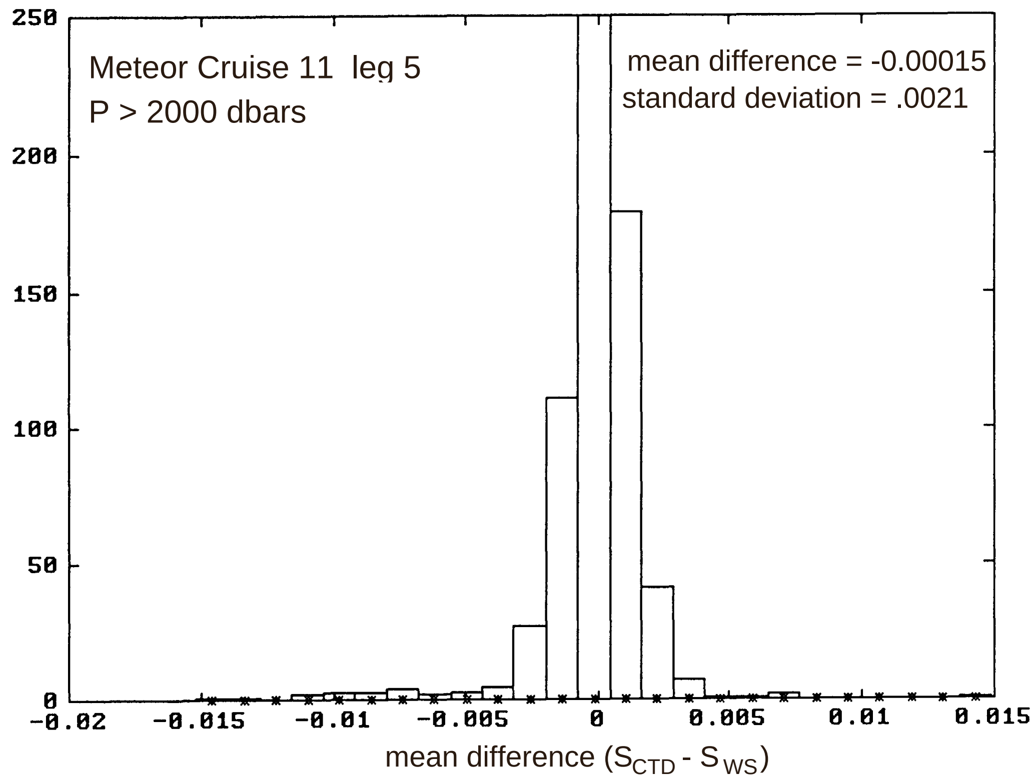
CTD DQE: Figure 3



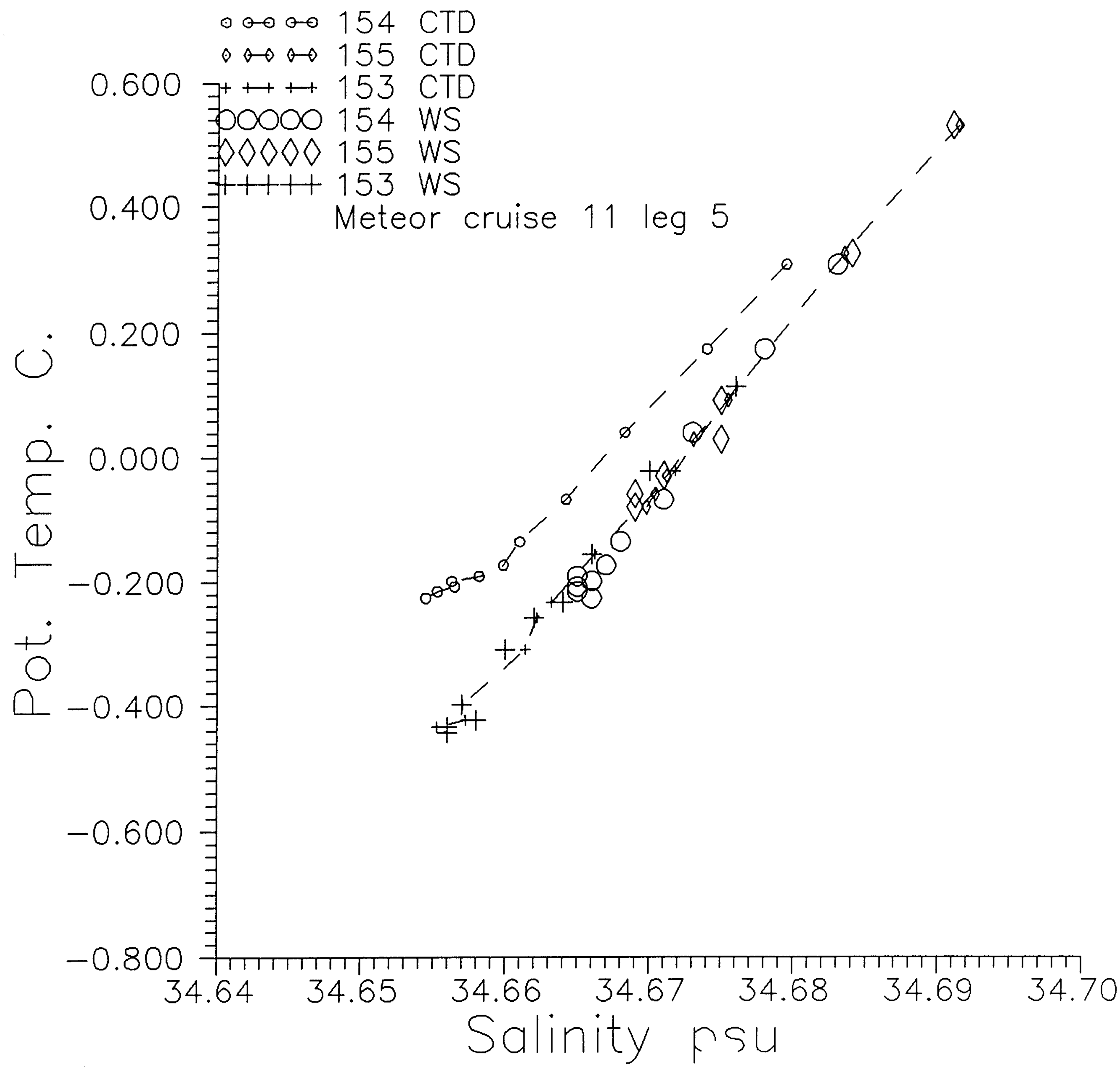
CTD DQE: Figure 4



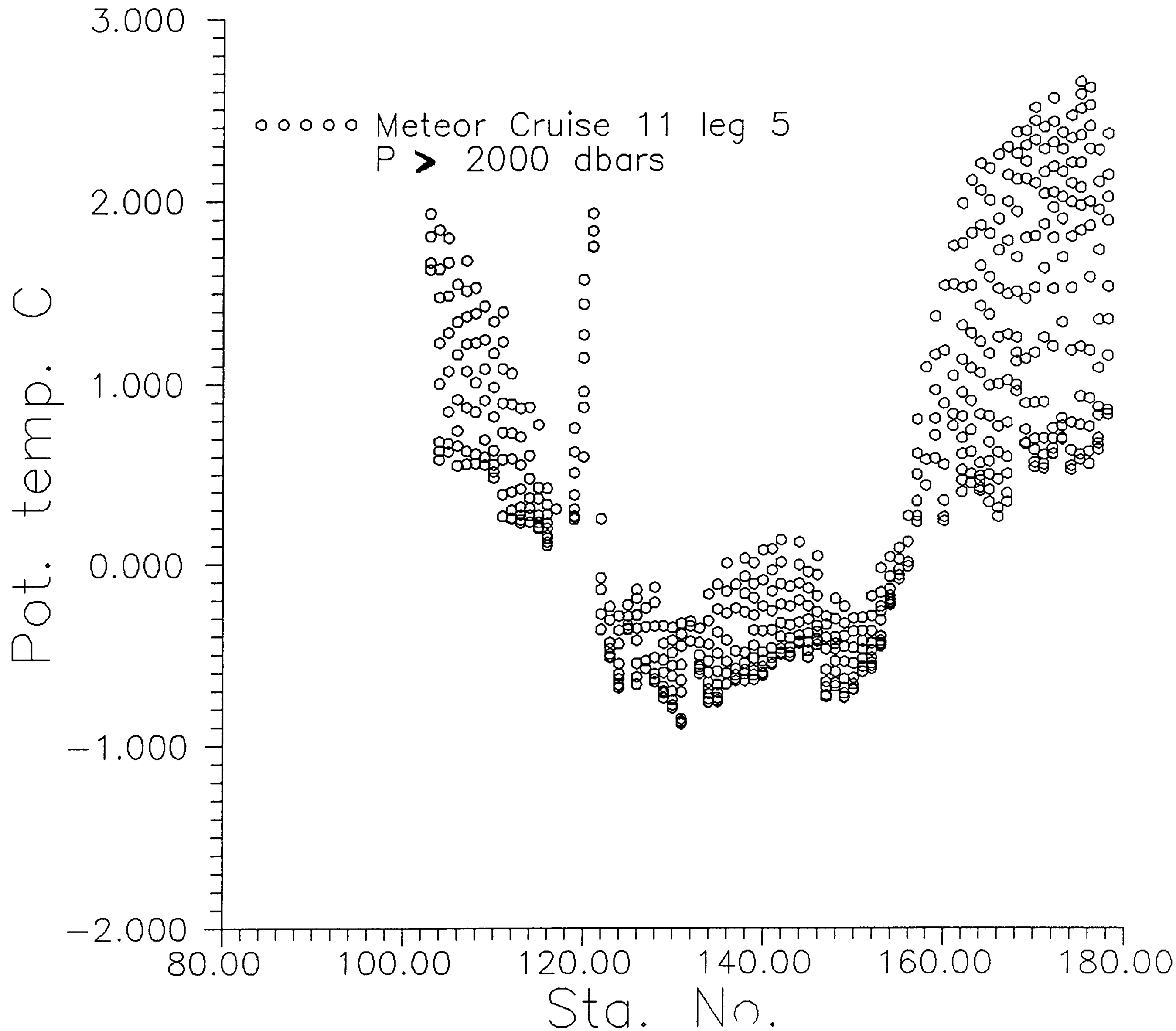
CTD DQE: Figure 5



CTD DQE: Figure 6



CTD DQE: Figure 7



Hydrographic Data Quality Evaluation
(Arnold Mantyla)
23 APR 1991

Meteor cruise 11/15 did not meet WOCE standards because of rather sparse sampling in the vertical; the majority of the stations had 23 or fewer discrete depth observations. Thirty-six bottles were tripped on the latter part of the cruise, but those stations did not sample 36 different depths because of duplicate sampling in the mixed layer and other wasted sampling at the same depths on both casts.

There were some obvious erroneous CTD pressure and temperature trip data assigned to the bottle data. Without access to a hard copy of the deck log with tabulations of intended sampling depths, that data could not be corrected. There is no quality code to indicate mis-assigned CTD information, so I've flagged all of the data for those depths as questionable. Actually, the water sample data is probably OK, we just don't know where they came from. The questionable stations are 166, 170, 174 and 178.

The nutrient data apparently had not been looked over very carefully. There were samples that were analyzed but not listed with the stations, chart read errors, key entry errors and calibration errors. Those have all been corrected by the Data Facility and the enclosed diskette now has the corrected data. The stations that have changed nutrients are: 108, 110, 111, 112, 114, 115, 132, 134, 139, 140, 141, 152, 153 and 174. The old AAII was showing its age with response shifts in the middle of a station set of samples, particularly for phosphate.

Silicate showed the typical sensitivity to ambient temperature change with standard solutions varying in response by about 5% per degree Celsius temperature change. The nitrate cadmium reduction columns had varying efficiency of several per cent during a station run, a rather common occurrence when immidazol is used as a buffer. All in all, the nutrient data are nowhere near the WOCE standards for precision and accuracy. They are however, comparable to historical nutrient data (GEOSECS and AJAX expeditions). The WOCE standards may be too optimistic.

Many oxygens were left out of station 162 because of a mix-up in oxygen flasks and stoppers. Mismatched stoppers cause a slight volume error with subsequent concentration errors. ODF can salvage that data by recalibrating those flasks with the flask/stopper combinations used on station 162. Since there are no other modern stations near station 162, the oxygen data should be recovered.

The salinity agreement with the processed CTD salinities were generally quite good, most +0.001 PSU. I noticed that in ODF's comments, the bottle salinometer salinities were changed by .005 "to agree with the CTD" on one station. That seems contrary to the WOCE goals of reporting all measured data, but I've let it pass without comment. If the correct trip levels are identified for sta. 166, 1 believe that the CTD salinities will need adjustment by about 0.005 lower. Should add to the permanent records for this cruise that SSW batch P111 was used for stations 102-129 and P112 for stations 130-179.

Salts were not run from every bottle tripped. They should be, because comparison of the bottle salinity with the CTD is the most sensitive verification of the rosette bottle performance. Many pycnocline salinities have been omitted by the data originators, apparently because of disagreement with the CTD. The original values should be retained with the appropriate quality flags. The fact that salinities are often deleted in high gradient regions is a clue that the console operators may have tripped the bottle too quickly, before the Niskin bottle had sufficient time to flush long enough to collect a sample representative of the depth. When that occurs, the salinity error is in the direction of salinities deeper in the water column, rather than in the direction expected from the rosette bottle placement above the CTD sensors. If that is the case, then all of the analyses are somewhat non-representative of the depth and the information is of importance to the user of the water sample data.

The CTD 02 data were either not taken or not processed. WOCE should encourage the reporting of CTD-02 data. Some questionable bottle oxygen data could have been resolved if the CTD-02 had been available.

Station 172, cast 3, bottle 6 had no water sample data, though an oxygen was listed there, but no 02 was listed for bottle 5. ODF believes, and I concur based on comparisons with adjacent stations, that the 02 belongs to bottle 5; so the 02 has been moved to bottle 5 from bottle 6.

