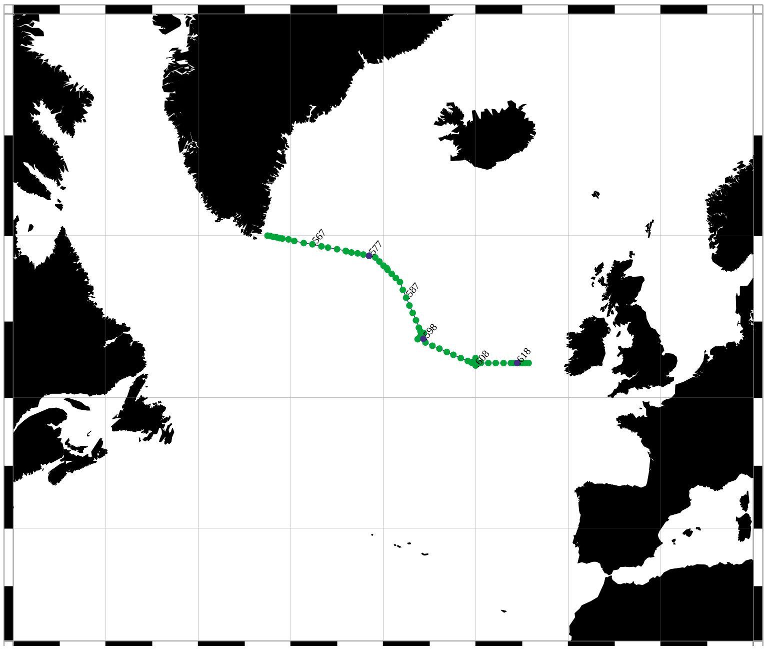
A. Cruise Narrative: A01E



A.1. Highlights

WHP Cruise Summary Information

WOCE section designation	**A01E**
Expedition designation (EXPOCODE)	**06MT18_1**
Chief Scientist(s) and their affiliation	**Jens Meincke/IfMH***
Dates	1991.SEP.02 – 1991.SEP.26
Ship	METEOR
Ports of call	Reyjavik, Iceland to Hamburg, Germany
Number of stations	64
Geographic boundaries of the stations	60°00.00' N 42°30.60' W 14°15.20' W 52°10.10' N
Floats and drifters deployed	0
Moorings deployed or recovered	6 moored current meter arrays
Contributing Authors	A. Sy, M. Bersch, A. Mittelslaedt, R. Bayer, B. Hoffahrt, A. Putzka, K. Blusiewicz, G. Fraas, B. Schneider, K. Johnson, L. Mintrop, H.-J. Isemer, J. Sußebach, H. Sonnabend, D. Ellett

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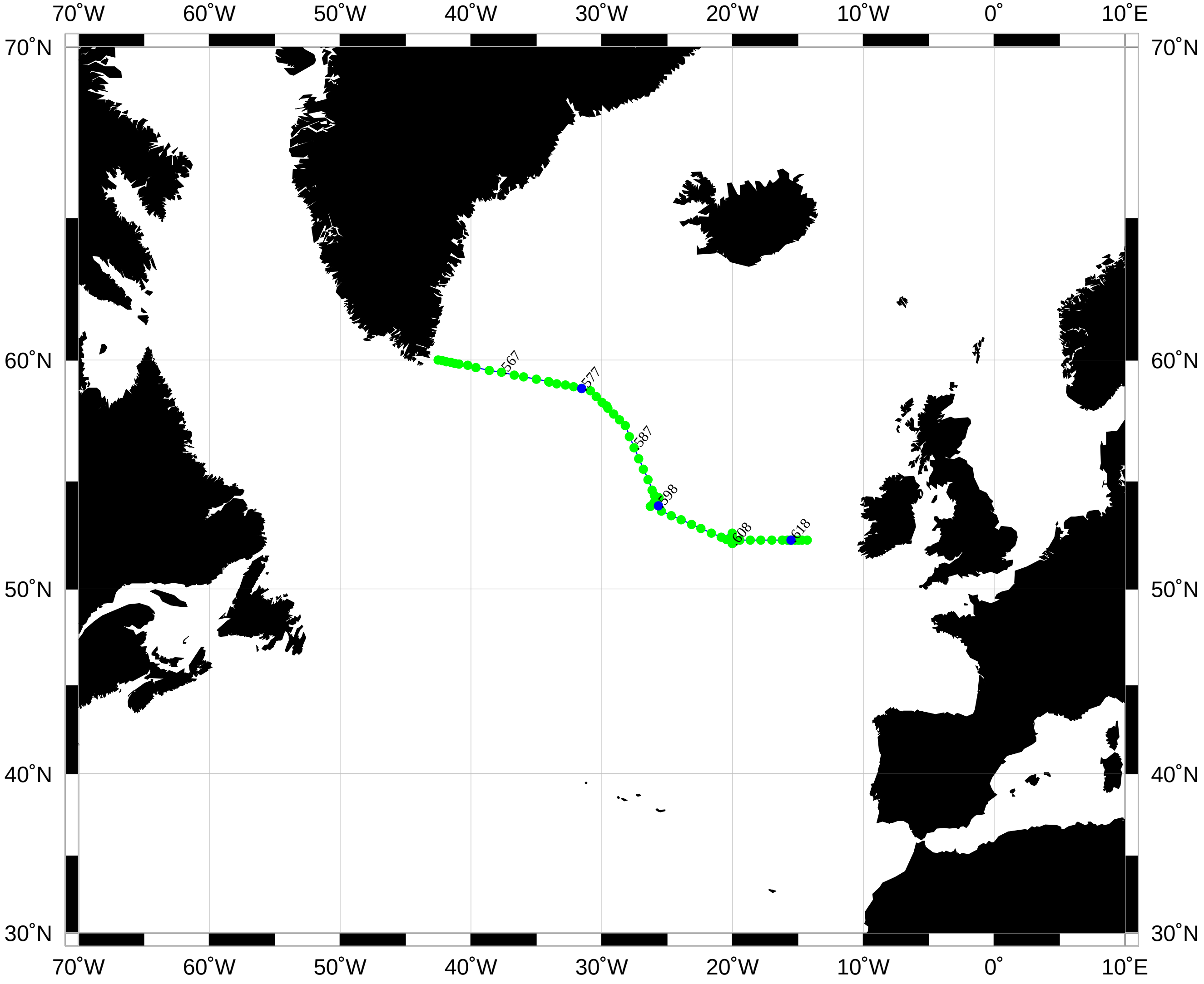
WHP Cruise and Data Information

Click on any item to locate primary reference or use PDF navigation tools above.

Cruise Summary Information	**Hydrographic Measurements**
Description of scientific program	CTD measurements
	Temperature
Geographic boundaries of the survey	Oxygen
Cruise track (figure)	Pressure
Description of stations	Salinity
Description of parameters sampled	
Bottle depth distributions (figure)	
	Bottle Data
Moorings deployed or recovered	Oxygen
	Salinity
Cruise Participants	Nutrients
	CFC-11 and CFC-12
	Helium/Tritium/C14
	Carbonate System
Underway Data Information	**DQE Reports**
	CTD
	Bottle
Acoustic Doppler Current Profiler (ADCP)	
XBT and/or XCTD	
Meteorological observations	
Data Processing Notes	**References**
	HYD/BTL

Station locations for A01E: Meincke, 1991



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Abstract

The METEOR cruise no. 18 was aimed at contributing to the World Ocean Circulation Experiment (WOCE) in particular to the one-time survey of the WOCE-Hydrographic Programme. The survey line from Ireland to Kap Farvel crosses the North Atlantic just to the south of the major convective regimes, so that transport estimates for the warm and the cold water masses can be used to estimate the North Atlantic overturning rate. This quantity is one of the key figures for the ocean's role in climate.

Measurements were carried out as outlined in the WOCE-documentation, i.e. the full suite of hydrographical and nutrient parameters and tracer substances as tritium, helium, CFCs and radiocarbon. In addition the quantities relevant to determine the ocean carbon cycle were sampled. The measurements on stratification were complemented by direct current measurements, employing an acoustic doppler current profiling system for the upper 300m and deploying long term moored current meter arrays at six locations along the survey line. The quality of the data obtained was generally confirming to the standards set by WOCE.

Zusammenfassung

Die 18. Reise der METEOR ist ein deutscher Beitrag zum World Ocean Circulation Experiment (WOCE), in diesem Falle sum sog. ‘one time survey’ des WOCE-Hydrographic Programme. Der bearbeitete hydrographische Schnitt von der Sudspitze Gronlands bis nach Irland quert den nordwärtsgerichteten Warmwassertransporte und die südwartsgerichteten Kaltwassertransporte bilanziert werden, un die für Klimabetrachtungen wichtige Umwalzrate des Nordatlantiks zu erhalten.

Das Meßprogramm entsprach den Vorgaben von WOCE, d.h. zu den hydrographischen Parametern wie Temperatur, Salzgehalt und Sauerstoffgehalt kamen Nährsalze und Spurenstoffe wie Tritium, Helium, FCKWs und ^{14}C hinzu. In enger Absprache mit dem internationalen Joint Global Ocean Flux Study (JGOFS) wurden die Komponenten zur Bestimmung des Kohlenstoffkreislaufes im Meer ebenfalls gemessen. Zur direkten Bestimmung der Strömung kam ein akustischer Profilmesser für die oberen 400 m vom fahrenden Schiff aus zum Einsatz und es wurden an 6 Positionen Stromungsmesserketten zur Langzeitregistrierung verankert. Die Datenqualität entsprach generell dem WOCE-Standard.

1 Research Objectives

The North Atlantic Ocean is characterized by an intense meridional circulation cell, carrying near surface waters of tropical and subtropical origin northwards and deep waters of arctic and subarctic origin southwards. The related "overturning" is driven by sinking of water masses at high latitudes. The overturning rate and thus the intensity of the meridional transports of mass, heat and salt is an important control parameter for the modeling of the ocean's role in climate. Certainly such estimates require more than one survey of the study area and therefore the METEOR cruise no. 18 was one in a series of cruises, which started in March 1991 and is expected to continue into 1995. This effort, which is a joint project of the

Institut für Meereskunde, University of Hamburg and the Bundesamt für Seeschiffahrt und Hydrographie, Hamburg in cooperation with varying groups from other marine institutions, serves two purposes: On the one hand it is a German contribution to the international World Ocean Circulation Experiment, WOCE-Hydrographic-Program, in particular to the WHP one-lime survey of the eastern part of the hydrographic section A1 and the repeats thereof (ANON, 1988). On the other hand it serves the national project WOCE-NORD (North Atlantic Overturning Rate Determination). Its objective is to determine directly the overturning rates by means of seasonally repeated hydrographic sections between the southern tip of Greenland and Ireland in combination with current measurements from long-term moored arrays (see Figure 1). The location of the section was chosen to be to the south of the major wintertime convection regions to avoid water mass formation processes and to stay away from shallow topography in order to avoid difficulties in applying the geostrophic method for volume transport estimates.

The occasion of the cruise M 18 was also used to contribute to the global study of the carbonate system, which is carried out in the framework of the Joint Global Ocean Flux Study in close coordination with WOCE.

2 Participants

Name	Specialty	Institute
Bassek, D., Technician	Meteorology	SWA
Bayer, R., Dr.	Tracer-Physics	IUPH
Beckmann, U., Technician	Oceanography	IFMK
Bersch, M., Dipl.-Oz.	Oceanography	IFMH
Bos, D., Technician	Tracer-Physics	SIO-ODF
Braun, W., Guest, State Dep	Oceanography	IFMH
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May, H., Technician	Oceanography	BSH
Meincke, J., Prof. Dr.	Oceanography	IFMH
Morak, A., Technician	Geochemistry	IFMK
Muus, D., Technician	Tracer-Physics	SIO-ODF
Nesemann, M., Student	Oceanography	IFMH
Paul, U., Dipl.-Oz.	Oceanography	BSH
Putzka, A., Dr.	Tracer-Physics	UBP
Ramirez, R., Technician	Geochemistry	BNL
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Name	Specialty	Institute
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Sußebach, W., Reg. Rat.	Meteorology	SWA
Sy, A., Dr.	Oceanography	BSH
Verch, N., Technician	Oceanography	BSH
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Wüllner, H., Technician	Oceanography	IFMH

Participating Institutions

BNL	Brookhaven National Laboratory Oceanographic and Atmospheric Sciences Division Upton, NY, 11973, USA
BSH	Bundesamt fur Seeschiffahrt und Hydrographie Bernhard-Nocht-Str.78 D-20359 Hamburg
IFMH	Institut fur Meereskunde der Universitat Hamburg Troplowitzstr.7 D-22529 Hamburg
IFMK	Institut fur Meereskunde der Universitat Kiel Dusternbrooker Weg 20 D-24105 Kiel
IUP	Institut fur Umweltphysik der Universitat Heidelberg Im Neuenheimer Feld 366 D-69120 Heidelberg
SIO-ODF	Scripps Institution of Oceanography Ocean Data Facility La Jolla, Cal., 92093, USA
SWA	Seewetteramt Hamburg, German Weather Service Bernhard-Nocht-Str. 76, D-20359 Hamburg
UBP	Universitat Bremen, Fachbereich Physik Postfach 330 440 D-28334 Bremen

3 Research Programme

3.1 Physical Oceanography

The physical oceanography programme consisted of two parts: Along the section between Greenland and Ireland 64 hydrographic stations were occupied. On each station the vertical distribution of temperature, salinity, dissolved oxygen content and nutrient content (NO_3, NO_2, SIO_3 and PO_4) was obtained, using continuously measuring $CTDO_2$-sondes as well as water samples from discrete depths. This data set will allow to determine the distribution of water masses and to estimate the relative transport distribution during the summer season.

At six locations near strong gradients of the bottom topography current meter moorings were deployed. These records will allow to quantify the transports of deep topographically steered boundary currents as well as their temperature fluctuations over the period of one year. Combining this information with the hydrographic data will result in total transport estimates of the various water masses present.

Throughout the cruise continuous current profiles using the ship-mounted acoustic doppler current profiler were measured as well as sea surface temperature and salinity. To increase the spatial resolution of the hydrographic sampling, temperature and salinity profiles up to a depth of 800 m were also obtained by use of expendable sondes (XBTs). These data were transmitted directly to the IGOSS (Integrated Global Ocean Services System) data bank via satellite.

3.2 Tracer Oceanography

Measurements of geochemical and radioactive tracers of anthropogenic origin allow an age determination of water masses if the atmospheric input function into the ocean is known. Thus they complement the classical hydrographic work for the determination of watermasses.

Tracer measurements carried out on the hydrographic section between Greenland and Ireland may serve as northern-boundary values, as needed for evaluations of Atlantic tracer distributions. The observations will specifically give starting concentrations for the North Atlantic Deep Water. Tracer concentrations within the overflows will moreover yield information on the turnover of the water masses feeding the overflows. Tracer measurements in the area have been carried out repeatedly since 1972, but for the first time, a complete section valuable in determining the temporal evolutions further on. The point is that the main information content of the distribution is contained in their transient nature, as well as in differences in between the various tracers.

Measurements were carried out of the CFC's F11 and F12. Samples for ^{3}He, tritium and ^{14}C, were taken for sample preparation and measurement at Heidelberg, the ^{14}C-measurements as such being carried out at Eidgenössische Technische Hochschule Zürich (ETH). A new seagoing ^{3}He sample extraction was tested, that is expected to improve sample quality and reduce the time lag until measurements can be made available. All measurements were to meet WOCE quality standards.

3.3 Marine Chemistry

The focus of the chemistry programme was on the carbonate system, which is studied globally within the frame of the JGOFS and which is tightly co-ordinated with WOCE.

CO_2 partial pressure difference (ΔpCO_2) between the atmosphere and the sea surface was measured along the section. This quantity is the driving force for the air/sea exchange of CO_2 into the ocean, provided sufficient information about the global distribution of ΔpCO_2 is available.

Vertical profiles of the parameters of the carbonate system were determined at selected stations. Such data, in connection with oxygen and nutrient concentration, may be used to reconstruct the conditions in pre-industrial ocean surface waters and thus identify the anthropogenic signal.

The stations were partly located at positions where previous investigations of the carbonate system have been made. This will allow to assess the seasonal variability, partial pressure, and pH. By this over-determination (two parameters are sufficient to describe the system) the measured data may be checked for the thermodynamical consistency.

The chemical analysis of all components of the carbonate system was performed on board. For the coulometric determination of the total carbonate, an additional system was used by a colleague from the Brookhaven National Laboratory (USA). This allowed an intercomparison of methods and data.

3.4 Marine Meteorology

The meteorological part of the cruise was aimed at instrument developments to measure precipitation. The ocean's thermohaline circulation is driven by density gradients that are to a large extent influenced by the freshwater balance at the sea surface. Hence, measurements of precipitation at sea are needed. Also, ground truth is still lacking for verification of both, numerical model results as well as satellite measurements and algorithms. Unfortunately, reliable methods to measure rain from ships are not available, and hence it is not possible to rely on the several thousands of voluntary observing ships that by routine provide the bulk of reliable values of other parameters for weather forecasting and climatology.

During METEOR cruise no. 14, newly developed rain measuring equipment with novel techniques has been tested. The experiences gained by these tests has led to improvements. Two advanced instruments with mechanical and optical gauging techniques were tested on METEOR cruise no. 18. This cruise was especially suited to test rain gauging equipment since the cruise lead right into the centre of the Atlantic storm activity. The meteorological program is a contribution to WOCE. In addition routine meteorological observation were made from the met-station aboard METEOR, to provide:

- short term weather and sea state forecasts,

- synoptic observations (every three hours) and radiosonde measurements (every twelve hours) transmitted to the GTS for use in the world-wide weather forecast centres,
- continuous registration of basic meteorological data for use by the scientific working groups aboard METEOR.

4 Narrative of the Cruise

(J. Meincke)

METEOR left Reykjavik on September 2, 1991, 11:00 UTC. With heavy south-westerly winds for the first two days the progress towards the starting position of WOCE section A1/east (see Figure 1) was rather slow. Two stations for testing the CTDs and the rosette sampling system were carried out en route to Kap Farvel before the hydrographic sampling was resumed with station 558 (see chapter 7) on September 5, 13:40 on the SE-Greenland shelf. The dense station spacing over the slope, in conjunction with quiet weather, made the establishing of the necessary routine in the station work a fast process. However, electrical problems with the sliprings of the CTD winch, the failure of a diode in the CTD fish and irregularities in the rosette bottle-release interrupted the routine on September 6 and 7. On September 9, the first two moored current meter arrays were deployed over the western flank of the Reykjanes Ridge (Positions A and B on Figure 1), then hydrographic station work continued until the deployment of mooring C on September 10 and mooring D on September 11. All moorings were deployed over rough topography, appropriate locations were found by means of short hydrosweep-surveys preceding each launch. Meanwhile winds had steadily increased, coming from SE. Upon completion of station 591 on September 13 all sampling had to be stopped for 16 hours because of winds with gale force up to 10, turning from SE to WNW. CTD work was resumed on September 14 without the rosette because of heavy seas and swell on stations 592 to 595. These stations were oriented normal to the WOCE section and up slope over the southern flank of the Eriador Seamount which forms the southwestern tip of the Hatton Bank. With this station arrangement, completed by the deployment of mooring E close to the intersection of the two hydrographic lines it is expected that the regional effect of topography on the flow pattern can be resolved.

The WOCE section was continued with full hydrography and reasonable weather conditions on September 15 and 16, only interrupted by the necessity to replace the electronics of the rosette underwater unit. On September 17, work had to be interrupted for about 9 hours, because of winds up to Beaufort 10 to 11. Measurements on station 606 were resumed with the CTD without water samples on the next two stations only 12 out of 24 sampling bottles were mounted on the rosette frame to minimize the risk of damaging gear and cable in the heavy seas. This "reduced" sampling again was restricted to another short hydrographic line normal to the WOCE line at the southern tip of Rockall Plateau. The WOCE section was continued with complete profiling from station 611 onwards.

Although the weather remained rough with SW-winds around Beaufort 7, all stations and the deployment of mooring F could be completed. The WOCE section was finished with station 622 on the Porcupine Shelf on September 21. Because of the weather forecasts the original plans to return to Hamburg via the northern route through the Pentlands in a partly repeat of

JGOFS-CO_2 measurements during the METEOR cruise no. 10 were dropped. Instead, the vessel set course for the English Channel and reached Hamburg on September 25, 06:00 LT.

5 Operational Details and Preliminary Results

5.1 Hydrographic Measurements

(A. Sy)

Hydrographic casts were carried out with a NBIS MK-III CTDO_2 unit mounted on a GO rosette frame with 24 x 10 litre Niskin bottles. EG&G's Oceansoft rev. 3.1 was used for data acquisition at a rate of 32 ms/cycle. The "NB3" CTD underwater unit was provided by IFM Kiel. Pre-and post-cruise calibrations were carried out in July and December 1992 by the calibration laboratory at IFM Kiel. This instrument ran without major problems during the whole cruise . However, all the rosette systems used proved to be poorly adapted to the CTD system and/or were subject to various mechanical/electrical problems. Three different systems were used. Nevertheless, tripping failures occurred more or less at most stations in particular at nos. 596 to 613 and additionally, CTD trip recording problems were experienced at station nos. 599 to 613. Repeated checks on board and several careful verifications with the complete bottle data set, however, should ensure that all the samples will finally be assigned to their correct pressure levels.

The bottle sampling sequence was as follows. Oxygen samples were collected soon after the CTD system was brought on board and after CFC and ^{3}He were drawn. The sample water temperature was measured immediately before the oxygen sample was drawn. The next samples collected were pCO_2, TCO_2 alkalinity, ^{14}C, ^{3}H, nutrients (NO_2, NO_3, SIO_3, PO_4) and salinity.

Salinity samples were drawn into dry 200 ml BSH salinity bottles (Besser, Hamburg) with polyethylene stoppers and external thread screw caps. It was found by KIRKWOOD and FOLKARD (1986) that these bottles guarantee best long-term storage conditions. Bottles were rinsed three times before filling. Samples were collected twice, once for shipboard salinity measurements and once for the possibility of cross checks by later shore-based salinity analyses. The rosette sampling procedure was completed by readings of electronic (SIS, Kiel) and mechanic (Gohla, Kiel) deep sea reversing thermometers (DSRT) for a first quick check of the scheduled bottle pressure level and for in situ control of the CTD pressure and temperature calibration.

Sixty-four CTD casts were carried out along section A1/East (Figure 1); one cast failed and had to be repeated. Four casts were used for rosette sample quality tests by means of multitrips at the same level. The number of water sampling levels was 1208. A distribution of water sample depths is given in Figure 2. An overview of activities, occurrences and measured parameters is summarized in the station listing (chapter 7).

To meet WOCE quality requirements, the processing and quality control of CTD and bottle data followed the published guideline of the WOCE Operations Manual (WHPO 91-9) as far as their realization was technically possible on this cruise.

CTD data were processed at BSH. As a first step, physical time series were generated from raw binary data for which the EG&G standard hardware calibration file was used (no laboratory calibration was applied at this stage) to allow pre-cruise, post-cruise and in situ correction comparisons as well as comparisons with the sensor history. It turned out that the pre- and post-cruise laboratory calibration of pressure and temperature was stable (no significant differences) and thus this function was used for the final correction of the field data.

The difference between in situ and laboratory correction functions of the low-gradient temperature domain was found to be +1 mK to +2 mK which corresponds well with the results of a temperature calibrations intercomparison carried out between 4 laboratories in January 1992. Whereas up to 12 electronic (SIS) DSRTs (calibrated in July and October 1992 by SIS, Kiel) are used in a rotating mode for in situ temperature comparisons, this cruise had at hits disposal only 2 electronic (SIS) DSR pressure sensors which were insufficient for in situ correction. In addition to the electronic DSRTs, 12 lowrange Hg DSRTs were used in the same mode. These were calibrated by Gohla Precision in Kiel in July and October 1992. However, whereas the reproducibility of the Hg DSRT readings was found to be better than 3 mK (reproducibility of electronic DSRTs was better than 2 mK), the much larger difference between the CTD and SRT means was interpreted as a DSRT calibration problem. Thus Hg DSRT readings were not used for CTD quality evaluation.

The salinity correction was carried out using in situ data only because it was found that the laboratory calibration facility was not sufficiently accurate to meet the WOCE requirements. For salinity measurements a standard Guildline Autosal salinometer was used on board as was 1 ampoule of IAPSO Standard Seawater (batch P 112) per station. Salinity was measured 1 –2 days after water collection. Owing to temporal conductivity sensor shifts, the correction was carried out for station nos. 558-566, 567-602 and 603-622 separately (Figure 3).

Because oxygen sensors cannot be calibrated satisfactorily on the laboratory, field calibration is the only alternative. This procedure was carried out in line with the guideline given by MILLARD (1991) by merging the down-profile CTD data with corresponding up-profile water samples. Oxygen residuals of the final fit versus stations are shown in Figure 4.

Oxygen and nutrient measurements were carried out by ODF-technicians: The bottle data were made useable on board. The final state, however, was obtained later by complete recalculation and verification at ODF in La Jolla.

After reading the water sample temperature, oxygen samples were drawn into 125 ml iodine flasks which were rinsed carefully with minimal agitation, then filled via a drawing tube and allowed to overflow for at least two flask volumes. Reagents were added to fix the oxygen before stoppering. The flasks were shaken twice – immediately and after 20 minutes – to ensure thorough dispersion of the $Mn(OH)_2$ precipitate. The samples were analyzed within 4 to 36 hours after water collection. Dissolved oxygen measurements were performed via titration in the volume-calibrated iodine flasks with a 1 ml microburet, using whole-bottle Winkler titration technique after CARPENTER (1965) with modifications by CULBERSON et al. (1991) except that standards and blanks were run in seawater. This parameter is reported in ml/1 units.

A BSH technician, using distilled water with a commercially prepared standard, drew samples from most of the test rosette stations and ran them on the BSH Dosimat dead stop indicator titration system. She consistently got lower values, from 0.20 ml/l on the first test cast to about 0.11 ml/l on the others. Standards were exchanged, but the difference in standards was much less than that in data. The reason for the difference was never conclusively determined. Laboratory temperature ranged from 20° to 22°C in the hood where the O_2-ring was set up based on periodic checks with the draw temperature. Several standards were made up and compared to ensure reproducibility of the results and to avoid basing the entire cruise on one standard. A correction was made for the amount of oxygen added with the reagents. Combined reagent/seawater blanks were determined to account for oxidizing or reducing materials in the reagents. The oxygen thionormality values and blanks were reviewed for possible problems and smoothed if necessary.

Nutrient samples were drawn into 45 cc high density polyethylene, narrow mouth, screwcapped bottles which were rinsed twice before filling. The water samples may have been refrigerated at 2° to 6°C for a maximum of 15 hours. Nutrient analyses were performed on a Technicon Autoanalyzer. The procedures used are described in HAGER et al. (1972) and ATLAS et al. (1971). Standardizations were performed with solutions prepared on board from pre-weighed standards. These solutions were used as working standards before and after each cast (approximately 36 samples) to correct instrumental drift during analyses. Sets of 4-6 different concentrations of shipboard standards were analyzed periodically to determine the linearity of colorimeter response and the resulting correction factors. Phosphate was analyzed using hydrazine reduction of phosphomolybdic acid as described by BERNHARDT and WILHELMS (1967). Silicate was analyzed using stannous chloride reduction of silicomolbdic acid. Nitrite was analyzed using diazotization and coupling to form dye. Nitrate was reduced by copperized cadmium and then analyzed as nitrite. These three analyses use the methods of ARMSTRONG et al. (1967). Nutrients are reported in µmol/l units.

Property sections from CTD data as well as from water sample data, calculated by means of objective analyses, are presented in Figures 5 to 11. CTD data processing and quality evaluation will be discussed in greater detail in a separate data report. Moreover, a scientific analysis of all hydrographic data is in preparation and will be published elsewhere and thus preliminary results are not presented here. All hydrographic data are submitted for independent quality evaluation to the WOCE Hydrographic Programme Office.