Bottle 6 malfunctioned often on the cruise, resulting in data gaps. Such obviously bad samplers should be replaced early in the cruise so as to avoid loss of so much data.

I am also enclosing a copy of my handwritten point check notes. I have not put them on electronic media because I feel freer to make my comments more candid if they are not likely to be widely distributed.

My proximity to ODF, just across the street, made some of the original data sheets for the Meteor cruise accessible so that some of the problems uncovered in this DQE exercise could be corrected. Many of the problems that show up in final data evaluations are easily corrected if one has access to the original data and computations. Without access to the original data, about all a DQE can do is pass judgement on whether the data seems to be OK, or seems to be questionable. Getting feedback from data originators in remote locations is not working. I've given up on trying to get the CTD trip problems resolved from Germany, so I'm sending the Meteor data back to you with known problems unresolved (but flagged).

INPUT FILE: METEOR.AWM Mantyla THE DATE TODAY IS: 25-APR-91

STNNBR	CASTNO	SAMPNO	CTDPRS	SALNTY	OXYGEN	SILCAT	NITRAT	NITRIT	PHSPHT	QUALT1	QUALT2
				******	******	******	******	******	******		
102	1	5	36.5						1.42	~~~~~2	~~~~~3
105	1	3	3247.4	34.7230						2~~~~~	3~~~~~
105	1	1	3755.2		216.9					~2~~~~	~3~~~~
106	1	17	2250.7						2.36	~~~~~2	~~~~~3
106	1	18	2499.5						2.44	~~~~~2	~~~~~3
106	1	19	2749.4						2.43	~~~~~2	~~~~~3
106	1	20	2999.0						2.37	~~~~~2	~~~~~3
106	1	21	3249.6						2.40	~~~~~2	~~~~~3
106	1	22	3449.1						2.41	~~~~~2	~~~~~3
106	1	23	3882.8						2.38	~~~~~2	~~~~~3
109	1	14	691.4						2.24	~~~~~2	~~~~~3
109	1	13	842.9						2.35	~~~~~2	~~~~~3
109	1	12	1040.5						2.29	~~~~~2	~~~~~3
109	1	11	1240.9						2.21	~~~~~2	~~~~~3
109	1	10	1492.6						2.12	~~~~~2	~~~~~3
109	1	9	1741.3						2.14	~~~~~2	~~~~~3
109	1	8	1993.9						2.10	~~~~~2	~~~~~3
109	1	7	2245.5						2.23	~~~~~2	~~~~~3
109	1	6	2496.0						2.22	~~~~~2	~~~~~3
109	1	5	2746.4						2.17	~~~~~2	~~~~~3
109	1	4	2997.0						2.11	~~~~~2	~~~~~3
109	1	3	3198.7						2.06	~~~~~2	~~~~~3
109	1	2	3398.8						2.11	~~~~~2	~~~~~3
109	1	1	3734.5						2.00	~~~~~2	~~~~~3
110	1	14	843.4	34.5460						2~~~~~	3~~~~~
110	1	12	1242.5						2.36	~~~~~2	~~~~~3
110	1	11	1493.4						2.30	~~~~~2	~~~~~3
110	1	10	1743.1						2.27	~~~~~2	~~~~~3
113	1	14	1492.2		197.8					~2~~~~	~3~~~~
117	1	18	7.4		351.1					~2~~~~	~3~~~~
117	1	2	1947.2						2.38	~~~~~2	~~~~~3
121	1	1	2419.9		188.6					~2~~~~	~3~~~~

INPUT FILE: METEOR.AWM   Mantyla   THE DATE TODAY IS: 25-APR-91

STNNBR	CASTNO	SAMPNO	CTDPRS	SALNTY	OXYGEN	SILCAT	NITRAT	NITRIT	PHSPHT	QUALT1	QUALT2
123	1	9	2200.7		229.6					~2~~~~	~3~~~~
123	1	1	3704.8						2.39	~~~~~2	~~~~~3
128	1	7	2244.7	34.6660	227.9	125.88				222~~~	333~~~
133	1	16	489.9	34.6760						2~~~~~	3~~~~~
138	1	5	3798.6			155.51				~~2~~~	~~3~~~
141	1	6	3100.9		234.9					~2~~~~	~3~~~~
149	1	4	4208.2	34.6440						2~~~~~	3~~~~~
149	1	3	4510.8	34.6410						2~~~~~	3~~~~~
150	1	5	3298.0		251.0					~2~~~~	~3~~~~
151	1	6	2750.4		241.6					~2~~~~	~3~~~~
153	2	23	52.6	33.8400						2~~~~~	3~~~~~
156	1	21	9.7						1.83	~~~~~2	~~~~~3
156	1	20	37.0						1.85	~~~~~2	~~~~~3
156	1	19	75.7						1.86	~~~~~2	~~~~~3
156	1	18	124.7						2.11	~~~~~2	~~~~~3
156	1	17	194.8						2.42	~~~~~2	~~~~~3
156	1	15	344.4						2.42	~~~~~2	~~~~~3
156	1	14	413.2						2.34	~~~~~2	~~~~~3
156	1	13	491.5						2.36	~~~~~2	~~~~~3
156	1	12	591.4						2.29	~~~~~2	~~~~~3
156	1	11	692.2						2.19	~~~~~2	~~~~~3
156	1	10	841.2						2.11	~~~~~2	~~~~~3
156	1	9	1059.7						2.16	~~~~~2	~~~~~3
156	1	8	1241.2						2.26	~~~~~2	~~~~~3
156	1	7	1491.5						2.15	~~~~~2	~~~~~3
156	1	6	1744.9						2.11	~~~~~2	~~~~~3
156	1	5	1993.3						2.30	~~~~~2	~~~~~3
156	1	4	2245.1						2.28	~~~~~3	~~~~~2
156	1	3	2495.1						2.24	~~~~~2	~~~~~3
156	1	2	2747.6						2.40	~~~~~2	~~~~~3
156	1	1	2858.1						2.13	~~~~~2	~~~~~3
160	1	13	992.0		191.6					~2~~~~	~3~~~~
161	1	18	316.7	34.1210	270.9	21.81	28.36	0.04	1.98	222222	333333

INPUT FILE: METEOR.AWM   Mantyla   THE DATE TODAY IS: 25-APR-91

STNNBR	CASTNO	SAMPNO	CTDPRS	SALNTY	OXYGEN	SILCAT	NITRAT	NITRIT	PHSPHT	QUALT1	QUALT2
161	1	3	2700.8		203.9					~2~~~~	~3~~~
162	3	22	298.7	34.1050	275.0	18.31	28.13	0.05	1.94	222222	333333
163	1	4	3503.4	34.7090	205.7	96.49	30.94	0.00	2.14	222222	333333
164	2	21	196.5					0.02		~~~~2~	~~~~3~
164	2	20	196.7					0.01		~~~~2~	~~~~3~
164	2	19	398.3					0.02		~~~~2~	~~~~3~
164	2	17	398.4					0.03		~~~~2~	~~~~3~
164	2	15	795.8					0.02		~~~~2~	~~~~3~
164	2	13	1188.0					0.02		~~~~2~	~~~~3~
164	2	11	1599.1					0.02		~~~~2~	~~~~3~
164	2	9	2000.0					0.02		~~~~2~	~~~~3~
164	2	7	2398.0					0.01		~~~~2~	~~~~3~
164	2	5	2799.4					0.03		~~~~2~	~~~~3~
164	2	3	3197.8					0.02		~~~~2~	~~~~3~
164	2	1	3968.4					0.11		~~~~2~	~~~~3~
164	1	1	4123.8		218.4					~2~~~~	~3~~~
165	2	10	2802.1	34.7930	215.1	77.37	28.39	0.00	1.94	222222	333333
165	2	7	3402.3	34.7480	212.5	100.26	30.79	0.00	2.11	222222	333333
166	3	11	2599.0	34.7880	208.7	76.00	28.42	0.00	2.00	222222	333333
166	3	10	2799.3	34.7900	212.3	80.13	28.45	0.00	2.01	222222	333333
166	3	9	3000.2	34.7850	213.6	83.51	28.60	0.00	2.02	222222	333333
166	3	8	3251.6	34.7740	213.3	89.67	29.16	0.00	2.05	222222	333333
166	3	7	3506.1	34.7590	214.3	97.10	29.71	0.00	2.11	222222	333333
166	3	6	3754.5	34.7430	214.6	105.08	30.52	0.00	2.17	222222	333333
166	3	5	4004.5	34.7280	214.8	112.84	31.24	0.00	2.21	222222	333333
166	3	4	4254.8	34.7170	214.9	117.80	31.62	0.00	2.26	222222	333333
166	3	3	4508.1	34.7070	215.3	123.56	32.12	0.00	2.29	222222	333333
166	3	2	4612.8	34.6970	216.9	128.04	32.36	0.00	2.30	222222	333333
167	2	23	128.1						0.90	~~~~~2	~~~~~3
169	2	22	271.4		266.4					~2~~~~	~3~~~~
170	2	13	2052.5	34.7420	196.7	67.12	30.46	0.00	2.05	222222	333333
174	2	5	4489.1	34.7520	222.9	104.40	30.15	0.00	2.01	222222	333333
175	2	15	1796.7		202.5					~2~~~~	~3~~~
178	2	16	1116.9	34.5460	177.8	64.61	33.53	0.00	2.31	222222	333333

Nutrient and Dissolved Oxygen QC notes; METEOR 11/5
(J.C. Jennings)
July 12, 1991

The METEOR 11/5 nutrient and dissolved oxygen data appears overall to be of high quality with much of the variability in nutrient/theta and oxygen/theta relationships due to real oceanographic features encountered during the cruise. The cruise track crosses the Polar Frontal Zone in the Drake Passage enters the northwestern Weddell Gyre near the South Orkney Islands, then proceeds generally eastward to the Greenwich Meridian, thence northeast to Capetown. Because the fronts separating the Antarctic Circumpolar Current and Scotia Sea from the Weddell Gyre are not at fixed latitudes, sequential stations along the main easterly track exhibit considerable variability in the Warm Deep Water (WDW) and Antarctic Bottom Water (AABW) water masses which is probably real and caused by eddies and multiple frontal crossings. On the northeasterly track from the Greenwich Meridian to Capetown, the Polar and Subantarctic fronts are crossed. The transition region from the eastward flowing ACC into the Agulhas retroflection area near the end of the cruise track is marked by numerous shallow property extrema which have been deemed "acceptable" because they correlate with features present in theta/salinity plots.

In carrying out the QC checking of these data, I used several versions of the "WHPEDIT.EXE" and "Q2EDIT.EXE" programs. The final version with QUALT2 bytes changed was produced by the Q2EDIT.EXE program and "Q2CHANGE.EXE". Each station was compared in groups of 2-10 sequential stations for consistency in variable/theta and variable/pressure relationships. In many cases, nutrient/oxygen and nutrient/salinity relationships were also examined. Where data have been flagged as "questionable", the intent is to suggest that it be reexamined by the originator and used judiciously. This is often the case where a single station's values lie just outside of the "envelope" of values for a group of stations. For example, the deep phosphate at station 139 appeared high and was flagged as questionable as was the deep silicate at station 110. Some individual data points were clearly out of the expected range and will probably be rejected in the final data report. Examples are the low silicate at 3503db in station 163 and the unusually high silicate value at 3798.6db in station 138.

In editing the nitrite data, I relied primarily on nitrite vs. pressure plots. Most of the nitrite data appears to be excellent with only a few anomalous deep water values. While deep water nitrite concentrations are usually near zero, in my experience the random noise in the nitrite analysis is often 0.01-0.02 ~mole/kg, so I have deliberately not flagged deep water nitrite values of less than 0.03~M/kg as questionable.

The most difficult of the nutrients to evaluate was nitrate. The range of nitrate values at the same potential temperature was often 1.5 to 2.0 ~M/kg within a grouping of 4 to 10 stations. This is about twice as much variability as I have observed in recent Weddell Sea nitrate data. When comparing nitrate/theta relationships for stations from 122-140, there are split envelopes. These may arise from genuine variability of the kind observed by

Whitworth and Nowlin (1987) in the AJAX nitrate data, but I was unable to find covarying phosphate and oxygen relationships in these same stations. The variability in the AJAX data was largely restricted to the WDW, but in this METEOR data set, the split envelopes persist throughout the water column in some cases. Station 124 and 125 have higher nitrate values in the WDW that are found at station 123, but all are similar in the AABW and Weddell Sea Bottom Water. Stations 126 and 127 have lower nitrate values throughout the water column. The 130 series stations also separate into two distinct nitrate/theta envelopes, but the 140 series stations are more consistent and have a tighter envelope. I have not flagged all of these stations as questionable, but I would urge that the nitrate data be carefully compared with historic nitrate data from this area and that cruise logbooks be examined for any suggestions of analytical problems before interpreting this nitrate variability as oceanographically significant.

In the data for station 158, there are 11-911 values for theta for three of the deep water rosette bottles so these samples could not be compared in the variable/theta plots.

References:

Whitworth, T.,III, and W. D. Nowlin, Jr. Water Masses and Currents of the Southern Ocean at the Greenwich Meridian. JGR 92(C6) 6462-64760, 1987.