For test reasons only, XBT measurements were carried out at selected CTD stations in parallel with CTD casts. The following probes of two manufacturers were tested: 24 SIppian “Deep Blue”, 12 Sparton “Deep Blue”, 12 SParton “T-7”, and 13 Sippican “T-5”. Acquisition systems used were Sippican MK-12 and Sparton BT. The purpose of this test was to provide data from the North Atlantic for the international co-ordinated re-evaluation of the probe’s depth fall rate with the aim of developing community-wide accepted recommendations for a new depth formula or a revision of the standard coefficients respectively (SY, 1991). A similar

XCTD versus CTD test sequence failed to take place because the manufacturer was not able to provide probes in time.

5.2 **Current Measurements** (M. Bersch, J. Meincke, A. Mittelstaedt)

Two types of current measurements took place during METEOR cruise no. 18: The recording of the instantaneous near surface currents by means of an acoustic doppler current profiler (ADCP) and the long-term recording of currents by means of moored current meters.

For the ADCP measurements a hull-mounted system from RD Instruments, San Diego, was employed, using a pulse frequency of 150 KHz. The data were sampled continuously and averaged over intervals of 4 minutes, starting September 2, 18:00 to September 22, 10:37 UTC. The parameters recorded were:

a) Horizontal and vertical velocity components relative to the ship in earth coordinates (due to coupling of the ADCP with the ship's maingyro) in 30 depth intervals of 16 m thickness in the upper 500 m. The velocity components were compensated for pitch and roll.
b) Navigation data of the Global Positioning System: latitude, longitude, ship speed, ship course, pdop.
c) Sea surface temperature recorded by the ADCP for the computation of the sound speed.

There were no larger gaps in GPS data available. Small data gaps of a few hours in ADCP measurements were caused by bad weather conditions and computer problems. In rough seas, which occurred only a few days, the depth penetration of the ADCP pulse reduced to less than 200 m. Most of the time the penetration depth was greater than 300 m. About 7000 velocity profiles were recorded during the cruise. Spatial resolution was about 1 km. On the Icelandic and Celtic shelves bottom tracking was activated and the ship speed was activated and the ship speed was recorded relative to the bottom, which enables a correction of the ADCP velocity data for misalignment of the ADCP transducer and the ship's keel. Figure 12 shows the distribution of the currents along the ships track, integrated over a depth interval from 70 to 380 and the tides eliminated (BERSCH, 1993)

The moored current meter arrays were of standard design by IFMH (moorings A, B, C, D) and BSH (moorings E, F). The deployment procedure was "top-buoyancy first-anchor last". Since all moorings were deployed over sloping bottom, a hydrosweep survey was carried out prior to deployment. This avoided effectively misplacements of the systems in the rough topography. The location of the moored arrays along the WOCE section A1/east and the vertical distribution of the recording instruments is given in Figure 13 as an overlay to the temperature distribution along the section. The recording instruments were all Aanderaa RCMs of the type 4, 5 and 8. Pre-cruise calibration of the sensors was provided by Aanderaa for the instruments in moorings A to D, and by BSH for mooring E and F. Details of the moorings will be part of the data volume, that is expected to be published after recovery of the systems. So far, Table 1 provides information about the basic instrument locations.

5.3 Tracer Oceanography: Tritium/Helium and Radiocarbon

(R. Bayer, B. Hoffarth)

An overview of the total of the stations occupied during M 18 is given in chapter 7. The tracer sampling program was performed with regard to the WHP sampling scheme but due to the restricted measurement capacity for tritium $^3He/^4He$ and ^{14}C the sampling density particularly for these tracers needed to be somewhat coarser. The basic horizontal resolution was between 30 nm and 60 nm with a smaller station spacing near ocean boundaries and large-scale topographic features as the continental slope and the Mid-Atlantic Ridge. The vertical sampling density was guided mainly from hydrographic features encountered with the CTD during the downcast. Special emphasis was given to obtain a representative tracer data set from all the watermasses involved in the North Atlantic Overturning.

All samples were drawn from 10 liter Niskin bottles mounted to a 24 bottles rosette/CTD system. Helium and tritium regularly were sampled parallel and only from bottles where also the CFCs were done. 450 tritium/helium pairs were derived from 43 stations, i.e. the tritium/helium coverage is about 35% of the total of water samples taken on the section (the lower limit recommended from WHP is about 20%). The typical sampling frequency varied between 10 and 14 sample pairs per station. Radiocarbon sampling was restricted only to a few stations to characterize typical watermasses and a total of 80 samples was obtained.

Due to the extremely low concentrations of our tracers special care has to be taken that the tracer content in the water is not altered by contamination with ambient air. To verify that no extraordinary levels for helium or tritium were encountered from the ship both air samples were flame sealed and water initially free of tritium was equilibrated with ambient water vapor repeatedly. As the other samples these background control samples will be analyzed under routine conditions.

The measurement of tritium/helium and radiocarbon requires extraordinary laboratory equipment and cannot be done at sea. For that reason our work during the cruise was restricted to the sampling program. The data subset reported below was obtained during 1992. The complete data set will be available until autumn 1993.

Due to the very low solubility in sea water, helium isotope analyses is very sensitive to any contamination and for this reason the water was sampled in an all metal pinched-off container. In the home laboratory the samples were degassed in a vacuum extraction system. The extracted gasses are transferred to a special mass spectrometer, where helium is separated from the other gasses and both the $^3He/^4He$ ratio and the ^4He concentration are measured subsequently. The achieved precision is about ±0.15% for the $^3He/^4He$ ratio and ca. ±0.5% for the ^4He concentration. Most of the helium isotope samples obtained from M 18 were processed during 1992 and the remaining measurements are scheduled for 1993.

Samples for tritium analyses were taken and stored in 1 liter glass bottles. All analyses will be applying the ^3He ingrowth method. For this the sample is degassed and sealed off in a glass bulb. During an appropriate time ^3He will ingrow from tritium decay. The measurement of this small gas amount is performed on the same mass spectrometer used for the helium isotopes.

All the mass spectrometric tritium measurements are scheduled for 1993. The tritium detection limit will be 0.05 TU or better and the measurement precision will be around ±1.5%. The tritium data shown in this report were obtained by low-level counting. The accuracy achievable with this classical method of tritium analysis does not fulfill the WHP requirements, but it comes very close to the standard recommended for the Northern Atlantic. We plan to compare our mass spectrometric tritium measurements with the results obtained by b-counting.

Table 1: Details on moored current meter arrays

Mooring ID	Latitude	Longitude	Bottom depth [m]	Instrument type/depth [m] (Aanderaa)	Date of deployment 1991
A1	59°08.8 N	34°01.0 W	2855	RCM 8 263	9/8
				RCM 8 876	
				RCM 8 2088	
				RCM 8 2551	
B1	59°01.0 N	32°48.6 W	2110	RCM 8 209	9/8
				RCM 8 822	
				RCM 8 1534	
				RCM 8 1996	
C1	58°10.9 N	2937.9 W	2067	RCM 8 171	9/10
				RCM 8 784	
				RCM 8 1496	
				RCM 8 1958	
D1	57°22.4 N	28°11.4 W	2633	RCM 8 238	9/11
				RCM 8 851	
				RCM 8 2063	
				RCM 8 2526	
E1	54°18.8 N	25°52.2 W	3123	RCM 8 222	9/14
				RCM 8 822	
				RCM 8 2022	
				RCM 8 2872	
F1	52°20.5 N	16°20.1 W	3481	RCM 8 210	9/19
				RCM 8 510	
				RCM 8 810	
				RCM 8 2010	
				RCM 8 3010	
				RCM 8 3460	

For ^{14}C analyses the water was transferred from the Niskin bottle into an evacuated glass bulb. On-shore the total inorganic carbon contained in the bulb was converted to carbon dioxide and the latter was extracted quantitatively. Afterwards carbon was reduced via combustion and pressed inside a so-called target. The carbon isotope ratio of the material derived is determined using accelerator mass spectrometry (co-operation with ETH-Zürich, Switzerland). The precision of the data is estimated to about ±0.5%.

An outline of the tritium distribution on the M 18 section is given in Figure 14. Denmark Strait Overflow Water (DSOW) derived from the Icelandic Sea is clearly indicated by high tritium concentrations in a deep boundary current at the western continental slope of the Irminger Sea. The tritium values are close to the recent surface level and reflect the rapid renewal of this watermass. The same feature is visible at the eastern slope of the Mid-Atlantic Ridge, where Iceland Scotland Overflow Water (ISOW) is spreading southward. The tritium concentrations are moderately lower compared to the DSOW and display both the higher age of ISOW and the stronger dilution by mixing with surrounding watermasses. In the deep eastern part of the section the tritium values drop below the detection limit. Here also extremely low CFC concentrations and an increased silicate content were observed and may be indicative for a northward moving watermass originating in the south. In the upper water column on the west and on the east side of the section the East Greenland Current and the North Atlantic Current are delineated with relatively high tritium concentrations down to about 400 m depth. In intermediate depths there seems to be a west to east tritium gradient with higher concentrations in the west where the water column is renewed by winter convection more effectively.

Figure 15 shows a part of the helium isotope data actually available (only some of the data obtained from below 1600 m depth are included) together the hydrographic measurements. The helium values are given as d^{3}He (the relative deviation of the samples ^{3}He/^{4}He ratio from that of atmospheric air), and the numbers are plotted at their respective positions in the T/S diagram. Apparently the DSOW obtained in the deep western Irminger Sea (stations 558-566) shows the lowest d^{3}He values (4.5-5.5%) in this part of the section. The samples obtained above and east from the DSOW (stations 558-577) show in three different branches the transition to Labrador Sea Water (LSW, d^{3}He ~5.5%) and to Gibbs Fracture Zone Water (GFZW, d^{3}He ~7.5%). On these branches from west to east (left to right in the Figure) d^{3}He tends to increase slightly and reflects the successively growing influence of waters derived from the Northeast Atlantic. Directly east of the Mid-Atlantic Ridge (stations 578-599) d^{3}He varies between 5% and 7% and in the branch connected to the IOSW a relative uniform distribution of d^{3}He (~6%) is observed. The lowest d^{3}He values obtained from the M 18 cruise were sampled in the deep eastern part of the section (2%<d^{3}He<4%, stations 600-622) where also zero tritium concentrations were detected. We attribute this feature to the high age of this watermass and part of the ^{3}He excess might be from terrigenic origin.

A rough sketch of tritium/^{3}He age distribution is given in Figure 16. Except the regions where deep western boundary currents are present ages apparently increase with depth. In the deep eastern part of the section values rise above 30 years and the tritium/^{3}He age is not trustworthy any longer. More information about this watermass will be obtained from the radiocarbon measurements. Minimum ages in DSOW (formal tritium/^{3}He age about 10 years) and in ISOW (~14 years) reflect their higher ventilation rates compared to the surrounding watermasses. To evaluate the ventilation age of both NADW constituents a model taking into account mixing effects and the mean residence time of the overflow waters in the European Polar Seas is needed. For a first order approximation we may neglect any mixing effects and compare the 14 years obtained in the ISOW to the Tritium/^{3}He age observed in the Faeroe-Bank-Channel (ca. 10 years, unpublished measurements). The resulting traveling time for ISOW of about 4 years is an upper limit, as the dilution by surrounding waters results in an overestimation of the apparent age. Therefore the mean propagation traveling velocity deduced from this guess (~1.3 cm/s) may be accepted as a lower limit.

The further evaluation will include the complete data set derived from M 18. Especially we plan to compare the tritium/^{3}He information with the CFC data obtained parallel to our measurements. In addition we plan to verify the potential of transient tracer ratios: we feel that the CFC/tritium ratio is a powerful tool to study watermass formation and circulation on the time scale of the last two decades. CFC/tritium will yield information orthogonal to both the tritium/3He and the CFC-11 /CFC-12 age.

5.4 Tracer Oceanography

(A. Putzka, K. Bulsiewicz, G. Fraas)

CFC-Work

Samples were taken according the WOCE scheme using glass syringes. The capacity for measurements allowed to analyze every second water sample for F-11 and F-12. The detection limits were 0.005 pmol/kg, and the precision for surface water concentrations better than 1% for both F-11 and F-12.

Industrial production of the CFC's F-11 and F-12 since the 1940ies caused increasing concentrations in the atmosphere, and, due to interfacial gas exchange, in the surface layer of the oceans. By transport processes surface water is transferred into the interior of the ocean where it can be traced by measuring distributions of non-steady state tracers (transient tracer concept). 'Younger' (age since leaving the surface) water is generally tagged with higher CFC concentration in comparison with 'older' water. Additionally, the F-11/F-12-ratio supplies information since the atmospheric ratios have changed with time.

- Deep water formation processes within the North Atlantic and Labrador Sea,
- overflows from the northern basins, ISOW and DSOW and,
- abyssal waters influenced by Antarctic Bottom Water supplied by eastern intensified northward flow mainly in the eastern Atlantic.

Overflow and formation processes supply 'young' (tagged with high CFC concentration) water masses, whereas original east Atlantic abyssal water is 'old', i.e. free of CFCs. In Figure 17 the CFC F-11 section for the cruise is shown. Except for the deep eastern part, we found CFC-concentrations of at least ten times the detection limit throughout the section.

At the bottom of the Irminger Basin (stations 558 to 573) high F-11 concentration of 3.1 pmol/kg were found, indicating, together with temperature and salinity, Denmark Strait overflow water (DSOW). A thin tongue reaching LIP to nearly 1500 m depth of DSOW-influenced water with high CFC concentration is met also at the slope to the Greenland continent. At the western slope of the Reykjanes ridge a water mass with substantially lower CFC-concentration was found. This CFC minimum spreads at mid-depth (about 2300 m) over nearly the whole basin except for the most western part. This water is believed to be coming from the Charles-Gibbs Fracture Zone south of the Reykjanes Ridge.

At the slope east of the Reykjanes Ridge within the Iceland Basin (stations 573 to 596) higher CFC concentrations were found. These waters belong to the Iceland Scotland Overflow Water (ISOW). For all stations within the Iceland Basin, aside from the shallow ones at the top of the ridge, the bottom CFC-concentrations were higher than those one to two hundred meters further up. Downwards the slope, the bottom CFC and the corresponding F-11/17-12 values decrease steadily. This indicates increasing 'age' of the corresponding waters. A first order estimate (comparing measured ratios and concentrations with that of the atmospheric input history) leads to about 13 years for water masses just at the top of the ridge and 20 years for the waters at the deepest part of the Iceland Basin. This age reflects the age of the 'youngest' component of the water considered, The parallel smooth increase of silicate concentrations downwards the slope indicates increasing contribution of deep east Atlantic water, providing together with T and S characteristics, evidence for eastern Atlantic deep water spreading into the Iceland Basin.

The stations 599 to 609 were south of the Rockall Plateau. The lowest CFC concentrations were detected at the bottom, decreasing from west to east. Both features signify westward flowing eastern Atlantic abyssal water.

The final part of the section (stations 611 to 622) covers the entrance of the Rockall Trough. The structure of the isolines in Figure 17 clearly indicates that the 'older' (lower CFC) water was intensified at the eastern slope as expected for northward flowing water. CFC values near the bottom below 4000 m were close to the detection limit but certainly significant. Since there are no other sources or 'young' bottom water in the East Atlantic aside from ISOW, this fact might be interpreted that at least part of the ISOW, this fact might be interpreted that at least part of ISOW mixes into the deep eastern Atlantic south of this section.

Two types of Labrador Sea Water (LSW) were observed during the cruise: one west of Reykjanes Ridge, the other east of it. Both types have homogeneous properties: LSW (west) with 3.46 pmol/kg and LSW (east) with 1.9 pmol/kg F-11. The downward CFC decrease below the two types of LSW were different: steep for the western, but gradual for most of the eastern type LSW. In the eastern part of the section below 2000 m substantial CFC concentrations were found down to more than 3000 m.

CFC Calibration

(Roether)

Only CFC11 and CFC12 have been measured during the cruise. The gas chromatograph was equipped with a packed column (Porasil C). Standard gas by Ray Weiss has been used for calibration. The original data have been reported against SIO86 and have now been corrected for SIO93. Quality flags for CFC11 and CFC12 follow Woce standard.

Problems noticed: Some F11 and F12 ratios show rather high values for low concentrations. Since no water was encountered during the cruise with vanishing CFC concentrations it could be not be ruled out if some of the rosette water samplers were contaminated.

Reproducibility:

F-11: 0.7 % or 0.006 pmol/kg (whichever is greater)
F-12: 0.8 % or 0,005 pmol/kg (whichever is greater)

Precision:

F11: 0.35% for concentrations >0.5 pmol/kg and 3 fmol/kg for concentrations <0.5 pmol/kg
F12: 0.41% for concentrations >0.5 pmol/kg and 2 fmol/kg for concentrations <0.5 pmol/kg

Mean water blank, detection limit:

(Has been measured in the lab after the cruise)
F-11: 0,00096 pmol/kg +/- 0.001
F-12: 0,0044 pmol/kg +/- 0.002

Air measurements:

Individual air measurements performed during the cruise (SIO 93 scale):

Quality byte:	F-11	F-12	F-113	F-10
	1	2	3	4

Idx	Stat	Rec	F12	F11	F113	CCl4	Volume	Ratio	Luftflag
1	563	11	510.64	267.61	1.00	1.01	3.45	-1.47	6699
2	563	12	510.44	266.66	1.00	1.01	3.45	-1.46	6699
3	563	13	514.02	271.11	1.00	1.01	3.45	-1.48	6699
Mean value F12 = 511.70					Error = 2.01			rel.Error = 0.4	
Mean value F11 = 268.46					Error = 2.35			rel.Error = 0.9	
31	571	21	504.25	265.57	1.00	1.01	3.45	1.49	6699
32	571	22	506.62	265.90	1.00	1.01	3.45	1.48	6699
33	571	23	505.98	266.07	1.00	1.01	3.45	1.49	6699
Mean value F12 = 505.62					Error = 1.22			rel.Error = 0.2	
Mean value F11 = 265.85					Error = 0.26			rel.Error = 0.1	
34	581	15	511.46	267.72	1.00	1.00	3.45	1.50	6699
35	581	16	510.55	267.01	1.00	1.00	3.45	1.50	6699
Mean value F12 = 511.01					Error = 0.65			rel.Error = 0.1	
Mean value F11 = 267.37					Error = 0.50			rel.Error = 0.2	
36	584	28	516.07	270.90	0.98	0.97	3.45	1.53	6699
37	584	29	514.32	268.06	0.98	0.97	3.45	1.52	6699
38	584	30	518.84	268.97	0.98	0.97	3.45	1.51	6699
Mean value F12 = 516.41					Error = 2.28			rel.Error = 0.4	
Mean value F11 = 269.31					Error = 1.45			rel.Error = 0.5	
39	585	21	515.44	270.09	0.97	0.96	3.45	1.54	6699
40	585	22	514.60	271.50	0.97	0.96	3.45	1.56	6699
41	585	23	515.37	270.09	0.97	0.96	3.45	1.55	6699
Mean value F12 = 515.14					Error = 0.47			rel.Error = 0.1	
Mean value F11 = 270.56					Error = 0.81			rel.Error = 0.3	

Idx	Stat	Rec	F12	F11	F113	CCl4	Volume	Ratio	Luftflag
42	588	11	509.35	266.34	1.01	1.02	3.45	1.54	6699
43	588	12	510.74	265.86	1.01	1.02	3.45	1.54	6699
44	588	13	510.82	265.78	1.01	1.02	3.45	1.53	6699
Mean value F12 = 510.30					Error = 0.83			rel.Error = 0.2	
Mean value F11 = 265.99					Error = 0.30			rel.Error = 0.1	
45	591	13	509.07	267.53	0.98	0.99	3.45	1.54	6699
46	591	14	511.89	269.60	0.98	0.99	3.45	1.55	6699
48	591	13	509.07	267.53	0.94	0.95	3.45	1.54	6699
49	591	14	511.89	269.60	0.94	0.95	3.45	1.55	6699
51	591	33	508.84	267.64	0.97	0.99	3.45	1.51	6699
Mean value F12 = 510.15					Error = 1.59			rel.Error = 0.3	
Mean value F11 = 268.39					Error = 1.10			rel.Error = 0.4	
55	1409	14	504.81	263.20	1.00	1.01	3.45	1.52	6699
56	1409	15	506.40	263.38	1.00	1.01	3.45	1.52	6699
57	1409	16	506.27	263.96	1.00	1.01	3.45	1.52	6699
Mean value F12 = 505.83					Error = 0.88			rel.Error = 0.2	
Mean value F11 = 263.51					Error = 0.40			rel.Error = 0.2	
1	591	13	510.43	268.66	0.94	0.95	3.45	1.54	6699
2	591	14	511.34	270.74	0.94	0.95	3.45	1.55	6699
3	591	15	509.45	270.39	0.94	0.95	3.45	1.53	6699
4	591	33	512.34	267.73	0.97	0.99	3.45	1.51	6699
5	591	34	511.01	272.03	0.97	0.99	3.45	1.53	6699
Mean value F12 = 510.91					Error = 1.07			rel.Error = 0.2	
Mean value F11 = 269.91					Error = 1.71			rel.Error = 0.6	
8	1409	14	505.68	264.23	1.00	1.01	3.45	1.52	6699
9	1409	15	507.31	264.43	1.00	1.01	3.45	1.52	6699
10	1409	16	507.20	265.02	1.00	1.01	3.45	1.52	6699
Mean value F12 = 506.73					Error = 0.91			rel.Error = 0.2	
Mean value F11 = 264.56					Error = 0.41			rel.Error = 0.2	
21	603	11	497.86	261.22	1.02	1.05	3.45	1.51	6699
22	603	12	499.20	260.17	1.02	1.04	3.45	1.50	6699
23	603	13	497.65	260.89	1.02	1.04	3.45	1.51	6699
Mean value F12 = 498.23					Error = 0.84			rel.Error = 0.2	
Mean value F11 = 260.76					Error = 0.54			rel.Error = 0.2	
24	1709	11	496.76	261.76	1.05	1.09	3.45	1.49	6699
25	1709	12	507.09	269.18	1.05	1.09	3.45	1.51	6699
26	1709	13	507.28	267.15	1.05	1.09	3.45	1.49	6699
Mean value F12 = 503.71					Error = 6.20			rel.Error = 1.2	
Mean value F11 = 266.03					Error = 3.83			rel.Error = 1.4	
33	613	33	505.17	261.63	0.92	0.93	3.45	1.40	6699
34	613	34	504.71	261.21	0.92	0.93	3.45	1.40	6699
35	613	35	502.87	260.98	0.92	0.93	3.45	1.40	6699
Mean value F12 = 504.25					Error = 1.21			rel.Error = 0.2	
Mean value F11 = 261.27					Error = 0.33			rel.Error = 0.1	

Idx	Stat	Rec	F12	F11	F113	CCl4	Volume	Ratio	Luftflag
36	622	11	506.14	263.15	0.98	0.97	3.45	1.12	6699
37	622	12	507.01	264.92	0.98	0.97	3.45	0.83	6699
38	622	13	505.59	263.88	0.99	0.97	3.45	1.43	6699
39	622	15	506.56	263.99	0.99	0.97	3.45	1.34	6699
40	622	16	507.21	264.38	0.99	0.97	3.45	1.35	6699
41	622	17	506.77	263.09	0.99	0.97	3.45	1.52	6699
42	622	18	506.89	262.49	0.99	0.97	3.45	1.52	6699
43	622	19	505.18	263.10	0.99	0.97	3.45	1.52	6699
Mean value F12 = 506.42					Error = 0.72			rel.Error = 0.14	
Mean value F11 = 263.62					Error = 0.80			rel.Error = 0.3	

Quality byte: 1 = Air from outside (good measurement)
2 = Air from outside (too high, first measurement)
3 = Air from laboratory
4 = Wallace Standard
5 = Bremer Standard
6 = Ueber wasserteil
7 = bad measurement to high
8 = bad measurement to low
9 = no measurement

Seagoing He-Extraction

He-extraction is a shorthand for transfer of the air dissolved in a water sample into a sealed-off glass ampoule. Later on, this ampoule is connected to the inlet system of a mass spectrometer to analyze the He-isotopes content. The standard procedure is accomplishing extraction in the home laboratory using clamped copper tubes to collect and store the samples. An extraction at sea avoids storage of the samples and allows one to shorten the required analysis time later on. The conventional extraction method could not be used at sea.

Our recently developed seagoing system includes a new type of sampling container: glass pipettes closed at both ends with special valves. For the extraction a defined amount of water is admitted from the pipette to a previously evacuated and leak tested extraction port, consisting of a glass bulb, a water cooler and the glass ampoule. The water is heated in the bulb. The cooler condenses most of the water vapour provided and leads it back to the glass bulb. A smaller permanent stream of vapour continues into the glass ampoule which is held at room temperature to condense the water vapour, thereby pushing the gases released from the water sample into the ampoule. The glass ampoule is flame sealed after about 12 min. The extraction system includes 8 extraction ports, vacuum pumps with gauges and a quadruple mass spectrometer for leak testing.

The work at sea included tests for all stages of the new procedure. More than 150 samples were extracted, extraction efficiency tests for real seawater samples were completed and 48 standard copper tube samples for inter-comparison were taken. The main concept of the extraction system was successful although critical points in handling and equipment were found during the cruise. The tests under real conditions on a cruise proved to be indispensable in order to establish the seagoing extraction as a standard procedure for future He-tracer work.

5.5 Marine Chemistry: The Carbonate System

(B. Schneider, K. Johnson, L. Mintrop)

Extended measurements of the parameters of the oceanic carbonate system were performed during M 1.8. The CO_2 partial pressure (pCO_2) in surface water was measured continuously along the WOCE line and also between Reykjavik and Cape Farvel. Hydrocast samples were analyzed for total carbonate (TCO_2), total alkalinity (TA), and pCO_2. However, due to the time consuming analytical procedure, not all the samples could be analyzed. TCO_2 was determined for each second profile, whereas TA and pCO_2 were measured at 13 stations for 12 selected depths.

The CO_2 partial pressure

The pCO_2 of surface water along the WOCE line (Figure 18a) varies between about 330 µatm and 280 µatm and corresponds to a partial pressure difference between seawater and the atmosphere of -53 atm to -73 µatm. Hence, this area acts as a strong source for atmospheric CO_2 during this time of the year. But the pCO_2 is not evenly distributed along the transect and as a first approximation to regimes may be distinguished.

Between Cape Farvel and the Reykjanes Ridge an extended area (150 km - 650 km) of relatively high (320 µatm) and uniform pCO_2 is observed. Nitrate surface concentration also show elevated levels of about 9 µmol/kg. Moreover, the pCO_2 changes only slightly with depth (Fig. 18b) and is close to equilibrium with the atmosphere even in depths down to 2000 m. This indicates that deep mixing occurs, inhibiting primary production in surface water and consequently preventing decomposition of sinking organic matter in deep water. These findings are consistent with the oxygen distribution in this area (Figure 7).