INPUT FILE: METEOR.LIG L Gordon/J Jennings   THE DATE TODAY IS: 16-JUL-91

STNNBR	CASTNO	SAMPNO	CTDPRS	OXYGEN	SILCAT	NITRAT	NITRIT	PHSPHT	QUALT1	QUALT2
				**********	*********	*********	********	**********		
102	1	2	92.2	291.0					2 ~ ~ ~ ~	3 ~ ~ ~
103	1	10	1801.0			35.48			~ ~ 2 ~ ~	~ ~ 3 ~ ~
104	1	20	292.7	284.3					2 ~ ~ ~ ~	3 ~ ~ ~ ~
104	1	19	391.8	296.6					2 ~ ~ ~ ~	3 ~ ~ ~ ~
104	1	11	1743.4	174.0					2 ~ ~ ~ ~	3 ~ ~ ~ ~
105	1	19	181.2	295.5					2 ~ ~ ~ ~	3 ~ ~ ~ ~
105	1	18	274.0	299.0					2 ~ ~ ~ ~	3 ~ ~ ~ ~
105	1	16	490.7	249.3					2 ~ ~ ~ ~	3 ~ ~ ~ ~
105	1	13	837.8					2.42	~ ~ ~ ~ 2	~ ~ ~ ~ 3
105	1	12	1039.4					2.51	~ ~ ~ ~ 2	~ ~ ~ ~ 3
105	1	11	1240.3					2.54	~ ~ ~ ~ 2	~ ~ ~ ~ 3
105	1	10	1501.3					2.50	~ ~ ~ ~ 2	~ ~ ~ ~ 3
105	1	9	1742.5					2.42	~ ~ ~ ~ 2	~ ~ ~ ~ 3
105	1	8	2015.7			34.36		2.47	~ ~ 2 ~ 2	~ ~ 3 ~ 3
105	1	7	2249.9					2.38	~ ~ ~ ~ 2	~ ~ ~ ~ 3
105	1	6	2497.1					2.47	~ ~ ~ ~ 2	~ ~ ~ ~ 3
105	1	5	2748.3					2.31	~ ~ ~ ~ 2	~ ~ ~ ~ 3
105	1	4	3002.2					2.31	~ ~ ~ ~ 2	~ ~ ~ ~ 3
105	1	3	3247.4					2.32	~ ~ ~ ~ 2	~ ~ ~ ~ 3
105	1	2	3500.2					2.37	~ ~ ~ ~ 2	~ ~ ~ ~ 3
105	1	1	3755.2	216.9				2.43	2 ~ ~ ~ 2	3 ~ ~ ~ 3
106	1	7	399.7	290.3					2 ~ ~ ~ ~	3 ~ ~ ~ ~
106	1	8	499.5	270.6			0.05		2 ~ ~ 2 ~	3 ~ ~ 3 ~
106	1	9	600.8	251.7					2 ~ ~ ~ ~	3 ~ ~ ~ ~
106	1	10	701.1					2.41	~ ~ ~ ~ 2	~ ~ ~ ~ 3
106	1	11	850.3					2.45	~ ~ ~ ~ 2	~ ~ ~ ~ 3
106	1	12	1049.7					2.45	~ ~ ~ ~ 2	~ ~ ~ ~ 3
106	1	13	1250.4					2.41	~ ~ ~ ~ 2	~ ~ ~ ~ 3
106	1	14	1499.8					2.43	~ ~ ~ ~ 2	~ ~ ~ ~ 3
106	1	15	1748.6					2.37	~ ~ ~ ~ 2	~ ~ ~ ~ 3
106	1	16	1999.9	189.7				2.31	2 ~ ~ ~ 2	3 ~ ~ ~ 3
106	1	17	2250.7	195.3				2.36	2 ~ ~ ~ 2	3 ~ ~ ~ 3
106	1	18	2499.5					2.44	~ ~ ~ ~ 2	~ ~ ~ ~ 3
106	1	19	2749.4	201.5				2.43	2 ~ ~ ~ 2	3 ~ ~ ~ 3

INPUT FILE: METEOR.LIG L Gordon/J Jennings THE DATE TODAY IS: 16-JUL-91

STNNBR	CASTNO	SAMPNO	CTDPRS	OXYGEN	SILCAT	NITRAT	NITRIT	PHSPHT	QUALT1	QUALT2
				**********	*********	*********	********	**********		
106	1	20	2999.0	205.2				2.37	2 ~ ~ ~ 2	3 ~ ~ ~ 3
106	1	21	3249.6	208.5				2.40	2 ~ ~ ~ 2	3 ~ ~ ~ 3
106	1	22	3449.1					2.41	~ ~ ~ ~ 2	~ ~ ~ ~ 3
106	1	23	3882.8					2.38	~ ~ ~ ~ 2	~ ~ ~ ~ 3
107	2	7	2258.8			32.16			~ ~ 2 ~ ~	~ ~ 3 ~ ~
107	2	6	2502.8			31.96			~ ~ 2 ~ ~	~ ~ 3 ~ ~
107	2	5	2750.5			31.86		2.17	~ ~ 2 ~ 2	~ ~ 3 ~ 3
107	2	4	2999.3			31.86			~ ~ 2 ~ ~	~ ~ 3 ~ ~
107	2	3	3300.2			32.06			~ ~ 2 ~ ~	~ ~ 3 ~ ~
107	2	2	3599.6			32.16			~ ~ 2 ~ ~	~ ~ 3 ~ ~
107	2	1	3855.2			32.35			~ ~ 2 ~ ~	~ ~ 3 ~ ~
108	1	9	1744.2			32.06			~ ~ 2 ~ ~	~ ~ 3 ~ ~
108	1	8	1994.4			32.13			~ ~ 2 ~ ~	~ ~ 3 ~ ~
108	1	6	2497.2			32.59			~ ~ 2 ~ ~	~ ~ 3 ~ ~
108	1	5	2745.6			31.96			~ ~ 2 ~ ~	~ ~ 3 ~ ~
108	1	4	2998.4			32.24			~ ~ 2 ~ ~	~ ~ 3 ~ ~
108	1	3	3248.1			32.39			~ ~ 2 ~ ~	~ ~ 3 ~ ~
109	1	11	1240.9					2.21	~ ~ ~ ~ 2	~ ~ ~ ~ 3
109	1	10	1492.6					2.12	~ ~ ~ ~ 2	~ ~ ~ ~ 3
109	1	9	1741.3					2.14	~ ~ ~ ~ 2	~ ~ ~ ~ 3
109	1	8	1993.9					2.10	~ ~ ~ ~ 2	~ ~ ~ ~ 3
109	1	5	2746.4					2.17	~ ~ ~ ~ 2	~ ~ ~ ~ 3
109	1	4	2997.0					2.11	~ ~ ~ ~ 2	~ ~ ~ ~ 3
109	1	3	3198.7					2.06	~ ~ ~ ~ 2	~ ~ ~ ~ 3
109	1	2	3398.8					2.11	~ ~ ~ ~ 2	~ ~ ~ ~ 3
109	1	1	3734.5					2.00	~ ~ ~ ~ 2	~ ~ ~ ~ 3
110	1	19	355.9	288.0					2 ~ ~ ~ ~	3 ~ ~ ~ ~
110	1	18	414.6	288.3			0.04		2 ~ ~ 2 ~	3 ~ ~ 3 ~
110	1	15	693.7		74.69				~ 2 ~ ~ ~	~ 3 ~ ~ ~
110	1	14	843.4		83.34				~ 2 ~ ~ ~	~ 3 ~ ~ ~
110	1	13	1042.8		91.21				~ 2 ~ ~ ~	~ 3 ~ ~ ~
110	1	12	1242.5		95.30			2.36	~ 2 ~ ~ 2	~ 3 ~ ~ 3
110	1	11	1493.4		97.34				~ 2 ~ ~ ~	~ 3 ~ ~ ~
110	1	10	1743.1		102.00				~ 2 ~ ~ ~	~ 3 ~ ~ ~

INPUT FILE: METEOR.LIG L Gordon/J Jennings   THE DATE TODAY IS: 16-JUL-91

STNNBR	CASTNO	SAMPNO	CTDPRS	OXYGEN	SILCAT	NITRAT	NITRIT	PHSPHT	QUALT1	QUALT2
				**********	*********	*********	********	**********		
110	1	9	1994.5		108.90			2.16	~ 2 ~ ~ 2	~ 3 ~ ~ 3
110	1	8	2245.2		111.78			2.17	~ 2 ~ ~ 2	~ 3 ~ ~ 3
110	1	7	2497.0		116.58			2.18	~ 2 ~ ~ 2	~ 3 ~ ~ 3
110	1	6	2746.4		121.32				~ 2 ~ ~ ~	~ 3 ~ ~ ~
110	1	5	2997.9		125.02				~ 2 ~ ~ ~	~ 3 ~ ~ ~
110	1	4	3249.6		129.97				~ 2 ~ ~ ~	~ 3 ~ ~ ~
110	1	3	3494.2		132.29				~ 2 ~ ~ ~	~ 3 ~ ~ ~
113	1	14	1492.2	197.8					2 ~ ~ ~ ~	3 ~ ~ ~ ~
115	1	2	3905.3		139.84				~ 2 ~ ~ ~	~ 3 ~ ~ ~
115	1	1	4107.3		141.37				~ 2 ~ ~ ~	~ 3 ~ ~ ~
117	1	3	1742.3					2.28	~ ~ ~ ~ 2	~ ~ ~ ~ 3
117	1	2	1947.2					2.38	~ ~ ~ ~ 2	~ ~ ~ ~ 3
119	2	5	2997.8		132.29				~ 2 ~ ~ ~	~ 3 ~ ~ ~
119	2	4	3197.3		134.42				~ 2 ~ ~ ~	~ 3 ~ ~ ~
119	2	3	3400.8		136.56				~ 2 ~ ~ ~	~ 3 ~ ~ ~
119	2	2	3500.1		136.38				~ 2 ~ ~ ~	~ 3 ~ ~ ~
119	2	1	3601.9		136.97				~ 2 ~ ~ ~	~ 3 ~ ~ ~
122	1	21	196.5			34.56			~ ~ 2 ~ ~	~ ~ 3 ~ ~
122	1	20	276.1	249.8		34.18	0.25		2 ~ 22 ~	3 ~ 33 ~
122	1	12	1242.8			32.75			~ ~ 2 ~ ~	~ ~ 3 ~ ~
123	1	6	2781.9					2.30	~ ~ ~ ~ 2	~ ~ ~ ~ 3
123	1	1	3704.8					2.39	~ ~ ~ ~ 2	~ ~ ~ ~ 3
124	2	17	595.4			35.09			~ ~ 2 ~ ~	~ ~ 3 ~ ~
124	2	9	2244.5					2.26	~ ~ ~ ~ 2	~ ~ ~ ~ 3
124	2	5	3247.1					2.23	~ ~ ~ ~ 2	~ ~ ~ ~ 3
124	2	4	3501.1					2.22	~ ~ ~ ~ 2	~ ~ ~ ~ 3
124	2	3	3798.2					2.23	~ ~ ~ ~ 2	~ ~ ~ ~ 3
124	2	2	4101.0					2.24	~ ~ ~ ~ 2	~ ~ ~ ~ 3
124	2	1	4166.4					2.24	~ ~ ~ ~ 2	~ ~ ~ ~ 3
125	1	14	689.8			34.21			~ ~ 2 ~ ~	~ ~ 3 ~ ~
125	1	13	841.8			34.60			~ ~ 2 ~ ~	~ ~ 3 ~ ~
125	1	5	2224.2					2.28	~ ~ ~ ~ 2	~ ~ ~ ~ 3
125	1	4	2495.8					2.31	~ ~ ~ ~ 2	~ ~ ~ ~ 3
126	1	1	3455.9					2.29	~ ~ ~ ~ 2	~ ~ ~ ~ 3

INPUT FILE: METEOR.LIG L Gordon/J Jennings   THE DATE TODAY IS: 16-JUL-91

STNNBR	CASTNO	SAMPNO	CTDPRS	OXYGEN	SILCAT	NITRAT	NITRIT	PHSPHT	QUALT1	QUALT2
				**********	*********	*********	********	**********		
127	1	15	362.1		104.88				~ 2 ~ ~ ~	~ 3 ~ ~ ~
127	1	3	2447.5					2.25	~ ~ ~ ~ 2	~ ~ ~ ~ 3
127	1	2	2647.8					2.24	~ ~ ~ ~ 2	~ ~ ~ ~ 3
127	1	1	2718.1					2.24	~ ~ ~ ~ 2	~ ~ ~ ~ 3
128	1	8	1996.7		120.74				~ 2 ~ ~ ~	~ 3 ~ ~ ~
130	1	13	1501.1		129.06				~ 2 ~ ~ ~	~ 3 ~ ~ ~
131	2	21	242.3					2.38	~ ~ ~ ~ 2	~ ~ ~ ~ 3
131	2	20	357.1					2.38	~ ~ ~ ~ 2	~ ~ ~ ~ 3
131	2	19	491.4					2.39	~ ~ ~ ~ 2	~ ~ ~ ~ 3
131	2	18	591.5					2.38	~ ~ ~ ~ 2	~ ~ ~ ~ 3
131	2	17	740.2					2.38	~ ~ ~ ~ 2	~ ~ ~ ~ 3
131	2	11	2497.0		132.25				~ 2 ~ ~ ~	~ 3 ~ ~ ~
132	1	1	2483.8	234.6				2.38	2 ~ ~ ~ 2	3 ~ ~ ~ 3
134	2	10	2998.0					2.32	~ ~ ~ ~ 2	~ ~ ~ ~ 3
134	2	6	4200.7					2.28	~ ~ ~ ~ 2	~ ~ ~ ~ 3
134	2	5	4500.6					2.30	~ ~ ~ ~ 2	~ ~ ~ ~ 3
134	2	4	4810.6					2.30	~ ~ ~ ~ 2	~ ~ ~ ~ 3
134	2	3	5102.0					2.29	~ ~ ~ ~ 2	~ ~ ~ ~ 3
134	2	2	5327.3					2.30	~ ~ ~ ~ 2	~ ~ ~ ~ 3
134	2	1	5496.7					2.30	~ ~ ~ ~ 2	~ ~ ~ ~ 3
135	1	12	1743.4	212.5					2 ~ ~ ~ ~	3 ~ ~ ~ ~
135	1	11	1993.0	216.6					2 ~ ~ ~ ~	3 ~ ~ ~ ~
135	1	10	2405.9	218.4					2 ~ ~ ~ ~	3 ~ ~ ~ ~
135	1	9	2811.7	237.4	127.55				22 ~ ~ ~	33 ~ ~ ~
136	1	6	3201.4			33.02			~ ~ 2 ~ ~	~ ~ 3 ~ ~
138	1	15	839.9		114.16		0.03		~ 2 ~ 2 ~	~ 3 ~ 3 ~
138	1	5	3798.6		155.51				~ 2 ~ ~ ~	~ 3 ~ ~ ~
139	1	24	10.7					1.37	~ ~ ~ ~ 2	~ ~ ~ ~ 3
139	1	23	81.9					1.83	~ ~ ~ ~ 2	~ ~ ~ ~ 3
139	1	21	235.8					2.36	~ ~ ~ ~ 2	~ ~ ~ ~ 3
139	1	20	317.7					2.36	~ ~ ~ ~ 2	~ ~ ~ ~ 3
139	1	19	414.8					2.33	~ ~ ~ ~ 2	~ ~ ~ ~ 3
139	1	18	494.3					2.33	~ ~ ~ ~ 2	~ ~ ~ ~ 3
139	1	17	596.9					2.32	~ ~ ~ ~ 2	~ ~ ~ ~ 3

INPUT FILE: METEOR.LIG L Gordon/J Jennings THE DATE TODAY IS: 16-JUL-91

STNNBR	CASTNO	SAMPNO	CTDPRS	OXYGEN	SILCAT	NITRAT	NITRIT	PHSPHT	QUALT1	QUALT2
				**********	*********	*********	********	**********		
139	1	16	696.2					2.34	~ ~ ~ ~ 2	~ ~ ~ ~ 3
139	1	15	852.0					2.34	~ ~ ~ ~ 2	~ ~ ~ ~ 3
139	1	14	1051.6					2.35	~ ~ ~ ~ 2	~ ~ ~ ~ 3
139	1	13	1248.9			33.89		2.38	~ ~ 2 ~ 2	~ ~ 3 ~ 3
139	1	12	1499.4			34.03		2.39	~ ~ 2 ~ 2	~ ~ 3 ~ 3
139	1	11	1805.1					2.39	~ ~ ~ ~ 2	~ ~ ~ ~ 3
139	1	10	2098.0					2.39	~ ~ ~ ~ 2	~ ~ ~ ~ 3
139	1	9	2407.1					2.40	~ ~ ~ ~ 2	~ ~ ~ ~ 3
139	1	8	2701.4			34.03		2.39	~ ~ 2 ~ 2	~ ~ 3 ~ 3
139	1	7	3008.3			34.07		2.39	~ ~ 2 ~ 2	~ ~ 3 ~ 3
139	1	6	3306.9			33.98		2.40	~ ~ 2 ~ 2	~ ~ 3 ~ 3
139	1	5	3603.5			33.94		2.39	~ ~ 2 ~ 2	~ ~ 3 ~ 3
139	1	4	3910.0			33.89		2.38	~ ~ 2 ~ 2	~ ~ 3 ~ 3
139	1	3	4208.2			33.80		2.34	~ ~ 2 ~ 2	~ ~ 3 ~ 3
139	1	2	4391.3			33.75		2.34	~ ~ 2 ~ 2	~ ~ 3 ~ 3
139	1	1	4537.7					2.33	~ ~ ~ ~ 2	~ ~ ~ ~ 3
140	2	11	3604.4		128.04				~ 2 ~ ~ ~	~ 3 ~ ~ ~
140	2	8	4611.4					2.32	~ ~ ~ ~ 2	~ ~ ~ ~ 3
140	2	6	5102.7					2.26	~ ~ ~ ~ 2	~ ~ ~ ~ 3
140	2	5	5218.4					2.24	~ ~ ~ ~ 2	~ ~ ~ ~ 3
143	1	17	495.2			32.18			~ ~ 2 ~ ~	~ ~ 3 ~ ~
143	1	16	594.3			32.48			~ ~ 2 ~ ~	~ ~ 3 ~ ~
143	1	15	693.6			32.56			~ ~ 2 ~ ~	~ ~ 3 ~ ~
143	1	14	842.4			32.77			~ ~ 2 ~ ~	~ ~ 3 ~ ~
143	1	13	1044.5			33.06			~ ~ 2 ~ ~	~ ~ 3 ~ ~
143	1	11	1753.8			33.18			~ ~ 2 ~ ~	~ ~ 3 ~ ~
143	1	10	1990.5			33.04			~ ~ 2 ~ ~	~ ~ 3 ~ ~
143	1	9	2299.8			32.99			~ ~ 2 ~ ~	~ ~ 3 ~ ~
143	1	8	2594.8			32.80			~ ~ 2 ~ ~	~ ~ 3 ~ ~
143	1	7	2896.6			32.71			~ ~ 2 ~ ~	~ ~ 3 ~ ~
143	1	6	3196.1			32.70			~ ~ 2 ~ ~	~ ~ 3 ~ ~
143	1	5	3595.8			32.73			~ ~ 2 ~ ~	~ ~ 3 ~ ~
145	1	18	423.2	217.4					2 ~ ~ ~ ~	3 ~ ~ ~ ~
145	1	8	2258.8					2.36	~ ~ ~ ~ 2	~ ~ ~ ~ 3

INPUT FILE: METEOR.LIG L Gordon/J Jennings THE DATE TODAY IS: 16-JUL-91

STNNBR	CASTNO	SAMPNO	CTDPRS	OXYGEN	SILCAT	NITRAT	NITRIT	PHSPHT	QUALT1	QUALT2
				**********	*********	*********	********	**********		
145	1	7	2502.8					2.34	~~~~2	~~~~3
145	1	6	2754.5					2.34	~~~~2	~~~~3
145	1	5	3010.8					2.34	~~~~2	~~~~3
145	1	4	3262.2					2.34	~~~~2	~~~~3
145	1	3	3514.5					2.32	~~~~2	~~~~3
145	1	2	3712.0					2.34	~~~~2	~~~~3
145	1	1	3742.5					2.34	~~~~2	~~~~3
146	1	9	2246.7			33.20			~~2~~	~~3~~
146	1	8	2501.1					2.35	~~~~2	~~~~3
146	1	7	2750.1					2.35	~~~~2	~~~~3
146	1	6	2999.4					2.35	~~~~2	~~~~3
146	1	5	3244.7					2.35	~~~~2	~~~~3
146	1	4	3512.6					2.34	~~~~2	~~~~3
146	1	3	3808.6					2.35	~~~~2	~~~~3
146	1	2	4067.4			32.86		2.34	~~2~2	~~3~3
146	1	1	4190.5					2.36	~~~~2	~~~~3
147	1	14	1054.6		128.79				~2~~~	~3~~~
147	1	13	1254.3		130.42				~2~~~	~3~~~
147	1	12	1511.9		128.80				~2~~~	~3~~~
147	1	11	1757.2		129.69				~2~~~	~3~~~
147	1	10	2010.3		129.07				~2~~~	~3~~~
147	1	9	2257.7		127.95				~2~~~	~3~~~
147	1	8	2508.0		127.09				~2~~~	~3~~~
147	1	7	2759.7		127.72				~2~~~	~3~~~
147	1	5	3259.9		126.11				~2~~~	~3~~~
149	1	20	197.8	210.3					2~~~~	3~~~~
150	1	15	591.6		116.85				~2~~~	~3~~~
150	1	5	3298.0	251.0					2~~~~	3~~~~
152	1	10	1998.4					2.28	~~~~2	~~~~3
152	1	3	3944.7					2.22	~~~~2	~~~~3
153	2	10	2099.7	218.0					2~~~~	3~~~~
153	2	9	2404.2	221.3					2~~~~	3~~~~
153	2	8	2703.3	231.4	133.32				22~~~	33~~~
153	2	7	3001.4		133.13				~2~~~	~3~~~

INPUT FILE: METEOR.LIG L Gordon/J Jennings THE DATE TODAY IS: 16-JUL-91

STNNBR	CASTNO	SAMPNO	CTDPRS	OXYGEN	SILCAT	NITRAT	NITRIT	PHSPHT	QUALT1	QUALT2
				**********	*********	*********	********	**********		
153	2	3	3894.2					2.36	~ ~ ~ ~ 2	~ ~ ~ ~ 3
156	1	21	9.7					1.83	~ ~ ~ ~ 2	~ ~ ~ ~ 3
156	1	20	37.0					1.85	~ ~ ~ ~ 2	~ ~ ~ ~ 3
156	1	19	75.7					1.86	~ ~ ~ ~ 2	~ ~ ~ ~ 3
156	1	18	124.7					2.11	~ ~ ~ ~ 2	~ ~ ~ ~ 3
156	1	17	194.8					2.42	~ ~ ~ ~ 2	~ ~ ~ ~ 3
156	1	15	344.4					2.42	~ ~ ~ ~ 2	~ ~ ~ ~ 3
156	1	14	413.2					2.34	~ ~ ~ ~ 2	~ ~ ~ ~ 3
156	1	13	491.5					2.36	~ ~ ~ ~ 2	~ ~ ~ ~ 3
156	1	12	591.4					2.29	~ ~ ~ ~ 2	~ ~ ~ ~ 3
156	1	11	692.2					2.19	~ ~ ~ ~ 2	~ ~ ~ ~ 3
156	1	10	841.2					2.11	~ ~ ~ ~ 2	~ ~ ~ ~ 3
156	1	9	1059.7					2.16	~ ~ ~ ~ 2	~ ~ ~ ~ 3
156	1	8	1241.2					2.26	~ ~ ~ ~ 2	~ ~ ~ ~ 3
156	1	7	1491.5					2.15	~ ~ ~ ~ 2	~ ~ ~ ~ 3
156	1	6	1744.9					2.11	~ ~ ~ ~ 2	~ ~ ~ ~ 3
156	1	5	1993.3					2.30	~ ~ ~ ~ 2	~ ~ ~ ~ 3
156	1	4	2245.1					2.28	~ ~ ~ ~ 2	~ ~ ~ ~ 3
156	1	3	2495.1					2.24	~ ~ ~ ~ 2	~ ~ ~ ~ 3
156	1	2	2747.6					2.40	~ ~ ~ ~ 2	~ ~ ~ ~ 3
156	1	1	2858.1					2.13	~ ~ ~ ~ 2	~ ~ ~ ~ 3
161	1	3	2700.8	203.9					2 ~ ~ ~ ~	3 ~ ~ ~ ~
162	3	22	298.7		18.31				~ 2 ~ ~ ~	~ 3 ~ ~ ~
162	3	20	793.6			35.71			~ ~ 2 ~ ~	~ ~ 3 ~ ~
162	1	1	816.5			35.56			~ ~ 2 ~ ~	~ ~ 3 ~ ~
162	3	19	946.2			36.05			~ ~ 2 ~ ~	~ ~ 3 ~ ~
162	3	18	1098.0			35.47			~ ~ 2 ~ ~	~ ~ 3 ~ ~
162	3	17	1246.4			35.18			~ ~ 2 ~ ~	~ ~ 3 ~ ~
162	3	14	1798.0			30.88			~ ~ 2 ~ ~	~ ~ 3 ~ ~
162	3	13	1998.0			30.49			~ ~ 2 ~ ~	~ ~ 3 ~ ~
162	3	12	2198.9			30.32			~ ~ 2 ~ ~	~ ~ 3 ~ ~
162	3	11	2399.2			30.65			~ ~ 2 ~ ~	~ ~ 3 ~ ~
162	3	10	2599.5			31.30		2.17	~ ~ 2 ~ 2	~ ~ 3 ~ 3
162	3	9	2800.7			31.90		2.21	~ ~ 2 ~ 2	~ ~ 3 ~ 3

INPUT FILE: METEOR.LIG L Gordon/J Jennings   THE DATE TODAY IS: 16-JUL-91

STNNBR	CASTNO	SAMPNO	CTDPRS	OXYGEN	SILCAT	NITRAT	NITRIT	PHSPHT	QUALT1	QUALT2
				**********	*********	*********	********	**********		
162	3	8	3002.5			32.37		2.24	~ ~ 2 ~ 2	~ ~ 3 ~ 3
162	3	7	3202.3			32.79		2.28	~ ~ 2 ~ 2	~ ~ 3 ~ 3
162	3	6	3402.7			33.08		2.30	~ ~ 2 ~ 2	~ ~ 3 ~ 3
162	3	5	3601.4			33.32		2.32	~ ~ 2 ~ 2	~ ~ 3 ~ 3
162	3	4	3801.4			33.65		2.34	~ ~ 2 ~ 2	~ ~ 3 ~ 3
162	3	3	4006.6			34.08		2.38	~ ~ 2 ~ 2	~ ~ 3 ~ 3
162	3	2	4202.5			34.23		2.40	~ ~ 2 ~ 2	~ ~ 3 ~ 3
162	3	1	4342.8			34.66		2.42	~ ~ 2 ~ 2	~ ~ 3 ~ 3
163	1	4	3503.4	205.7	96.49	30.94			222 ~ ~	333 ~ ~
163	1	3	3755.2			31.77			~ ~ 2 ~ ~	~ ~ 3 ~ ~
164	2	5	2799.4				0.03		~ ~ ~ 2 ~	~ ~ ~ 3 ~
164	2	3	3197.8			30.41			~ ~ 2 ~ ~	~ ~ 3 ~ ~
164	2	1	3968.4				0.11		~ ~ ~ 2 ~	~ ~ ~ 3 ~
164	1	1	4123.8	218.4					2 ~ ~ ~ ~	3 ~ ~ ~ ~
165	2	10	2802.1		77.37				~ 2 ~ ~ ~	~ 3 ~ ~ ~
165	2	7	3402.3		100.26				~ 2 ~ ~ ~	~ 3 ~ ~ ~
167	2	23	128.1					0.90	~ ~ ~ ~ 2	~ ~ ~ ~ 3
167	1	9	129.9					1.02	~ ~ ~ ~ 2	~ ~ ~ ~ 3
170	1	8	210.1	235.5					2 ~ ~ ~ ~	3 ~ ~ ~ ~
170	1	4	421.2			24.16		1.69	~ ~ 2 ~ 2	~ ~ 3 ~ 3
170	1	3	501.8			24.26		1.69	~ ~ 2 ~ 2	~ ~ 3 ~ 3
170	2	17	1181.7			34.59			~ ~ 2 ~ ~	~ ~ 3 ~ ~
170	2	16	1331.5			34.64			~ ~ 2 ~ ~	~ ~ 3 ~ ~
170	2	15	1383.8			34.57			~ ~ 2 ~ ~	~ ~ 3 ~ ~
170	2	14	1484.8			34.16			~ ~ 2 ~ ~	~ ~ 3 ~ ~
170	2	12	2086.6			29.32			~ ~ 2 ~ ~	~ ~ 3 ~ ~
170	2	11	2287.8			28.00			~ ~ 2 ~ ~	~ ~ 3 ~ ~
170	2	10	2493.7			27.33			~ ~ 2 ~ ~	~ ~ 3 ~ ~
170	2	9	2743.7			26.62			~ ~ 2 ~ ~	~ ~ 3 ~ ~
170	2	8	3002.8			27.20			~ ~ 2 ~ ~	~ ~ 3 ~ ~
170	2	7	3246.8			28.51			~ ~ 2 ~ ~	~ ~ 3 ~ ~
170	2	6	3503.5			30.04			~ ~ 2 ~ ~	~ ~ 3 ~ ~
170	2	5	3753.1			31.18			~ ~ 2 ~ ~	~ ~ 3 ~ ~
170	2	4	4002.4			31.86			~ ~ 2 ~ ~	~ ~ 3 ~ ~