East of Reykjanes Ridge (800 km) the pCO_2 drops to values of roughly 285 µatm, but is then increasing to about 310 µatm, west of Ireland (2200 km). This increase is superimposed by strong small scale fluctuations with amplitudes up to ±15 µatm. Low nitrate concentrations in this area indicate that production of biomass has drawn down the pCO_2. However, nitrate concentrations cannot explain the increase of pCO_2 between 800 km and 2200 km as NO_3 is decreasing from about 3 µmol/kg to <0.5 µmol/kg). Therefore, the trend in pCO_2 has to be explained by the increasing surface temperature and possibly by an enhanced uptake Of CO_2 from the atmosphere due to an earlier onset of the spring bloom in the Southeast. The distribution of pCO_2 with depth (Fig. 18b) in the area between the Reykjanes Ridge and Ireland shows a distinct pCO_2 maximum with values up to 410 µatm between 200 in and 1000 m. This is obviously an older water mass that is enriched in CO_2 and consequently depleted in O_2 (Figure 7) due to the decomposition of sinking organic matter. As this layer is close to the surface, local upwelling may introduce CO_2-enriched water to the surface and is thus causing the observed small scale variability of pCO_2. As no pCO_2 measurements for the winter months exist for the North Atlantic, the depth profile for TCO_2 and pCO_2 at station 607

(52.5° N/20.0° W) were used to calculate the surface pCO_2 for the months October through March. It was assumed that neither primary production nor respiration takes place during this time and that only convective mixing, cooling, and exchange with the atmosphere (20 cm/h), the state of the carbonate system was recalculated in time steps of one month. Figure 19 shows the results of these calculation and also obtained during other expeditions in May and June. As this approach is very sensitive to the choice of the maximum of 335 µatm it gives only a first idea and has to be examined by direct measurements. Following the same procedure, also winter NO_3 concentration were calculated and are presented in Figure 19.

Total carbonate and total alkalinity

The evaluation of TCO_2 data is not yet finalized. However, a plot of the TCO_2 distribution using preliminary data was produced and showed a pattern of consistent with that of the pCO_2 distribution.

The alkalinity profiles of the stations sampled showed rather uniform characteristics: relative high but varying values (around 2330 - 2350 µeq/kg) in the samples from the upper 40 - 60 m and a decrease to values below 2300 µeq/kg at depth between 1000 and 2000 in, corresponding to oxygen minima and nutrient maxima. This was more expressed for the more southern stations (station 591 and higher), where nutrient concentrations approached zero at the surface. Below 2000 m values gradually increase toward the sea floor and reach again values like at the surface or even higher (up to 22370 µeq/kg). Disregarding the contributions of different water masses, this behaviour can in principle be explained by remineralization of nitrate at medium depth, leading to alkalinity decrease and dissolution of calcium carbonate at greater depth, thus increasing alkalinity. While the nitrate effect will only be of minor importance (approx. 10 µeq/kg), dissolution of carbonate particles has a strong impact on alkalinity. The substantially higher values at the surface therefore might reflect the properties of different water masses. Superimposed on the alkalinity profiles is a salinity effect, since alkalinity often is regarded as a rather conservative property. Since salinity variation is low in these profiles, however, the normalization of the alkalinity values to constant salinity will not alter the profiles significantly.

A more detailed evaluation of the carbonate system of the part of the North Atlantic requires the compilation of all hydrographic and chemical data available and is undertaken at present.

5.6 Marine Meteorology

(H.-J. Isemer)

During the cruise, the Department of Meteorology, Institut für Meereskunde, Kiel tested newly developed rain gauges. The high relative wind velocities necessitate special construction for rain gauges to be used at moving ships. The mechanical IFM ship rain gauge was deployed at FS METEOR together with an optical disdrometer. Comparison of both provided the first in situ calibration of the ship rain gauge. The high wind speeds encountered during this cruise were extremely favourable for this calibration. The result of the cruise further led to an improvement of details of construction. Since cruise M 18 a mechanical ship rain gauge is in continuous use onboard METEOR. The instrument has been replaced in mid 1992 with the improved version. The help of the personal of the Deutscher Wetterdienst is acknowledged.

6 Ship's Meteorological Station

(J. Sußebach, H. Sonnabend)

Cruise M 18 began under rough weather conditions. A low with S to SW winds of gale force 8 to 9 Beaufort moved from the Irminger Sea into NE direction. The following quiet period until September 10 was characterized by warm and humid air masses with weak fronts over relatively cold water, resulting in extended fog coverage of the central and southwestern Irminger Sea. On September 11, a cold front of a low pressure system between Newfoundland and Cape Farvel developed a wave, which intensified into a large scale storm system about 400 nm SE of Greenland. With pressure failing to 980 hPa, its center passed METEOR slightly to the north and moved into the Norwegian Sea. This development resulted in two days of unfavourable weather conditions with wind from cast turning through south to west and gale force 8 to 9, gusting up to 11 Beaufort, and wave heights reaching 8 m.

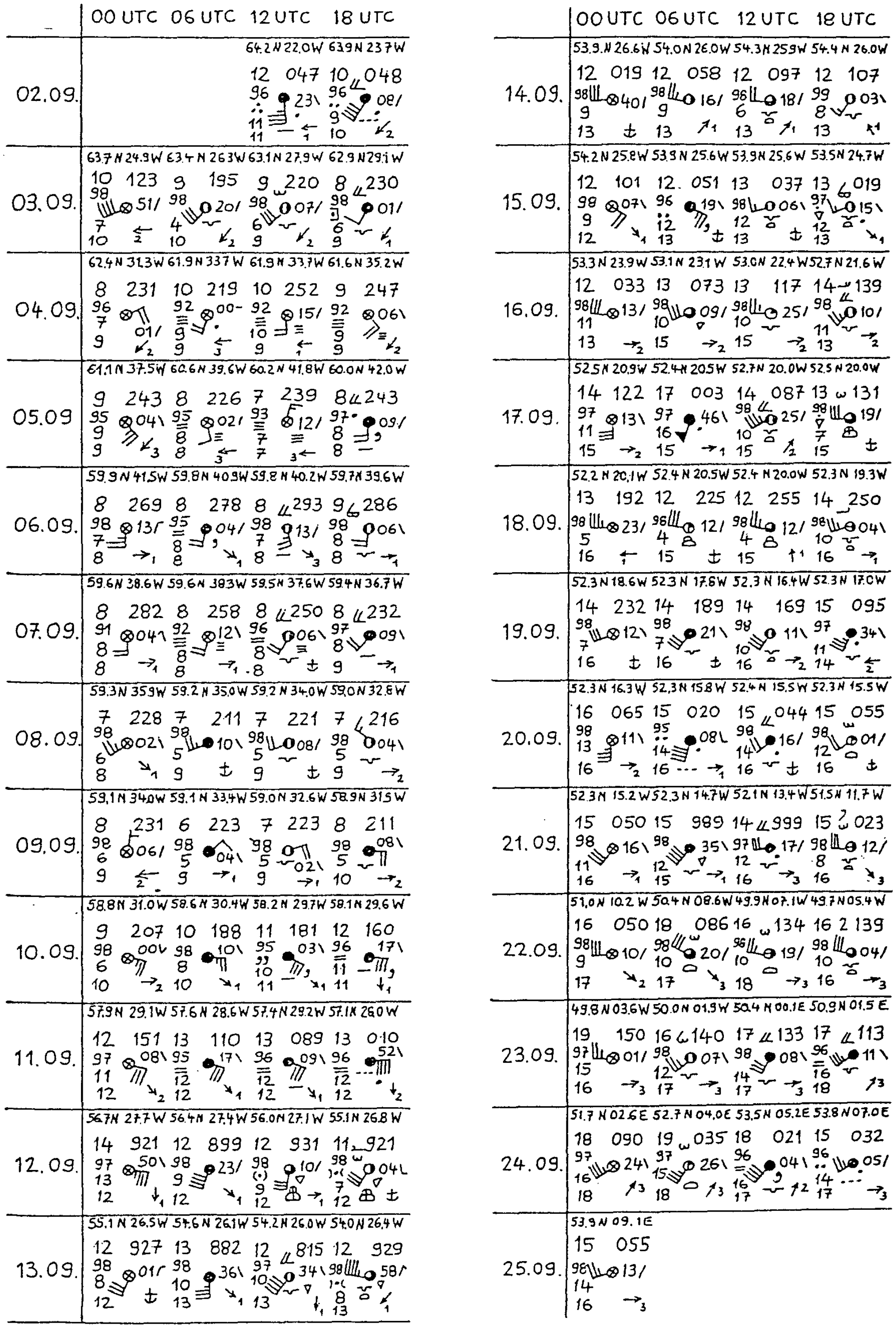
Extreme temperatures up to 18'C were reported on this occasion from Narssarssuaq in S-Greenland, which was caused by foehn at the edge of the a.m. depression.

Following another period of 3 days with relatively quiet weather, an initially minor low approached from SW of the Azores. It suddenly deepened and in passing METEOR slightly to the NW of her position it brought an outburst of a SSW gale with 10 to 11 Beaufort for several hours. There were two other days with reasonable wind conditions, before a rapid succession of two lows with S to SW winds up to 9 Beaufort brought about difficult working conditions for the oceanographic programme for the period September 19 to 22.

En route to Hamburg via the English Channel the strong winds related to the warm sector of a low near the Faeroe Islands were from astern and helped with a fast journey.

The statistics of the cruise are given in Figure 20 (winds) and 21 (waves) in addition to the actual observations at the synoptic hours (Table 2). In total 187 weather observations were taken. 186 of them were transmitted into the GTS, 40 radiosondes were launded (0 and 12 UTC) and automatically transmitted into the GTS.

Table 2 Graphical listing of weather observations during METEOR cruise 18. The standard meteorological station code is given for the synoptic hours 00, 06, 12, 18 UTC. The positions at the synoptic hours are indicated on top of each entry.



8 Concluding Remarks

The 18th cruise of METEOR turned out to be an extremely rewarding effort with respect to participating expertise on water mass issues for the northern North Atlantic. We expect from the Joint analysis of the most complete data set describing water mass properties in eddy-resolving section mode a reliable quantification of North Atlantic overturning rates.

A large portion of the success of this cruise has to be attributed to the captain and crew of METEOR who provided a reliable and enjoyful platform for our work under not always nice environmental conditions.

We appreciate the support from the Bundesminister ftir Forschung und Technologie (WOCE) and the Deutsche Forschungsgerneinschaft.

9 References

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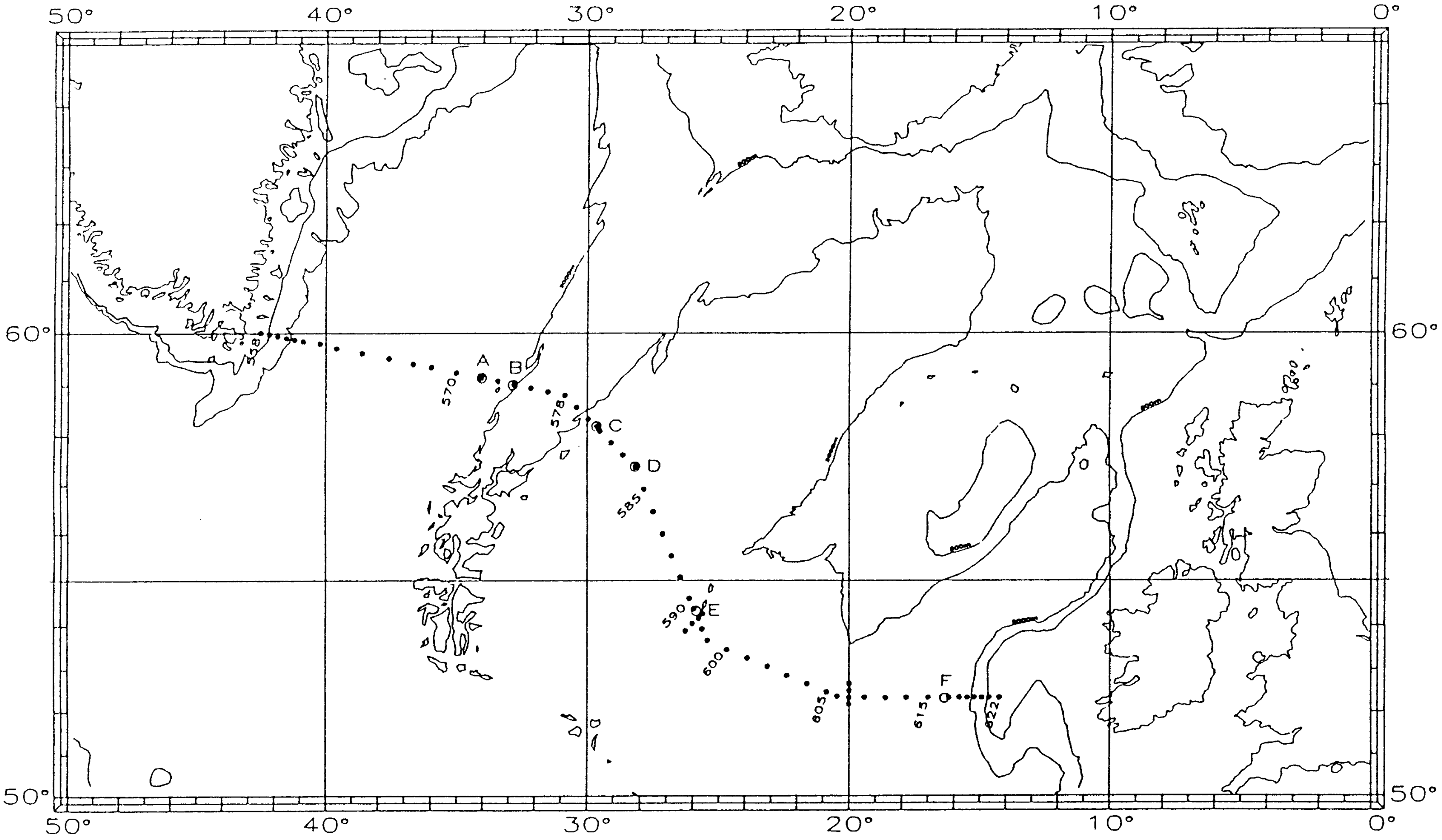
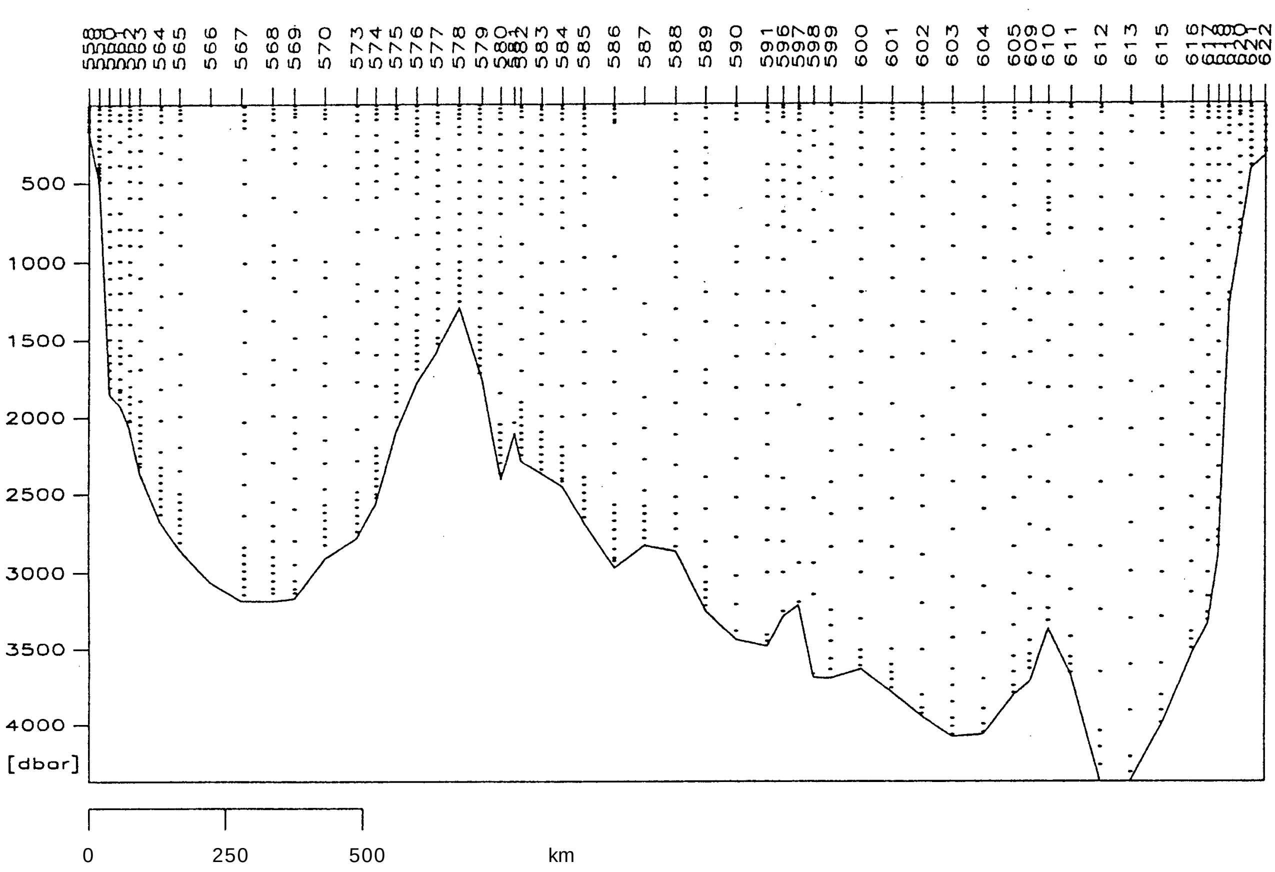


R.V."METEOR" cruise # 18 (WHP A1 05.09.1991 - 21.09.1991) • CTD-station o mooring B.S.H. M442

Figure 1: The WOCE A1-cast section. CTD02-stations are marked by dots. Station numbers are indicated. The circles denoted A to F are locations of moored current meter arrays.



FS Meteor 18

BSH
Homburg

Gridding Parameter:
No of GRD-Points in X=
No of GRD-Ponts in Y=

Area in X, by no. of profiles=
Area in Y, by physical units =
Order of Orthogonal Srface =

Figure 2: Distribution of water sample taken along the section

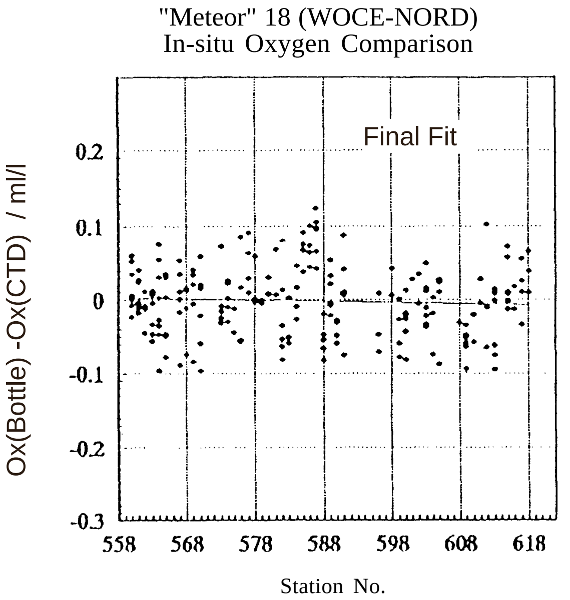


Figure 3: Salinity differences salinometeter versus CTD

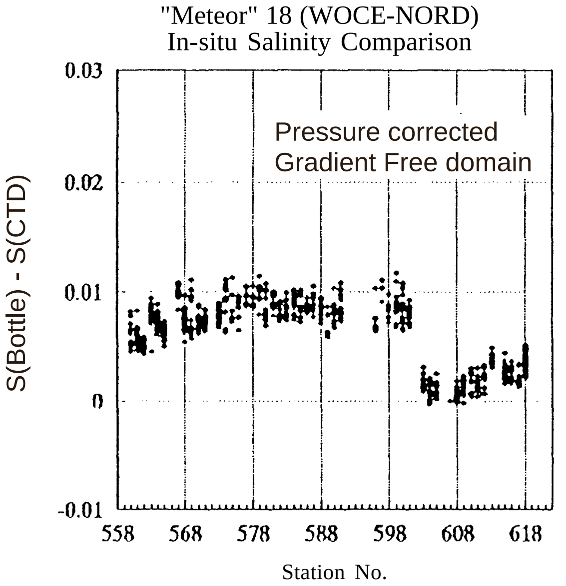


Figure 4: Oxygen residuals of final fit CTD02-sensor versus titrated samples

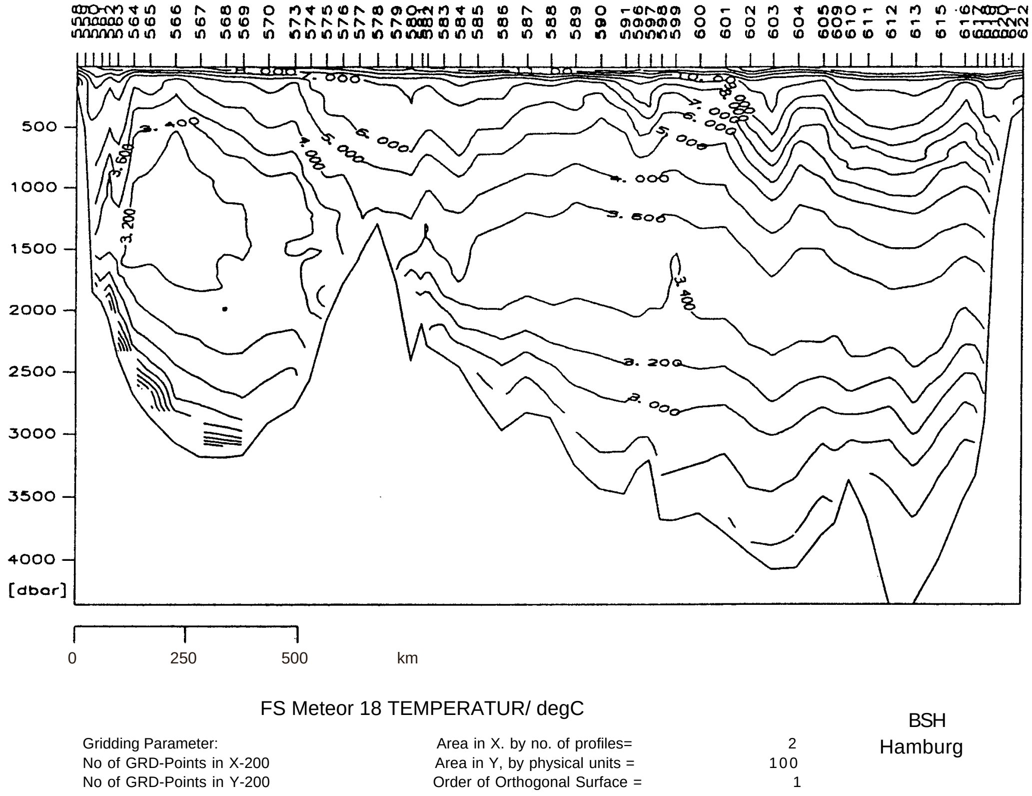


Figure 5: CTD temperature section (°C)

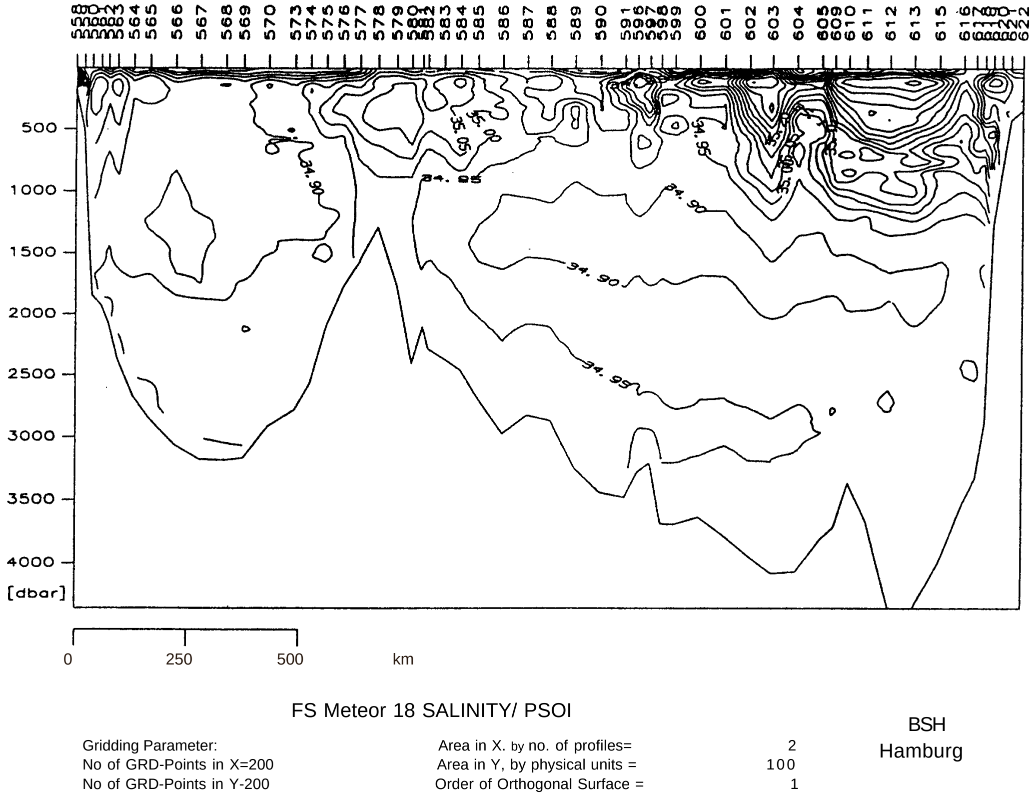


Figure 6: CTD salinity section (PSU)

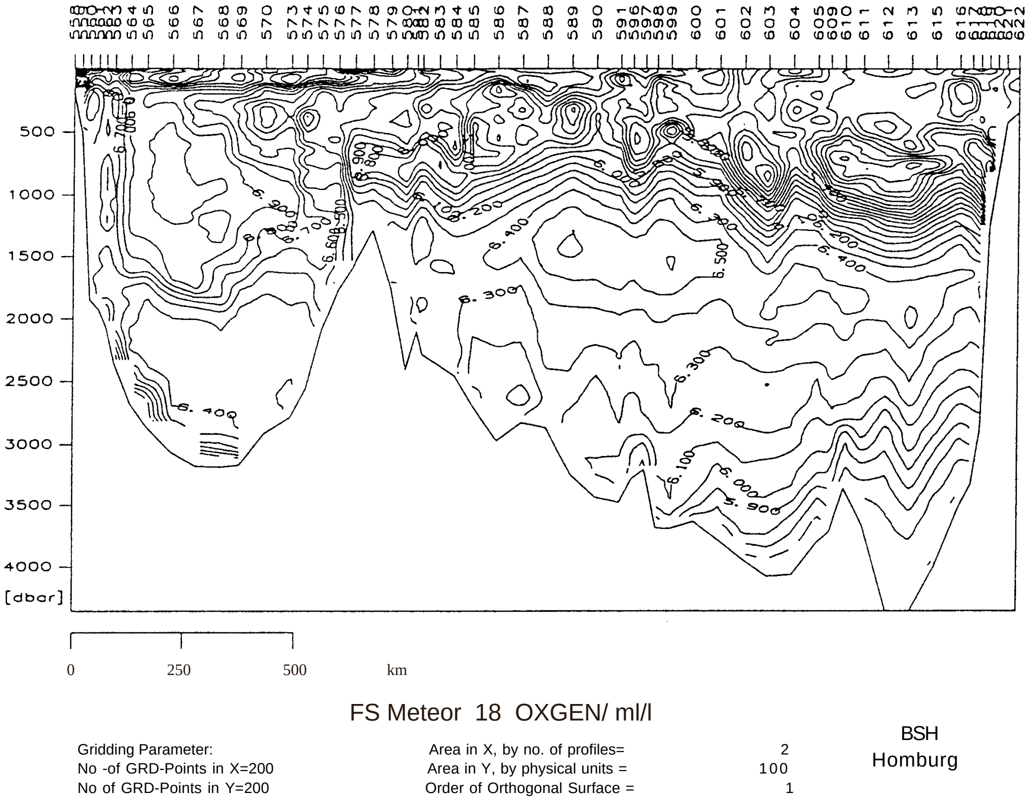


Figure 7: CTD oxygen section (ml/l)