INPUT FILE: METEOR.LIG L Gordon/J Jennings   THE DATE TODAY IS: 16-JUL-91

STNNBR	CASTNO	SAMPNO	CTDPRS	OXYGEN	SILCAT	NITRAT	NITRIT	PHSPHT	QUALT1	QUALT2
				**********	*********	*********	********	**********		
170	2	3	4205.2			32.22			~ ~ 2 ~ ~	~ ~ 3 ~ ~
170	2	2	4405.6			32.46			~ ~ 2 ~ ~	~ ~ 3 ~ ~
170	2	1	4506.1			32.57			~ ~ 2 ~ ~	~ ~ 3 ~ ~
171	1	6	299.4	234.9					2 ~ ~ ~ ~	3 ~ ~ ~ ~
172	1	6	380.2	254.0	6.55				22 ~ ~ ~	33 ~ ~ ~
174	1	4	500.2	231.5					2 ~ ~ ~ ~	3 ~ ~ ~ ~
175	1	10	90.4		8.93				~ 2 ~ ~ ~	~ 3 ~ ~ ~
175	1	2	601.7	234.8					2 ~ ~ ~ ~	3 ~ ~ ~ ~
175	1	1	714.7	201.3					2 ~ ~ ~ ~	3 ~ ~ ~ ~
175	2	15	1796.7	202.5					2 ~ ~ ~ ~	3 ~ ~ ~ ~
175	2	7	3750.1	229.9					2 ~ ~ ~ ~	3 ~ ~ ~ ~
179	1	17	242.3		19.12				~ 2 ~ ~ ~	~ 3 ~ ~ ~
179	1	16	298.2		27.55				~ 2 ~ ~ ~	~ 3 ~ ~ ~
179	1	15	366.8		25.48				~ 2 ~ ~ ~	~ 3 ~ ~ ~

CFC Data Qualilty Evaluation
(R. Van Woy)
1991 July 24

I have completed a preliminary flagging of the Roether Meteor data. Since the PI has not supplied the additional information that I requested on 1 Mar 1991, 1 am not satisfied with my flag determinations. I wish to reserve the right to change them when the necessary data and plots are given me, to allow a proper job of quality control.

Following is a list of additional information that I will need to continue the quality control of the CFC measurements from the Meteor cruise. I am most worried about the possibility of the CFC's being low due to the problem described in the comments to the data report submitted to the WOCE WHP. A plot of the surface partial pressures indicate that both CFCs, and especially CFC12, are unrealistically undersaturated in the surface (the oxygen is near saturation). This problem appears to continue to station 161 when water went past the stripping volume and the calibration curves changed. I hope that it is just a calibration problem rather than a equipment problem that would prevent the data from being recovered easily.

Additional Needs From Meteor Group:

1. Air data to use for saturation calculations.
2. Blank corrections applied.
3. Stripping efficiency determination.
4. Calibration curves data and plots.
5. Observers quality control flags in WOCE format.
6. Trapping experiment results to show no loss of either CFC by bleedthrough.
7. Sample chromatograms especially for surface waters where a problem is indicated for CFC12.
8. Reasoning and or repair history of problem that caused CFC's to be partially lost for stations 122-139 since data indicates problem continues after station 139.
9. The remaining contour plots.
10. A list of any replicate samples if only mean values given. I wish to reserve the right to change them, when the necessary data and plots are given me, to allow a proper job of quality control.

The problem with the M 11/5 data is not unusual. An immediate solution would have been either an adjustment of the precolumn backflushing timing sequence, with a corresponding experiment to show that no CFC11 is being lost, or an adjustment in the analysis timing to allow the baseline to return to normal before injecting the next sample.

As far as recovering what data is available, it will be necessary to go through all the chromatograms and flag which CFC12 peaks were integrated or a peak from the previous sample. Samples run after blanks, airs, standards, or the first water of a series should be free of this problem. I must assume that the samples were run in somewhat of a random order such that some surface samples are run after deeper samples. Also, if replicate samples were drawn from the surface bottles, then should be some of these that were integrated without the interference peak that might allow you to estimate the error caused by the late eluting peak. Comparing the CFC12 peaks that were flagged good to the integration-problem-flagged peaks should allow a correction factor to be determined. Of course these data will need to be flagged as such. I have just sent my preliminary flag determinations to the WOCE office, but I really need the additional information requested earlier for proper quality control.

N.B. On 29 SEP 1993 C. Correy noted that problems with these CFC data had not been addressed by the PI.

On 10 MAR 1999 B Klein resubmitted CFC data with the following documentation:

From: Birgit Klein
Cruise M11/5: Expocode 06MT11/5

CFCs are measured directly on the ship using a electron capture Detector (ECD) packed column gas chromatograph. The column was filled with Porasil C and Porapak T.

Only f11 and f12 have been measured during the cruise. Part of the original documentation as been lost, information on system blanks and air measurements is unfortunately not available. The original measurements have been recorded on the sio86 scale and have latter been converted to sio93. Contamination problems and calibration problems are reflected in the relatively high errors. Quality flag for CFCs follow woce standards:

2 good measurement
3 questionable measurement
4 bad measurement
5 not reported
6 replicate sample
9 no sample drawn

errors:

sta.	f11	f12
102-117	2% or 0.01 pmol/kg	2% or 0.01 pmol/kg
118-161	3% or 0.01 pmol/kg	2% or 0.01 pmol/kg
166-179	2% or 0.01 pmol/kg	2% or 0.01 pmol/kg

CFC DQE QUALITY FLAGS INPUT FILE: METEOR.RVW THE DATE TODAY IS: 15-AUG-91

#STNNBR	CASTNO	SAMPNO	CTDPRS	CFC-11	CFC-12	QUAL1	QUAL2
102	1	17	10	3.6412	1.4098	22	34
102	1	15	25.5	3.6547	1.3643	22	34
102	1	14	25.5	3.6305	1.3852	22	34
102	1	13	25.5	3.6939	1.3908	22	34
102	1	12	25.5	3.6636		2~	3~
102	1	11	25.5		1.3997	~2	~4
102	1	10	25.5	3.6418	1.3931	22	34
102	1	8	25.5	3.6218	1.3702	22	34
102	1	7	25.5		1.4238	~2	~4
102	1	6	25.5	3.5808	1.3578	22	34
102	1	5	36.5	3.734	1.3971	22	34
102	1	4	56.2	3.7772	1.7648	22	33
102	1	3	75.1	3.8381	1.4408	22	34
102	1	2	92.2	4.2238	2.0567	22	33
103	1	12	1398	0.242	0.1207	22	33
103	1	10	1801	0.0292	0.0224	22	33
103	1	8	2249.7		0.0264	~2	~3
103	1	3	3067.3		0.0135	~2	~3
104	1	16	692.2		1.513	~2	~4
104	1	15	841.8		0.772	~2	~4
104	1	13	1242.5		0.1071	~2	~3
104	1	12	1493.7		0.0946	~2	~3
104	1	9	2292.1	0.0516		2~	3~
104	1	8	2597.3		0.0189	~2	~3
105	1	5	2748.3		0.0159	~2	~3
105	1	4	3002.2		0.0121	~2	~3
105	1	1	3755.2		0.0126	~2	~3
106	1	21	3249.6		0.0154	~2	~3
106	1	14	1499.8		0.0275	~2	~3
107	2	21	157.2	4.3086		2~	3~
107	2	19	261.1	4.233	2.2469	22	34
107	2	18	321.6	4.463	2.4052	22	34
107	2	12	1050.9		0.1365	~2	~3
108	1	19	243.3		1.9326	~2	~3
108	1	9	1744.2		0.0154	~2	~3
108	1	2	3498.8		0.014	~2	~3
109	1	4	2997		0.0143	~2	~3
109	1	3	3198.7		0.0138	~2	~3
109	1	1	3734.5		0.0127	~2	~3
110	1	23	46.8	5.2285		2~	3~
110	1	1	3852.6	0.0203	0.0225	22	33
112	2	23	64.5	6.0164		2~	3~
112	2	22	124.2	6.0363		2~	3~
112	2	21	171.6	6.0044		2~	3~
112	2	19	292.9	2.8475	1.3704	22	33
113	1	3	114.4	6.9463	2.7996	22	33
113	1	2	65.6	7.5009	3.7225	22	34
114	1	21	74.9	6.869		2~	3~
114	1	20	116.5	6.3054		2~	3~
114	1	18	259.7	1.657		2~	3~
114	1	17	259.7	1.6854		2~	3~

CFC DQE QUALITY FLAGS INPUT FILE: METEOR.RVW THE DATE TODAY IS: 15-AUG-91

#STNNBR	CASTNO	SAMPNO	CTDPRS	CFC-11	CFC-12	QUAL1	QUAL2
114	1	9	1751.2		0.0125	~2	~3
114	1	5	2701.7		0.0107	~2	~3
114	1	4	2900.5		0.0216	~2	~3
114	1	3	3104.8		0.0191	~2	~3
114	1	2	3303.4		0.0266	~2	~3
114	1	1	3589.4		0.036	~2	~3
116	2	24	7.1	5.945		2~	3~
116	2	23	61.1	6.1689		2~	3~
116	2	15	836.4	0.021	0.0174	22	33
117	1	19	7.3	5.9731	2.505	22	33
117	1	18	7.4	5.9666	2.5696	22	33
117	1	17	34.8	6.2608		2~	3~
118	1	21	842.9	0.096	0.055	22	33
118	1	20	1048.4	0.0587	0.0432	22	33
118	1	13	42.4	6.6274		2~	3~
118	1	12	112.1	6.4431		2~	3~
118	1	7	491	0.3699	0.1676	22	33
118	1	6	491	0.2513	0.108	22	33
118	1	5	491	0.2416	0.1126	22	33
118	1	2	594.2		0.1225	~2	~3
119	2	21	1096.4	0.0648	0.0182	22	33
120	1	8	3000.7		-0.014	~2	~3
121	1	24	11.4	3.9962		2~	3~
121	1	21	295.5	2.376	0.7374	22	33
121	1	18	593.4	1.7487	0.6101	22	33
121	1	17	693	1.0867	0.2871	22	34
121	1	15	1039.7	0.2912	0.0913	22	33
121	1	14	1242	0.1775	0.0669	22	33
121	1	12	1743.2	0.1422	0.0502	22	33
121	1	9	2247.5	0.0381	0.0749	22	34
122	1	23	11.2	5.6248	2.3937	22	33
122	1	22	100.7	4.2078	1.7512	22	33
122	1	21	196.5	2.1411	1.1461	22	33
122	1	20	276.1	2.7645	1.2764	22	33
122	1	19	353.6	0.5437	0.2337	22	33
122	1	18	425.1	0.1653	0.0663	22	33
122	1	17	503	0.1359	0.0659	22	33
122	1	16	592.7	0.1846	0.0798	22	33
122	1	15	692.7	0.3814	0.1477	22	33
122	1	14	842.3	0.7236	0.2933	22	33
122	1	13	1041.9	0.3366	0.1171	22	33
122	1	12	1242.8	0.268	0.085	22	33
122	1	11	1495.5	0.1442	0.0294	22	33
122	1	10	1749.1	0.1271	0.0542	22	33
122	1	8	2497.3	0.3525	0.1572	22	33
122	1	7	2745.3	0.3399	0.1323	22	33
122	1	6	2997	0.3347	0.1228	22	33
122	1	5	3199.6	0.5392	0.2863	22	33
122	1	4	3446.4	-9	-9	55	33
122	1	3	3652.6	0.5976	0.2573	22	33
122	1	2	3857.1	0.6998	0.3025	22	33