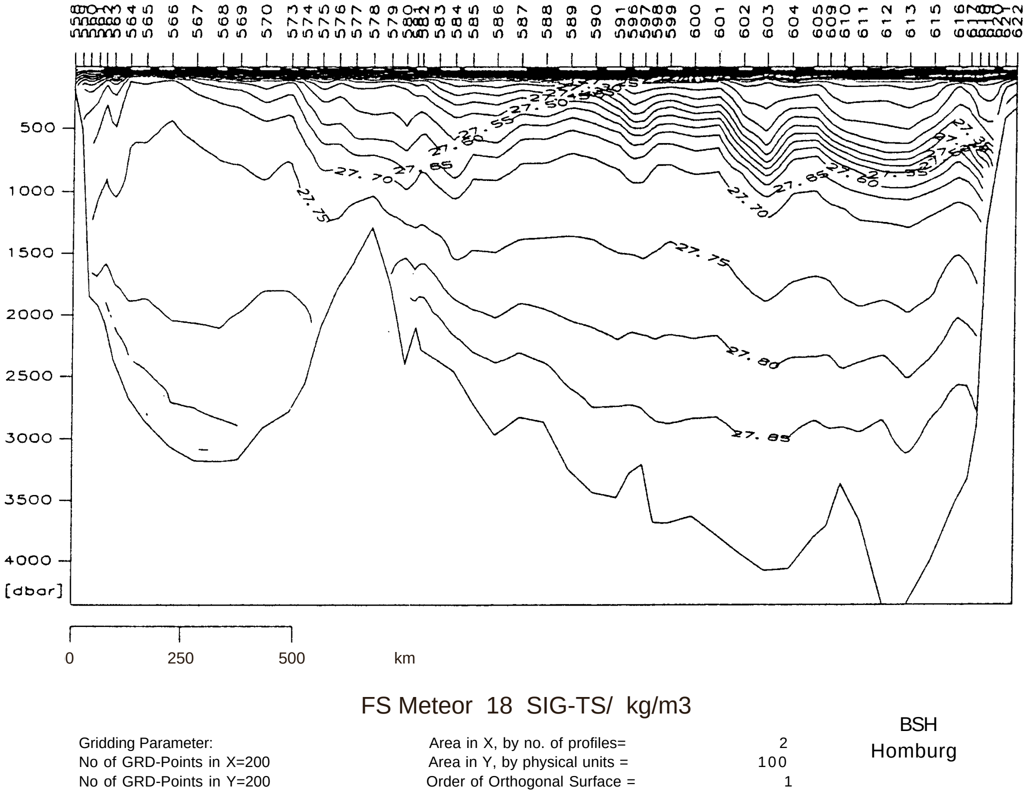
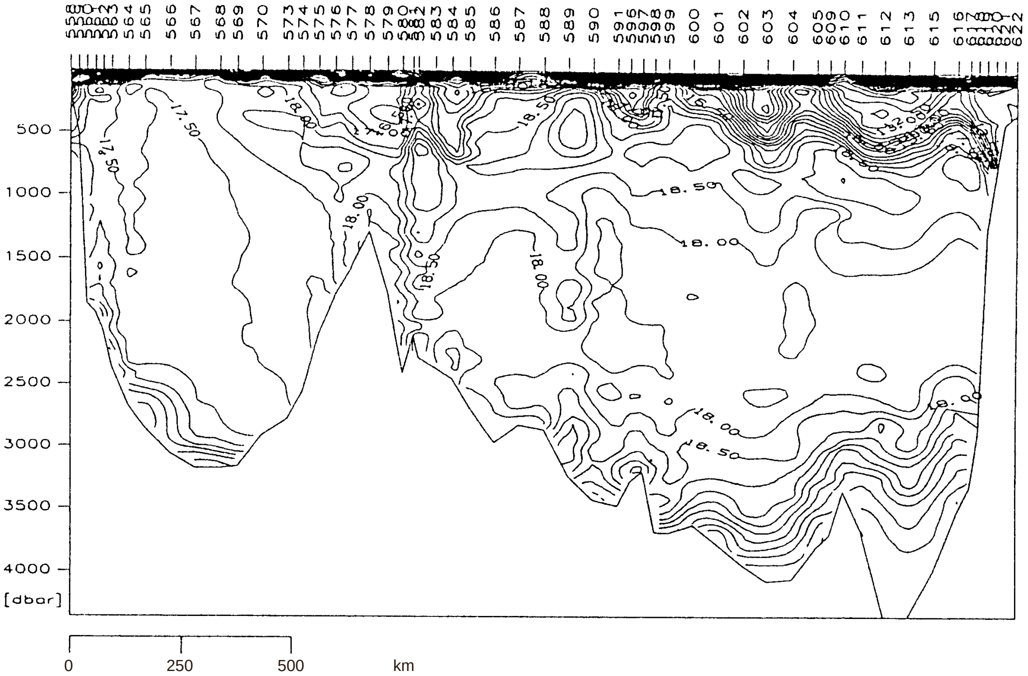


Figure 8: CTD density section (sig-t)



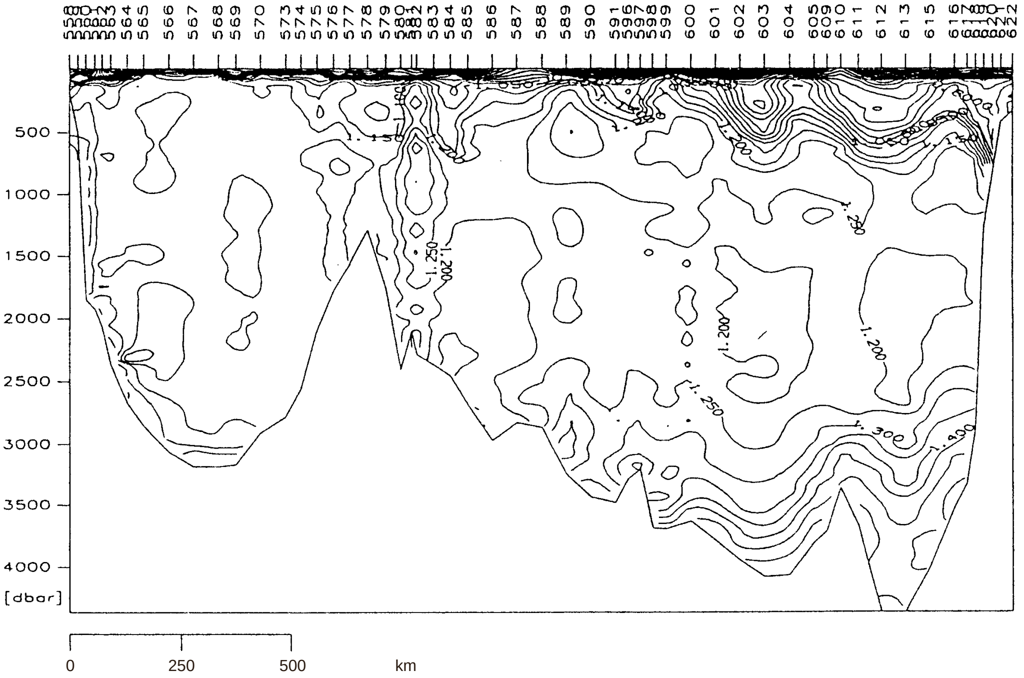
FS Meteor 18 NITRAT/ UMOL/L

BSH
Homburg

Gridding Parameter:
No of GRD-Points in X= 99
No of GRD-Ponts in Y= 99

Area in X, by no. of profiles= Auto.
Area in Y, by physical units Auto.
Order of Orthogonal Srface = Auto.

Figure 9: Sample nitrate section (µmol/l)



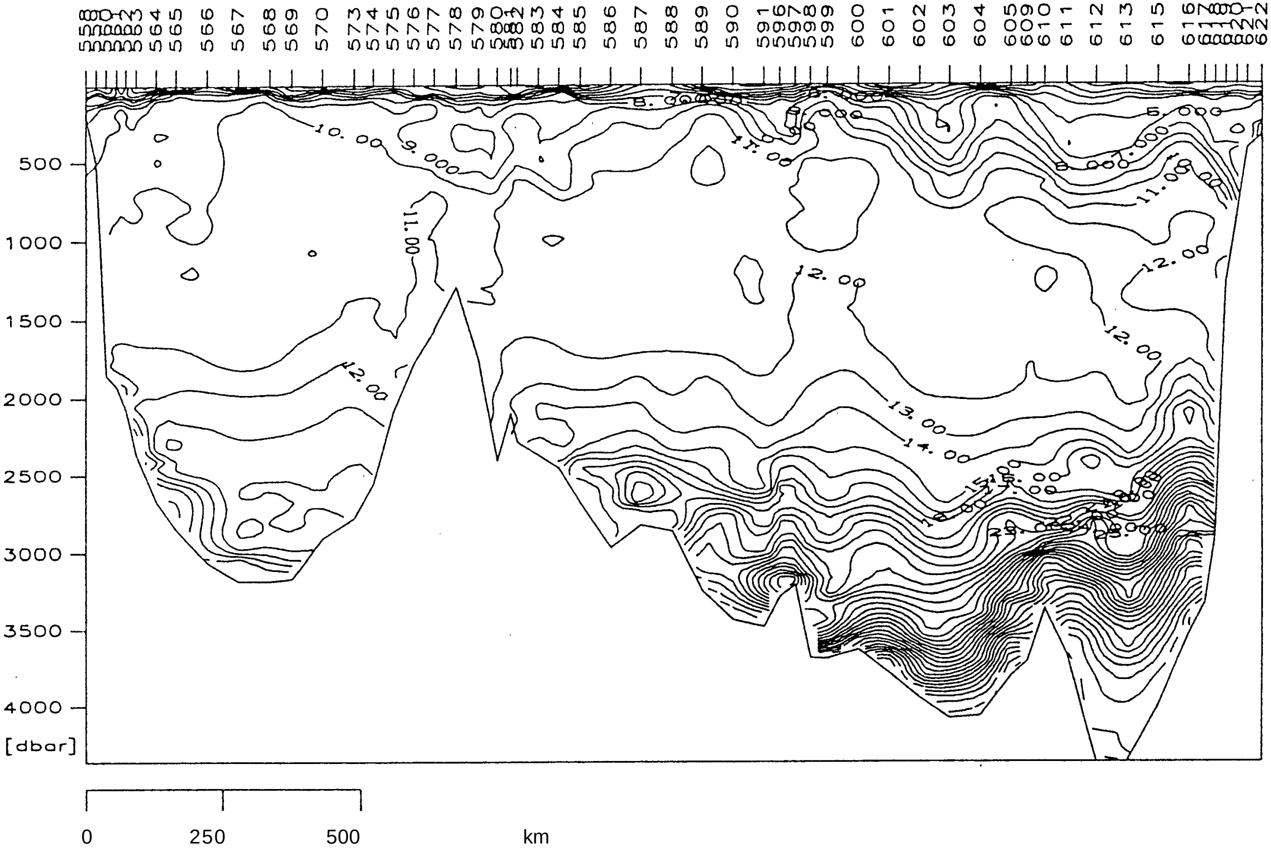
FS Meteor 18 PHSPHT/ UMOL/L

BSH
Hamburg

Gridding Parameter:
No of GRD-Ponts in X = 99
No of GRD-Ponts in Y = 99

Area in X, by no. of profiles= Auto.
Area in Y, by physical units = Auto.
Order of Orthogonal Srface = Auto.

Figure 10: Sample phosphat section (µmol/I)



FS Meteor 18: SILCAT/ UMOL/L

BSH
Hamburg

Gridding Parameter:

No of GRD-Points in X= 99

No of GRD-Ponts in Y = 99

Area in X, by no. of profiles= Auto,

Area in Y, by physical units Auto.

Order of Orthogonal Srface = Auto.

Figure 11: Sample silicate section (µmol/l)

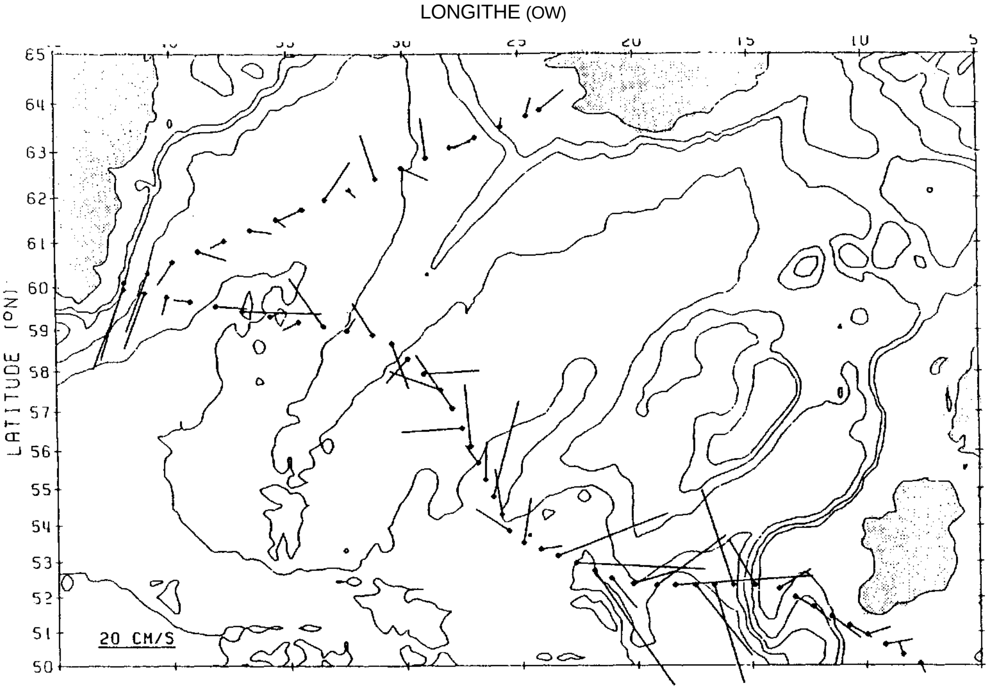
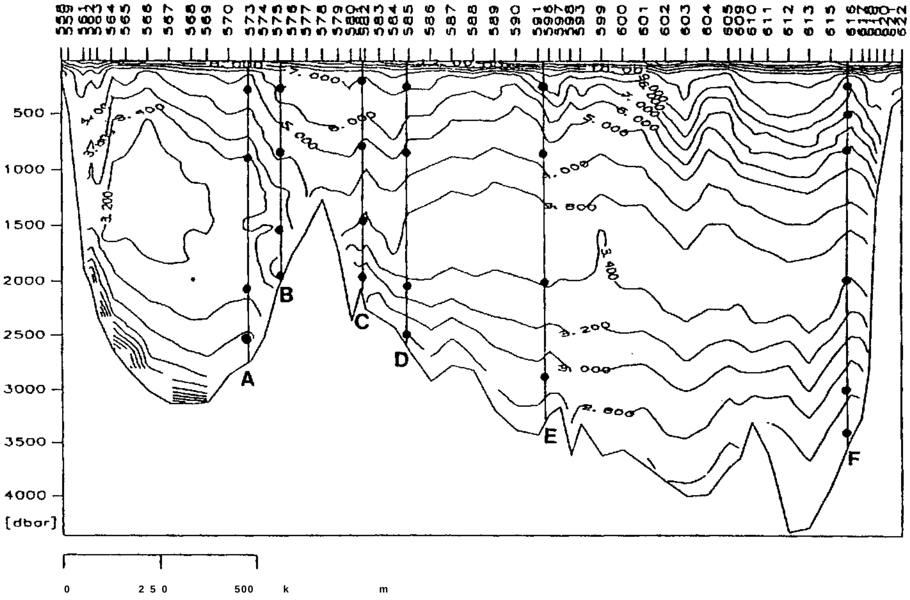


Figure 12: Distribution of the horizontally (over distance between dots) and vertically (70- 350m) averaged currents as obtained from ADCP -measurements. Diurnal (K1) and semidiurnal (M2) tides subtracted.