CFC DQE QUALITY FLAGS INPUT FILE: METEOR.RVW THE DATE TODAY IS: 15-AUG-91

#STNNBR	CASTNO	SAMPNO	CTDPRS	CFC-11	CFC-12	QUAL1	QUAL2
122	1	1	3915.9	0.668	0.2913	22	33
123	1	24	9.2	5.2856	2.0517	22	33
123	1	23	50	5.1656	2.0667	22	33
123	1	19	397.2	1.1307		2~	3~
123	1	18	497	0.854		2~	3~
123	1	17	595.9	0.5204		2~	3~
123	1	16	695.3	0.4607		2~	3~
123	1	15	846.6	0.424		2~	3~
123	1	14	994.2	0.2713		2~	3~
123	1	13	1248	0.406	0.1837	22	33
123	1	12	1499.2	0.4095	0.1576	22	33
123	1	11	1742.2	0.3792	0.1584	22	33
123	1	10	1986.6	0.3168	0.1121	22	33
123	1	9	2200.7	0.3593	0.1513	22	33
123	1	8	2394.7	0.3822	0.1521	22	33
123	1	7	2595.4	0.3211	0.098	22	33
123	1	6	2781.9	0.593	0.2519	22	33
123	1	5	2996.1	0.659	0.2869	22	33
123	1	4	3196.2	0.5765	0.2442	22	33
123	1	3	3399.6	0.6422	0.2718	22	33
123	1	2	3600.4	0.6473	0.2647	22	33
123	1	1	3704.8	0.679	0.285	22	33
124	2	24	11.1	5.469	2.1089	22	33
124	2	23	79.5	4.345	1.639	22	33
124	2	22	131.8	3.8664	1.5434	22	33
124	2	21	209.9	2.039	0.8318	22	33
124	2	19	378.4	0.906	0.3859	22	33
124	2	18	491.2	0.5566	0.2297	22	33
124	2	17	595.4	0.3887	0.1549	22	33
124	2	16	694.7	0.2468	0.0968	22	33
124	2	15	841	0.1497	0.0585	22	33
124	2	14	1040.4	0.1363	0.0584	22	33
124	2	13	1240.7	0.1569	0.067	22	33
124	2	11	1738.2	0.4001	0.1729	22	33
124	2	10	1992.7	0.4113	0.1642	22	33
124	2	9	2244.5	0.4464	0.1869	22	33
124	2	8	2496.1	0.4346	0.185	22	33
124	2	7	2745.1	0.5769	0.2357	22	33
124	2	6	2997.5	0.6036	0.2186	22	33
124	2	4	3501.1	0.9502	0.3931	22	33
124	2	2	4101	1.0795	0.4504	22	33
124	2	1	4166.4	1.0462	0.4402	22	33
125	1	24	6.2	6.3391.	2.8322	22	33
125	1	23	6.5	4.7671	1.8816	22	33
125	1	22	6.3	5.9029	2.4292	22	33
125	1	21	74	3.7713	1.3082	22	33
125	1	20	123.3	3.6457	1.487	22	33
125	1	19	213.9	2.328	0.9552	22	33
125	1	18	292.9	1.3733	0.4815	22	33
125	1	17	387	1.3247	0.6326	22	33
125	1	16	490.9	0.9069	0.391	22	33

CFC DQE QUALITY FLAGS INPUT FILE: METEOR.RVW THE DATE TODAY IS: 15-AUG-91

#STNNBR	CASTNO	SAMPNO	CTDPRS	CFC-11	CFC-12	QUAL1	QUAL2
125	1	15	591.5	0.5436	0.2244	22	33
125	1	14	689.8	0.444	0.1883	22	33
125	1	13	841.8	0.2156	0.0653	22	33
125	1	11	1240.8	0.3373	0.0992	22	33
125	1	10	1491.4	0.3032	0.1274	22	33
125	1	9	1741.7	0.3367	0.1366	22	33
125	1	8	1993.7	0.3147	0.1113	22	33
125	1	7	1994.3	0.3833	0.1679	22	33
125	1	5	2224.2	0.4026	0.1804	22	33
125	1	4	2495.8	0.4528	0.1971	22	33
125	1	3	2700.2	0.3944	0.1325	22	33
125	1	2	2847.5	0.4889	0.1963	22	33
125	1	1	3026.4	0.5278	0.2356	22	33
126	1	24	9.5	4.9894	1.9286	22	33
126	1	22	52.6	5.1957	2.1575	22	33
126	1	21	116.6	2.6966	1.1024	22	33
126	1	20	198.6	1.8681	0.7688	22	33
126	1	19	296.7	1.494	0.658	22	33
126	1	18	394.8	0.7262	0.3143	22	33
126	1	16	594.2	0.5082	0.2139	22	33
126	1	15	693.2	0.4524	0.1851	22	33
126	1	13	1039.5	0.4697	0.1915	22	33
126	1	12	1243.1	0.4031	0.1769	22	33
126	1	11	1488.7	0.3562	0.1529	22	33
126	1	10	1742.7	0.3975	0.1714	22	33
126	1	9	2001.3	0.3496	0.1382	22	33
126	1	8	2249.2	0.3888	0.1515	22	33
126	1	7	2502.7	0.4295	0.1781	22	33
126	1	6	2503.2	0.4604	0.2034	22	33
126	1	5	2748.6	0.4612	0.188	22	33
126	1	4	3001.5	0.4558	0.1619	22	33
126	1	3	3240.1	0.7839	0.3297	22	33
126	1	2	3406.5	0.9371	0.408	22	33
126	1	1	3455.9	0.991	0.4222	22	33
127	1	19	83.1	3.7651	1.3146	22	33
127	1	18	161.7	2.6234	1.015	22	33
127	1	16	291.7	1.3503	0.4744	22	33
127	1	13	491.8	0.8966	0.3693	22	33
127	1	12	590.8	0.5784	0.242	22	33
127	1	11	691.2	0.4136	0.1637	22	33
127	1	9	1041.3	0.2681	0.1002	22	33
127	1	8	1241.4	0.2461	0.0958	22	33
127	1	6	1741.6	0.2777	0.1222	22	33
127	1	5	1992.4	0.2791	0.1188	22	33
127	1	4	2245	0.3357	0.1382	22	33
127	1	3	2447.5	0.3947	0.1613	22	33
127	1	2	2647.8	0.6679	0.2701	22	33
127	1	1	2718.1	0.7248	0.2862	22	33
128	1	23	6.6	4.9697	1.8939	22	33
128	1	21	98.8	4.2123	1.8085	22	33
128	1	19	200	1.9343	0.8304	22	33

#STNNBR	CASTNO	SAMPNO	CTDPRS	CFC-11	CFC-12	QUAL1	QUAL2
128	1	18	300.2	1.2212	0.4963	22	33
128	1	17	398.3	0.764	0.2573	22	33
128	1	16	499	0.6715	0.266	22	33
128	1	15	596.7	0.4827	0.163	22	33
128	1	14	699.5	0.4056	0.1172	22	33
128	1	13	846.8	0.5227	0.2089	22	33
128	1	12	1044.6	0.3161	0.1497	22	33
128	1	10	1492.6	0.2824	0.1293	22	33
128	1	8	1996.7	0.2408	0.0747	22	33
128	1	6	2502.5	0.277	0.1126	22	33
128	1	5	2750.9	0.3716	0.1349	22	33
128	1	3	3203.1	0.8866	0.386	22	33
128	1	2	3307.7	0.8644	0.3466	22	33
128	1	1	3352.9	0.8854	0.3488	22	33
129	2	24	13	5.8911	2.3649	22	33
129	2	23	85.8	3.3859	1.3522	22	33
129	2	21	293.5	0.6725	0.2673	22	33
129	2	20	395	0.354	0.1266	22	33
129	2	19	492.8	0.2145	0.0698	22	33
129	2	18	591.3	0.1659	0.0582	22	33
129	2	17	691.8	0.1336	0.0421	22	33
129	2	16	841.4	0.0543	0.0199	22	33
129	2	15	1043.5	0.0614	0.0207	22	33
129	2	13	1492.1	0.1141	0.0518	22	33
129	2	12	1743.4	0.1365	0.0673	22	33
129	2	11	1993.5	0.1756	0.0753	22	33
129	2	10	2244.9	0.1972	0.0733	22	33
129	2	9	2495.3	0.3505	0.1459	22	33
129	2	8	2746.1	0.4238	0.1634	22	33
129	2	6	3246.9	0.9304	0.3908	22	33
129	2	5	3499.4	0.8991	0.3364	22	33
129	2	4	3748.7	0.8981	0.3347	22	33
129	2	3	3999.4	0.8639	0.3154	22	33
129	2	2	4230.1	0.8354	0.3006	22	33
129	2	1	4283.2	0.8727	0.3121	22	33
130	1	24	4.3	4.749	1.7467	22	33
130	1	23	98.7	2.2402	0.7624	22	33
130	1	22	195.2	0.6447	0.22	22	33
130	1	21	294.7	0.2348	0.0712	22	33
130	1	19	496.6	0.132	0.0593	22	33
130	1	18	596.4	0.1365	0.0507	22	33
130	1	17	692.7	0.0641	0.0266	22	33
130	1	16	842.1	0.0543	0.0219	22	33
130	1	15	1040.7	0.0507	0.0229	22	33
130	1	13	1501.1	0.0749	0.0362	22	33
130	1	12	1740.8	0.0782	0.0373	22	33
130	1	11	1998	0.1075	0.0577	22	33
130	1	10	2300.8	0.117	0.0542	22	33
130	1	9	2605.3	0.1275	0.0633	22	33
130	1	8	2898.7	0.1554	0.0579	22	33
130	1	6	3500.1	0.2658	0.1271	22	33

CFC DQE QUALITY FLAGS INPUT FILE: METEOR.RVW THE DATE TODAY IS: 15-AUG-91

#STNNBR	CASTNO	SAMPNO	CTDPRS	CFC-11	CFC-12	QUAL1	QUAL2
130	1	5	3749.9	0.6605	0.2763	22	33
130	1	4	4001.3	0.8911	0.3769	22	33
130	1	3	4252.5	0.9271	0.3506	22	33
130	1	2	4421.1	1.0156	0.4046	22	33
130	1	1	4468.7	1.0858	0.4578	22	33
131	2	24	9.3	5.4042	1.891	22	33
131	2	23	64.4	4.2074	1.5155	22	33
131	2	22	142	2.2344	0.8095	22	33
131	2	21	242.3	0.3724	0.1661	22	33
131	2	20	357.1	0.1147	0.037	22	33
131	2	19	491.4	0.0884	0.0364	22	33
131	2	18	591.5	0.076	0.0292	22	33
131	2	17	740.2	0.0478	0.0168	22	33
131	2	16	990.8	0.0615	0.0217	22	33
131	2	15	1287.1	0.0632	0.0279	22	33
131	2	13	1891.1	0.0811	0.0261	22	33
131	2	12	2192.6	0.093	0.0244	22	33
131	2	10	2846.7	0.0935	0.0352	22	33
131	2	9	3349	0.1401	0.0444	22	33
131	2	8	3698.2	0.1981	0.0558	22	33
131	2	7	3897.7	0.4856	0.2032	22	33
131	2	5	4498.7	0.9085	0.3201	22	33
131	2	4	4799.8	0.7947	0.2364	22	33
131	2	3	5081.5	0.9005	0.3016	22	33
131	2	2	5133.5	1.0215	0.3683	22	33
131	2	1	5134.5	0.768	0.2298	22	33
132	1	17	48.3	5.9639	2.4515	22	33
132	1	15	198.3	1.7816	0.5787	22	33
132	1	13	302	0.5721	0.1859	22	33
132	1	11	504.3	0.2679	0.0868	22	33
132	1	10	607.6	0.2671	0.1359	22	33
132	1	9	705.2	0.162	0.0715	22	33
132	1	8	798.5	0.1445	0.0652	22	33
132	1	7	1002.1	0.0971	0.0368	22	33
132	1	6	1208	0.1521	0.0818	22	33
132	1	5	1498.7	0.1798	0.0734	22	33
132	1	4	1798.5	0.2691	6.1238	22	33
132	1	2	2193.4	0.3508	0.1516	22	33
132	1	1	2483.8	0.3749	0.1454	22	33
133	1	24	10.7	6.2131	2.4518	22	33
133	1	22	78.9	5.3327	2.067	22	33
133	1	21	114.3	4.0871	1.4609	22	33
133	1	19	216.7	1.4166	0.4919	22	33
133	1	18	292.6	0.6599	0.2147	22	33
133	1	17	394.1	0.2793	0.0882	22	33
133	1	15	570.5	0.138	0.0414	22	33
133	1	14	690.4	0.1675	0.0779	22	33
133	1	13	842.8	0.0911	0.0476	22	33
133	1	12	1040.8	0.0903	0.0341	22	33
133	1	11	1246.7	0.1028	0.0496	22	33
133	1	10	1497.5	0.1595	0.0668	22	33

CFC DQE QUALITY FLAGS INPUT FILE: METEOR.RVW THE DATE TODAY IS: 15-AUG-91

#STNNBR	CASTNO	SAMPNO	CTDPRS	CFC-11	CFC-12	QUAL1	QUAL2
133	1	9	1742	0.1632	0.0539	22	33
133	1	8	1994.2	0.1962	0.0802	22	33
133	1	7	2247.9	0.2871	0.0978	22	33
133	1	6	2501.4	0.3343	0.0968	22	33
133	1	5	2741.8	0.4315	0.1464	22	33
133	1	4	2997.4	0.5777	0.1989	22	33
133	1	3	3152.2	0.7157	0.304	22	33
133	1	2	3299.4	0.5619	0.1986	22	33
133	1	1	3419.3	0.4581	0.1539	22	33
134	2	24	133.6	4.5359	1.7306	22	33
134	2	23	214.4	1.9352	0.7354	22	33
134	2	21	272.8	0.8885	0.3781	22	33
134	2	20	343.2	0.4956	0.1961	22	33
134	2	19	489.4	0.303	0.1196	22	33
134	2	18	648	0.3517	0.1298	22	33
134	2	17	788	0.3047	0.1266	22	33
134	2	16	991.4	0.2321	0.0823	22	33
134	2	15	1190.4	0.2203	0.0888	22	33
134	2	14	1492	0.2271	0.1015	22	33
134	2	13	1791.3	0.2066	0.0923	22	33
134	2	12	2193.8	0.1986	0.0892	22	33
134	2	11	2595.5	0.2615	0.1096	22	33
134	2	10	2998	0.3497	0.15	22	33
134	2	9	3296.4	0.3999	0.1552	22	33
134	2	8	3598.1	0.5075	0.2076	22	33
134	2	7	3899.6	0.6179	0.2671	22	33
134	2	6	4200.7	0.5849	0.2245	22	33
134	2	5	4500.6	0.5802	0.2033	22	33
134	2	4	4810.6	0.5851	0.1869	22	33
134	2	3	5102	0.6983	0.2238	22	33
134	2	2	5327.3	0.6373	0.2317	22	33
134	2	1	5496.7	0.7757	0.3116	22	33
135	1	23	7.1	5.8954	2.5317	22	33
135	1	22	77	5.0935	1.7273	22	33
135	1	20	191.1	2.4123	0.8724	22	33
135	1	19	319	0.942	0.3127	22	33
135	1	18	400.4	0.5847	0.1612	22	33
135	1	17	492.8	0.7113	0.3101	22	33
135	1	16	643.8	0.543	0.2195	22	33
135	1	15	792.3	0.3409	0.1008	22	33
135	1	13	1492.3	0.2066	0.0591	22	33
135	1	11	1993	0.2302	0.0769	22	33
135	1	10	2405.9	0.2122	0.0832	22	33
135	1	9	2811.7	0.3094	0.1245	22	33
135	1	8	3199.5	0.3149	0.1473	22	33
135	1	7	3599.8	0.359	0.1575	22	33
135	1	6	4000	0.4655	0.1991	22	33
135	1	5	4402.2	0.5634	0.2158	22	33
135	1	3	5155.7	0.6561	0.2662	22	33
135	1	1	5712.9	0.6572	0.3513	22	33
136	1	24	8.7	6.04	2.4074	22	33

CFC DQE QUALITY FLAGS INPUT FILE: METEOR.RVW THE DATE TODAY IS: 15-AUG-91

#STNNBR	CASTNO	SAMPNO	CTDPRS	CFC-11	CFC-12	QUAL1	QUAL2
136	1	22	138.7	4.3209	1.6641	22	33
136	1	20	212.3	3.1453	1.2281	22	33
136	1	18	397.3	0.6936	0.2653	22	33
136	1	17	496.4	0.5314	0.1701	22	33
136	1	16	595.6	0.4591	0.1884	22	33
136	1	15	689.9	0.2967	0.0958	22	33
136	1	14	795.9	0.2721	6.0857	22	33
136	1	13	956.6	0.2383	0.0856	22	33
136	1	12	1095.6	0.2724	0.0956	22	33
136	1	11	1392.7	0.2215	0.0662	22	33
136	1	10	1691.2	0.2661	0.0991	22	33
136	1	9	1996.7	0.2248	0.0917	22	33
136	1	8	2400.6	0.2336	0.0912	22	33
136	1	7	2801.6	0.2193	0.0921	22	33
136	1	6	3201.4	0.2409	0.1001	22	33
136	1	5	3653.1	0.2986	0.1085	22	33
136	1	4	4199	0.3605	0.1332	22	33
136	1	3	4631	0.3753	0.1235	22	33
136	1	1	4813.2	0.3958	0.1158	22	33
137	1	22	117.3	4.3501	1.8471	22	33
137	1	21	178.2	1.7758	0.7186	22	33
137	1	20	233.9	1.0146	0.4134	22	33
137	1	19	309.4	0.5955	0.2425	22	33
137	1	18	391.2	0.3866	0.1577	22	33
137	1	17	495.1	0.3415	0.1347	22	33
137	1	16	591.2	0.3048	0.1116	22	33
137	1	15	692.1	0.3554	0.149	22	33
137	1	14	840.5	0.4422	0.1678	22	33
137	1	13	1040.3	0.2944	0.1182	22	33
137	1	12	1240.8	0.2267	0.0818	22	33
137	1	11	1491.6	0.2486	0.0859	22	33
137	1	10	1741.1	0.2088	0.0849	22	33
137	1	9	1994.9	0.1937	0.0708	22	33
137	1	8	2394.6	0.2595	0.1156	22	33
137	1	7	2794.7	0.2601	0.109	22	33
137	1	5	3598.8	0.3335	0.1391	22	33
137	1	4	4000	0.4354	0.1786	22	33
137	1	3	4301.9	0.4805	0.2087	22	33
137	1	2	4503.9	0.477	0.1985	22	33
137	1	1	4608.3	0.5279	0.225	22	33
138	1	24	8	6.1028	2.3714	22	33
138	1	23	73.4	5.8682	2.2131	22	33
138	1	22	112.5	5.6357	2.1795	22	33
138	1	21	153.4	3.9186	1.5456	22	33
138	1	18	491.1	0.449	0.1754	22	33
138	1	17	591.4	0.2202	0.0953	22	33
138	1	15	839.9	0.558	0.2534	22	33
138	1	14	1038.5	0.3343	0.1364	22	33
138	1	13	1242.7	0.324	0.1379	22	33
138	1	12	1489.5	0.2551	0.112	22	33
138	1	11	1790.6	0.2273	0.0985	22	33

CFC DQE QUALITY FLAGS INPUT FILE: METEOR.RVW THE DATE TODAY IS: 15-AUG-91

#STNNBR	CASTNO	SAMPNO	CTDPRS	CFC-11	CFC-12	QUAL1	QUAL2
138	1	10	2092.4	0.1682	0.0606	22	33
138	1	9	2393.6	0.2127	0.0869	22	33
138	1	8	2695.7	0.2905	0.1078	22	33
138	1	7	2995.7	0.2902	0.1272	22	33
138	1	5	3798.6	0.3098	0.1198	22	33
138	1	4	4197.1	0.4094	0.1792	22	33
138	1	3	4601.1	0.3996	0.1576	22	33
138	1	1	4955.4	0.5679	0.2386	22	33
139	1	24	10.7	6.1165	2.5159	22	33
139	1	20	317.7	1.1367	0.4364	22	33
139	1	18	494.3	0.4522	0.1792	22	33
139	1	17	596.9	0.3092	0.1255	22	33
139	1	15	852	0.2915	0.1051	22	33
139	1	13	1248.9	0.2797	0.0956	22	33
139	1	12	1499.4	0.2178	0.079	22	33
139	1	11	1805.1	0.1902	0.0707	22	33
139	1	10	2098	0.2488	0.1024	22	33
139	1	9	2407.1	0.2674	0.1139	22	33
139	1	8	2701.4	0.2637	0.109	22	33
139	1	7	3008.3	0.2605	0.1039	22	33
139	1	5	3603.5	0.305	0.123	22	33
139	1	3	4208.2	0.4539	0.1872	22	33
139	1	2	4391.3	0.4864	0.1977	22	33
139	1	1	4537.7	0.5357	0.206	22	33
140	2	22	496	0.287	0.1111	22	33
140	2	20	697.1	0.278	0.099	22	33
140	2	19	845.4	0.1913	0.07	22	33
140	2	18	995.2	0.2041	0.0724	22	33
140	2	12	3202.6	0.1814	0.0666	22	33
140	2	10	4004.5	0.2137	0.0714	22	33
140	2	9	4313.6	0.251	0.0962	22	33
140	2	8	4611.4	0.3305	0.1185	22	33
141	1	24	8.7	6.018	2.3836	22	33
141	1	23	67.8	6.1653		2~	3~
141	1	22	108.4	5.9288		2~	3~
141	1	21	196.5	1.8872	0.7239	22	33
141	1	6	3100.9	0.1243	0.057	22	33
142	1	24	10.5	6.2346	2.5337	22	33
142	1	3	4003.3	0.2704	0.0901	22	33
143	1	24	15	6.2659		2~	3~
143	1	23	72.6	6.273	2.4433	22	33
144	1	5	3006.5	0.2181	0.1123	22	33
146	1	24	9	6.2247	2.3731	22	33
146	1	23	54.8	6.4936	2.4507	22	33
146	1	22	118.1	6.0147		2~	3~
146	1	11	1741.7	0.3215	0.1204	22	33
146	1	10	1998.8	0.2162	0.0824	22	33
147	1	24	28.8	5.971		2~	3~
147	1	23	63.9	6.0404	2.3719	22	33
148	1	24	6.6	6.0981	2.4455	22	33
148	1	23	44.6	6.0447	2.4699	22	33

#STNNBR	CASTNO	SAMPNO	CTDPRS	CFC-11	CFC-12	QUAL1	QUAL2
149	1	23	4.4	6.2331	2.3689	22	33
149	1	22	49	6.2748	2.4126	22	33
149	1	13	1497		0.0776	~2	~3
150	1	24	7.1	6.4232	2.6341	22	33
150	1	22	7.3	6.3875	2.658	22	33
150	1	21	7.3	6.3586	2.596	22	33
151	1	24	3.7	6.2098	2.2891	22	33
151	1	23	37.8	6.1418	2.3206	22	33
152	1	24	5.6	6.3788		2~	3~
152	1	23	45.1	6.0594		2~	3~
153	2	24	52.6	6.3189	2.3411	22	33
153	2	23	52.6	6.2088	2.2687	22	33
153	2	8	2703.3		0.1151	~2	~3
154	1	22	117.8	5.8231		2~	3~
155	1	21	10.4	6.404	2.4394	22	33
155	1	20	39.9	6.4449	2.4768	22	33
155	1	19	89.2	5.6275		2~	3~
156	1	19	75.7	6.4205	2.4568	22	33
156	1	18	124.7	5.7608		2~	3~
157	1	23	8.5	5.8627	2.2899	22	33
157	1	22	48.1	6.0816	2.3617	22	33
157	1	15	591.7	0.3182	0.1689	22	33
157	1	9	1595.4	0.09	0.064	22	33
157	1	8	1805.5	0.0924	0.0729	22	33
157	1	6	2198.9	0.116	0.0802	22	33
157	1	5	2399.5	0.112	0.0851	22	33
157	1	4	2602.9	0.109	0.0753	22	33
157	1	3	2812.1	0.1269	0.076	22	33
157	1	2	3001.6	0.1432	0.09	22	33
157	1	1	3084.8	0.1418	0.0874	22	33
158	2	24	9	5.5825	2.3323	22	33
158	2	23	37.3	5.545	2.2047	22	33
158	2	22	108.1	5.5648	2.2078	22	33
159	1	24	15.1	5.4662	2.1345	22	33
159	1	23	42.4	5.4369	2.1264	22	33
159	1	22	101.8	5.4104	2.1501	22	33
159	1	15	696.6	0.4907	0.1697	22	33
159	1	14	843.1	0.3842	0.1451	22	33
160	1	24	33.3		2.0017	~2	~3
160	1	23	79.7		2.0037	~2	~3
160	1	12	1141.9	0.1267	0.04	22	33
160	1	5	2747.7	0.1626	0.0534	22	33
160	1	4	2998	0.1365	0.0441	22	33
161	1	23	8.3		1.9787	~2	~3
161	1	4	2296.5	0.1394	0.0297	22	33
161	1	3	2700.8	0.1179	0.0385	22	33
161	1	1	3038.9	0.0658	0.0445	22	33
166	3	15	1594.9	0.1115	0.0742	22	33
166	3	14	1797	0.0422	0.0594	22	33
166	3	13	1998.4	0.0454	0.0109	22	33
166	3	2	4612.8	0.0073	0.0254	22	33

CFC DQE QUALITY FLAGS INPUT FILE: METEOR.RVW THE DATE TODAY IS: 15-AUG-91

#STNNBR	CASTNO	SAMPNO	CTDPRS	CFC-11	CFC-12	QUAL1	QUAL2
166	3	1	4607.8	0.0197	0.0404	22	33
167	2	18	1145.8	0.8275	0.3152	22	33
167	2	10	2751.6		0.017	~2	~3
167	2	9	3002.3		0.0208	~2	~3
167	2	4	4256.7		0.0251	~2	~3
167	2	3	4406.1		0.0221	~2	~3
167	2	2	4555.1	0.0406	0.0215	22	33
168	2	14	1691.9	0.0549	0.0409	22	33
168	2	13	1894.2	0.028	0.0277	22	33
168	2	11	2295.8	0.0395	0.0096	22	33
168	2	10	2494.6	0.0051		2~	3~
168	2	8	2903.4	0.02	0.0217	22	33
168	2	1	3836	0.0376	0.0122	22	33
169	2	10	2297.3	-0.0183	-0.0156	22	33
169	2	5	3751	0.0262		2~	3~
169	2	2	4504.9	0.0136		2~	3~
169	2	1	4586.2		0.0116	~2	~3
170	2	17	1181.7	0.523	0.3213	22	33
170	2	3	4205.2	0.0145	0.0176	22	33
170	2	2	4405.6		0.0263	~2	~3
171	2	16	1395.6	0.2891	0.1062	22	33
171	2	13	1999.1	0.0091	0.0199	22	33
171	2	11	2495.7		0.0139	~2	~3
171	2	10	2747.3	0.0173	0.0238	22	33
171	2	9	2999.2	0.0144	0.0261	22	33
171	2	6	3751.9		0.0129	~2	~3
171	2	5	4001.4		0.0121	~2	~3
171	2	4	4254.5	0.0325	0.025	22	33
171	2	3	4510.6	0.0209	0.0278	22	33
171	2	2	4706.1		0.0225	~2	~3
171	2	1	4811.2	0.0376	0.0441	22	33
172	3	16	1796.7	0.0058	0.0243	22	33
172	3	15	2004.8	0.002	0.0104	22	33
173	1	11	36.4	3.0108	1.3036	22	33
173	2	9	3001.2	-0.012		2~	3~
173	2	8	3253.1	-0.0145		2~	3~
173	2	7	3503.9	-0.0153		2~	3~
173	2	3	4505.5		0.0113	~2	~3
174	2	11	2749.9		0.0172	~2	~3
174	2	9	3252.4		0.0097	~2	~3
175	2	13	2248.2	-0.0124		2~	3~
175	2	11	2741.3	-0.013		2~	3~
175	2	9	3250.3	0.0281		2~	3~
175	2	4	4509.7	-0.0073	-0.0014	22	33
176	2	23	15.2	1.2716	0.5334	22	33
176	2	22	80.9	1.6971	0.7678	22	33
176	2	18	1047.5	0.8307	0.322	22	33
176	2	14	1652.8	0.15	0.0306	22	33
176	2	11	2248.1		0.0135	~2	~3
176	2	5	4010	-0.005		2~	3~
176	2	3	4510.8	-0.0037		2~	3~

CFC DQE QUALITY FLAGS   INPUT FILE: METEOR.RVW   THE DATE TODAY IS: 15-AUG-91

#STNNBR	CASTNO	SAMPNO	CTDPRS	CFC-11	CFC-12	QUAL1	QUAL2
177	2	18	943.9	0.1464	0.0877	22	33
178	1	13	6.1	2.1409	1.0641	22	33
178	2	8	2754		0.013	~2	~3
178	1	4	903.1		0.1499	~2	~3
178	1	3	903.1	0.3723		2~	3~
178	1	2	902.9	0.4061	0.1768	22	33

Data Processing Notes

Date	Contact	Data Type	Data Status Summary
03/04/91	Van Woy	CFCs	DQE Begun
	needs more info. to continue. See cruise report for Van Woy's full DQE report and suggested flags.		
03/08/91	Mantyla	NUTs/O	DQE Begun; Problems w/ nuts data
04/23/91	Mantyla	NUTs/O	DQE Report Submitted
	Data do not meet WOCE standards. See cruise report for Mantyla's full DQE report and suggested flags.		
07/12/91	Jennings-Jr.	NUTs/O	DQE Complete
	"Data appears overall to be of high quality". See cruise report for Jennings' full DQE report and suggested flags.		
05/06/93	Millard	CTD	DQE Report Submitted
07/15/93	Witte	CTD	Calibration Report Submitted
	DQE Issues Unresolved The following is a description of the pressure averaging used at AWI for preparing the 2-decibar CTD data. (see cruise report, "CTD calibration report 06MT11_5") It is difficult to explain the difference between CTD salinity and water sample salinity in the station number 154, since the CTD salinity data used in the plot are not the data from the 2-decibar CTD profile. Nothing points to a defect in the CTD during stations 175, 176, 178 and 179. It may be that the questionable data are an indication of the extreme variability of the survey region.		
12/09/94	Kozyr	CO2	Final Data Submitted
03/09/99	Newton	Tracers	cfc hel trit delhe neon merged into btl file
	• Data status notes say DQE found nuts/oxy/sal not up to WOCE standards, but there is no explanation in cruise docs. • merged CFC-11 CFC-12 TRITUM HELIUM DELHE3 TRITER HELIER DELHER. added NEON NEONER. • Changed stn116 cast1 to cast2. • New values from stn173 cast1 had unmatched sampno's. No way to reconcile and merge into a21hy.txt. 12 samples not merged. • New values from stn140 cast2 sampno1->4 had no counterparts in a21hy.txt. • New values from stn164 cast2 sampno 2,4,6,8,10,12 had no counterparts in a21hy.txt - can't tell if something's amiss here. • In a21hy.txt changed HELIUM and HELIER from 8.3 to 8.4, changed DELHE3 missing code from -9. to -999. • new a21hy.txt datestamp: 20000626WHPOSIODMN		
03/09/99	Klein	Tracers	He/Tr/cfc/neon data Submitted

03/10/99	Diggs	Tracers	(He/Tr/cfc) Clarification Requested

After careful inspection of the data file that you sent, I have concluded that there are some potential problems that we need to resolve before I merge your A21/S04 data (Helium, Neon, Tritium, CFCs) with the rest of the bottle data.

Your data file has some minor problems with the header, but the serious issues are those with the precision of the CFC, and NEON values. The WOCE specification of these fields is F8.3, yet you report your values are F8.4. I had reformatted your files earlier and noticed that my software caused your values to be rounded (not truncated). It may seem like a lot of trouble, but I don't think that the WHPO should be in the business of reproducing data values from the originator's file. Therefore, would you be so kind as to re-send the data? If not, I *could* use the values that I have. I would need some official statement from you. I could even send you my program that I wrote to reformat your files (it is written in Perl 5).

In addition, I have included two short files, which are the first 16 lines of your original file and my reformatter file. These are attachments.

08/03/99	Diggs	He/Tr/cfc/	Data are Final; questions resolved
2/14/00	Kozyr	TCARBN/PCO_2	Final Data Submitted

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

03/10/00	Holliday	Cruise ID	Website Update

A20 NOT included in this cruise A21/S04/SR02 (Roether) you also have this under S01 but the cruise clearly isn't on S01 so that entry should be removed.

04/18/00	Kappa	Cruise ID	Data Update; s01 designation changed to a21
06/12/00	Huynh	DOC	Line designations corrected in onine doc files
06/26/00	Newton	Tracers	Merged into hyd file

Merge notes for a21 06MT11/5 :
Please let me know what you decide.

- Merged file: Mar 9 1999 a21_bklein_cfc_tr-hr-ne_FIXED.dat directory: ..../a21/original/TRACERS_1999.03 .sea file: Feb 27 1998 a21hy.txt (no WHPO datestamp)
- Data status notes say DQE found nuts/oxy/sal not up to WOCE standards, but there is no explanation in cruise docs.
- Merged CFC-11 CFC-12 TRITUM HELIUM DELHE3 TRITER HELIER DELHER.
- Added NEON NEONER.
- Changed stn116 cast1 to cast2.
- New values from stn173 cast1 had unmatched sampno's. No way to reconcile and merge into a21hy.txt. 12 samples not merged.
- New values from stn140 cast2 sampno1->4 had no counterparts in a21hy.txt.
- New values from stn164 cast2 sampno 2,4,6,8,10,12 had no counterparts in a21hy.txt - can't tell if something's amiss here.
- In a21hy.txt changed HELIUM and HELIER from 8.3 to 8.4, changed DELHE3 missing code from -9. to -999.
- New a21hy.txt datestamp: WHPOSIODMN

07/10/00	Bartolacci	BTL	Website Updated; newly merged file online

Parameters: cfc-11, cfc-12, tritum, helium, delhe3, neon, triter, helier, delher, neoner, qualt1, qualt2

I have replaced the current botlte file with the newly merged file containing cfc's he, trit, delhe3, neon, and associated errors, merged by D. Newton

06/20/01	Uribe	BTL	Website Updated; EXCHANGE File Added

Bottle file in exchange format has been linked to website.

06/21/01	Uribe	CTD/BTL	Website Updated

CTD EXCHANGE File Added, BTL EXCHANGE file modified The exchange bottle file name in directory and index file was modified to lower case. CTD exchange files were put online.

06/27/01	Uribe	CTD	Website Updated; EXCHANGE File put online

12/20/01	Uribe	CTD	Website Updated; EXCHANGE File put online

CTD has been converted to exchange using the new code and put online.

12/21/01	Hajrasuliha	CTD	Internal DQE completed

created *check.txt file for this cruise. Created .ps files for this cruise.

2/18/02	Klein	Tracers	CFC/He/Tr/Ne/DEL3HE resubmitted

When I last submitted the final helium/tritium data for the cruise and and updated version of the cfc data, I noted a problem in the merged data file later on due to an inconsitency of the basic hydrography data. It resulted in profiles that were upside-down (in CFC, helium, delta-3he, neon and Tritium) fo st. 106 and 113. Sta. 173 had different bottle numbers in our file and therefore the CFC data for this profile had not been remerged. And station 116 had a different cast number so data from that statin were also not remerged. I have written to you about it in the past but somehow the wrong profiles never got changed. Since we have been working on a data quality assessment for the tracer data of the south Atlantic we also examined the consistency of the tracer data and gave new quality flags. Especially for the CFCs we have added a larger number of data questionable. I changed our hydrography data to be the same as yours and merged all tracer data and new quality flags to your a21hy.txt file. The file I am sending now is correct in all tracer values, has unchanged data for stat, cast, sample, bottle, pres, temp, ctdsal, ctdoxy, theta, sal, oxy, silicate, nitrate, nitrit, phosphate and has an update of tracer quality flags. You don't have to merge it again by your side, just check for yourself against your old file that I only altered the above mentioned problematic tracer profiles and changed tracer quality bits and then please replace it on your webside.

2/18/02	Diggs	Tracers	Need to be remerged into online file

To be on the safe side, we will re-merge your file for the parameters listed (CFC/He/Tr/Ne/DEL3HE) with our own online version and re-check the values. This should happen over the course of the next two weeks.

Take another look at our online files, just to be sure, sometime around the first week in April.

2/18/02	Bartolacci	DOC	Update Needed

change line numbrs in doc to A21 and S04, SR02. 06MT11_5 occurred during a time when PIs were not using current WOCE line naming conventions. Various segments of this cruise were given multiple basin line designations according to the PI's discretion. Since that time, the WHOI WHPO has renamed parts of the cruises line designations in an attempt to make the lines conform to recognized WOCE lines.

The original cruise track for 06MT11_5 was divided into 2 sections: S01/A21 and S02/A12. After the completion of the cruise the S02/A12 designation was dropped and that section was divided into S04 and SR02.

The sum file now has line A21, S04 and SR02 as line numbers covered by this cruise. However the DOC file still lists the old line designations of S01/A21, S02/A12 as well as the new designation of A21/S04/SR02. This cruise is currently on the WHPO public table under the lines A21 and S04, SR02.

05/22/02	Key	LV data	Submitted

I have attached my version of the LV data file for Meteor 11/5. In this case, the "my" is important. This file was assembled from various partial files obtained over a period of years. Simply stated, the merging process was a nightmare. At the very least, there are bound to be some errors in the flags (except for C14). The file contains C13 data, which I have not checked at all. My guess is that all these C13 data should be flagged 3 as is the case for all the LV U.S. C13 data. The low quality of the C13 is a result of the old technique (LV C13 data were only measured in order to correct C14 measurements for fractionation during processing).

Regardless, this is probably the most complete and correct version of the LV data for that cruise which exists (at least electronically). I have also attached a copy of my summary README* which gives a small portion of the history of various data components. I have far more info when/if needed.

In the attached file I intentionally deleted all calculated parameters (theta, sigmaX, aou, etc.) except for depth in case the official WHP software differs from mine. The file format is very similar to the WHP "exchange" format with "," separators and with QUALT1 burst to single digit integers. I don't think you'll have any problem reading it. Units are all WOCE standard.

After taking a look at these 2 files, let me know what additional info is needed - hopefully I can provide it.

All the above specifically EXCLUDES H-3/He-3 info, details, etc. I have never been on the "inside" with respect to these data streams.

*1/3/2001 (continued)

05/22/02	Key	LV data	Submitted (continued)

Initialized README file Meteor cruise 11/5
WOCE sections A12 and A21 (old designations, currently A21 S04 SR02)
EXPOCODE: 06MT11_5
Ushuaia, Argentina to Capetown, South Africa
January 23, 1990 to March 8, 1990
78 stations with 24 place Rosette
18 LV stations for C14, K85, Ar39, Ra
W. Roether, Ch. Sci.

- Hydro: Who: G. Rohardt, E. Fahrbach
  Status: final
  S Plus: up to date
- Nuts/O2: Who: SIO
  Status: final
  S Plus: up to date
- TCO2: Who: D. Chipman & T. Takahashi;
  Status: Final
  S Plus: Up to date
  Notes: prior to CRM, coulometer analysis with estimated precision of 1 µmol/kg. Calibration against high purity CO2 gas also measured on LV samples NDP 045
- TA: Who: n/a
  Status: not measured
  S Plus: n/a
- pCO2: Who: D. Chipman & T. Takahashi
  Status: Final
  S Plus: Up to date
  Notes: measured at 20C via fid GC on 500ml samples
- pH25: Who: n/a
  Status: not measured
  S Plus: n/a
- CFC: Who: W. roether
  Status: final?
  S Plus: up to date
  Notes: data from Smethie 5/10/93
- C-14: Who: P. Schlosser
  Status: final
  S Plus: up to date
  Notes: AMS + LV collected. All existing results in LV files
- C-13: Who: P. Schlosser
  Status: final
  S Plus: up to date
  Notes: AMS + LV collected. All existing results in LV files
- H-3/He-3: Who: W. Roether
  Status: ?
  S Plus: no data

06/21/02	Wanninkhof	BTL	Update Needed; BTL stations need updating

we are working with Bob Key, Alex Kozyr, Chris Sabine and many others on the Global Carbon synthesis. The following notes are for the synthesis group but some might be of relevance to you as well.

Betty has been doing a last check of our carbon synthesis product for the Atlantic and the "WOCE bottle data" and "WOCE bottle data in exchange format". Unfortunately the data in these files are not always the same. [note, whpo@ucsd.edu perhaps clearly indicate last updates in each of the files].

We made the following changes to our data files which were originally obtained from Alex via CDIAC. The following are the notes from Betty and will be reflected in our version 11 data.

Alex please note the unresolved issues for A01W and AO2. Alex, could you please determine if the WOCE files have the latest carbon data. Because of differences in sample # between the original file you sent and the WOCE file we cannot merge data from one file to the other for A01W and A02

A21 - In the WOCE file the last station is 120 while our file has A21 ending at station 121. Otherwise, the files are the same. This is an issue of where A21 ends and A12 starts. that is in our file A12 starts with station A122 and the WOCE file starts with A120.

05/02/03	Kappa	Doc	New PDF & TXT docs assembled

Additions to cruise reports:

1. CTD Calibration report
2. CO_2 Report
3. Data Quality Reports:
   - CTD DQE report (Robert Millard)
   - Nutrients/Salinity/Oxygen DQE report (Arnold Mantyla)
   - Nutrients/Salinity/Oxygen DQE report (J.C. Jennings)
   - CFC DQE report (R. Van Woy)
4. WHPO-generated cruise/station tracks
5. Visually enhanced figures
6. List of contributing authors
7. These WHPO data processing notes
8. Corrected line designations