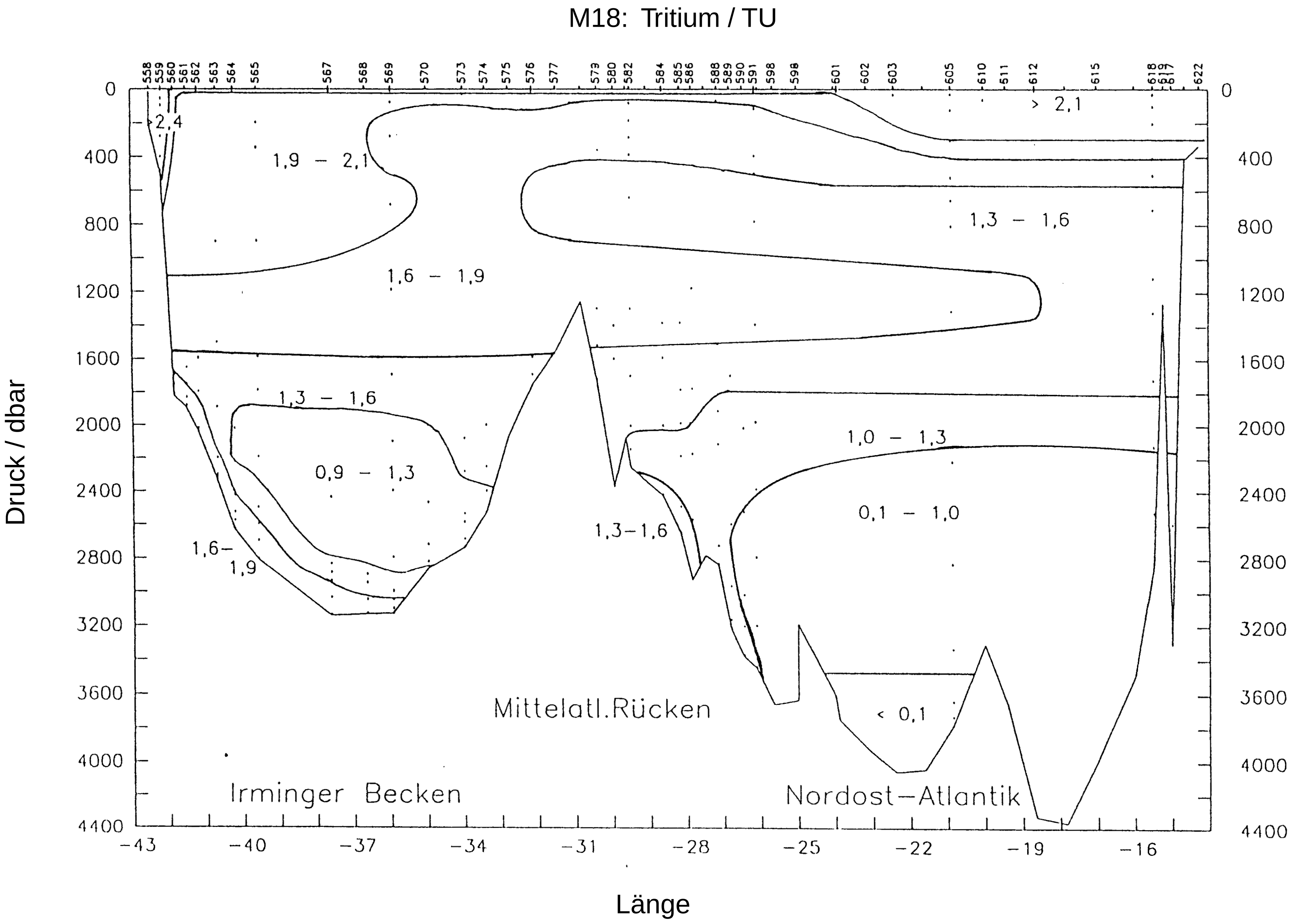


Gridding Parameter:
No of GRD-Points in X=200
No of GRO-Points in Y =200

Area in X. by no. of profiles- 2
Area in Y, by physical units 100
Order of Orthogonal Surface 1

BSH
Hamburg

Figure 13: The distribution of moorings A to F along the section A1-east, as overlaid on the observed temperature distribution as in Figure 5. The depth of the recording current meters are indicated by a dot.



M18: Tritium / TU

Figure 14: Rough sketch of the tritium distribution on the M 18 section (see text)

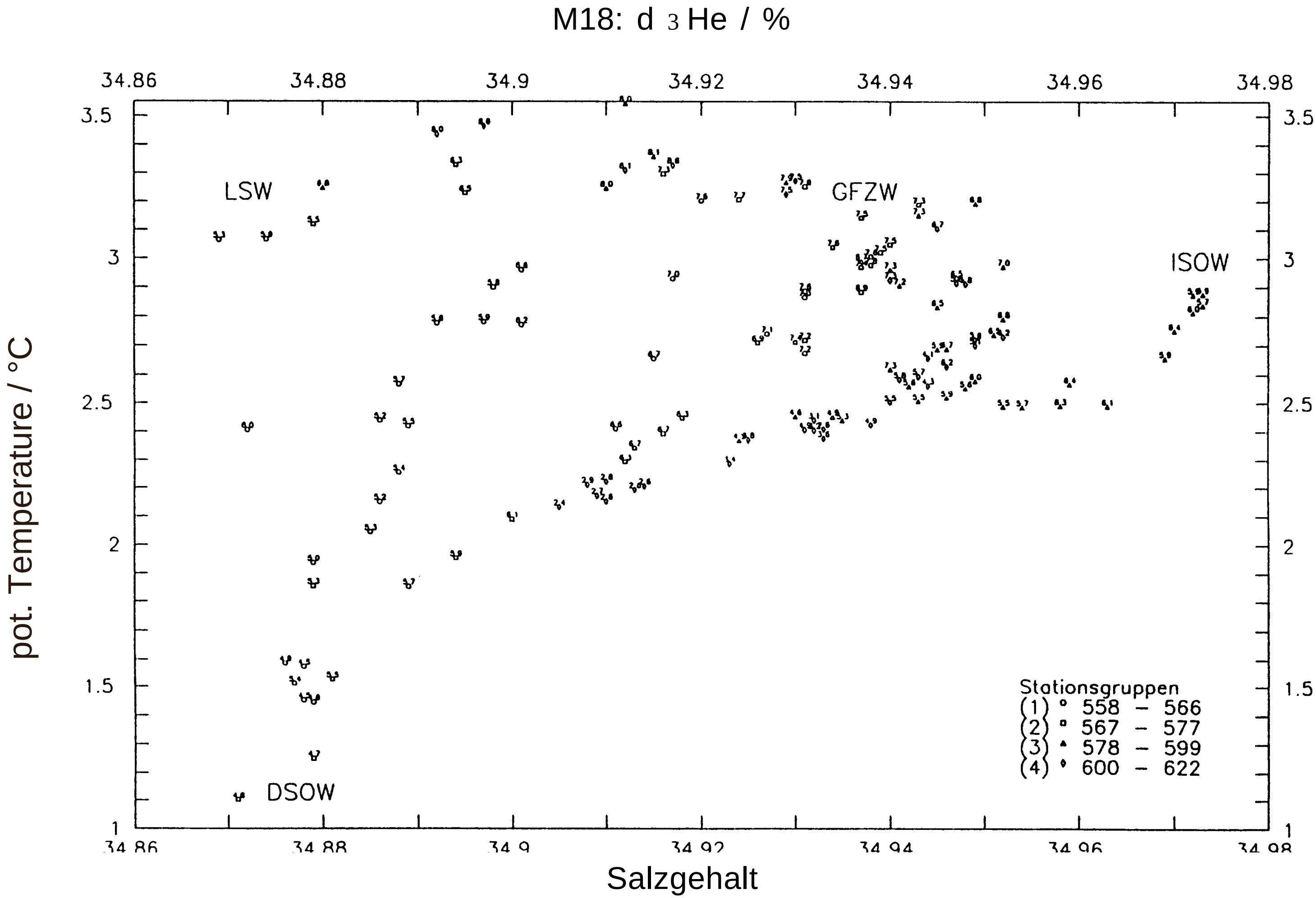


Figure 15: Selection of d3He values obtained from below 1600 m depth plotted at their respective positions in a T/S diagram. The helium isotope ratio shows significant features in the different watermasses and may be discussed together with the tritium distribution (see text). The position of the watermasses indicated need not to meet the classical definations but should be indicated for the mixing partners.

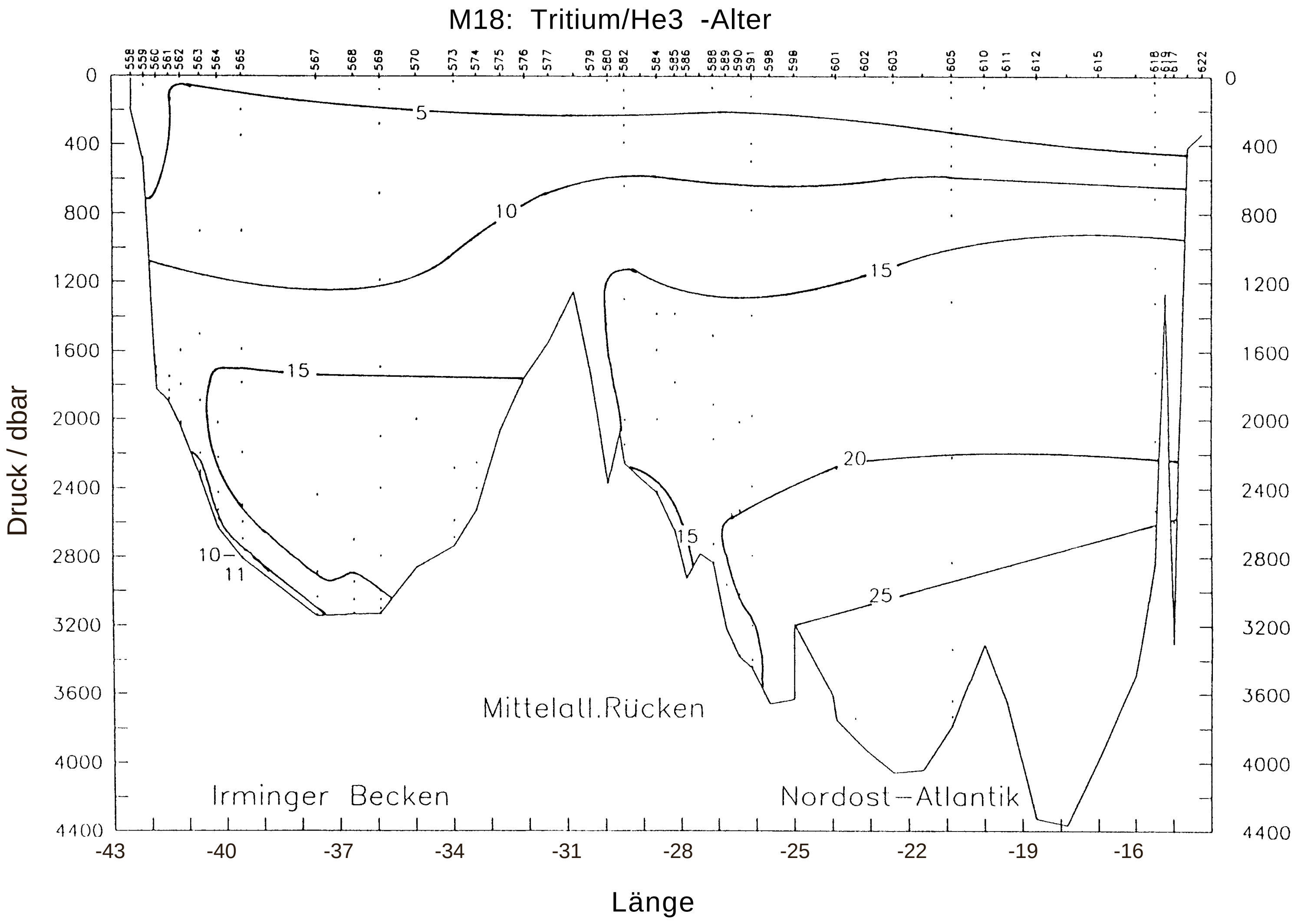


Figure 16: Flirst overview on the distribution of tritium/3He ages. The deep boundary currents connectcd to the overflowing waters from the European Polar Seas are indicated by lower apparent ages (see text).

CFM-11 [pmol kg-1] - METEOR 18

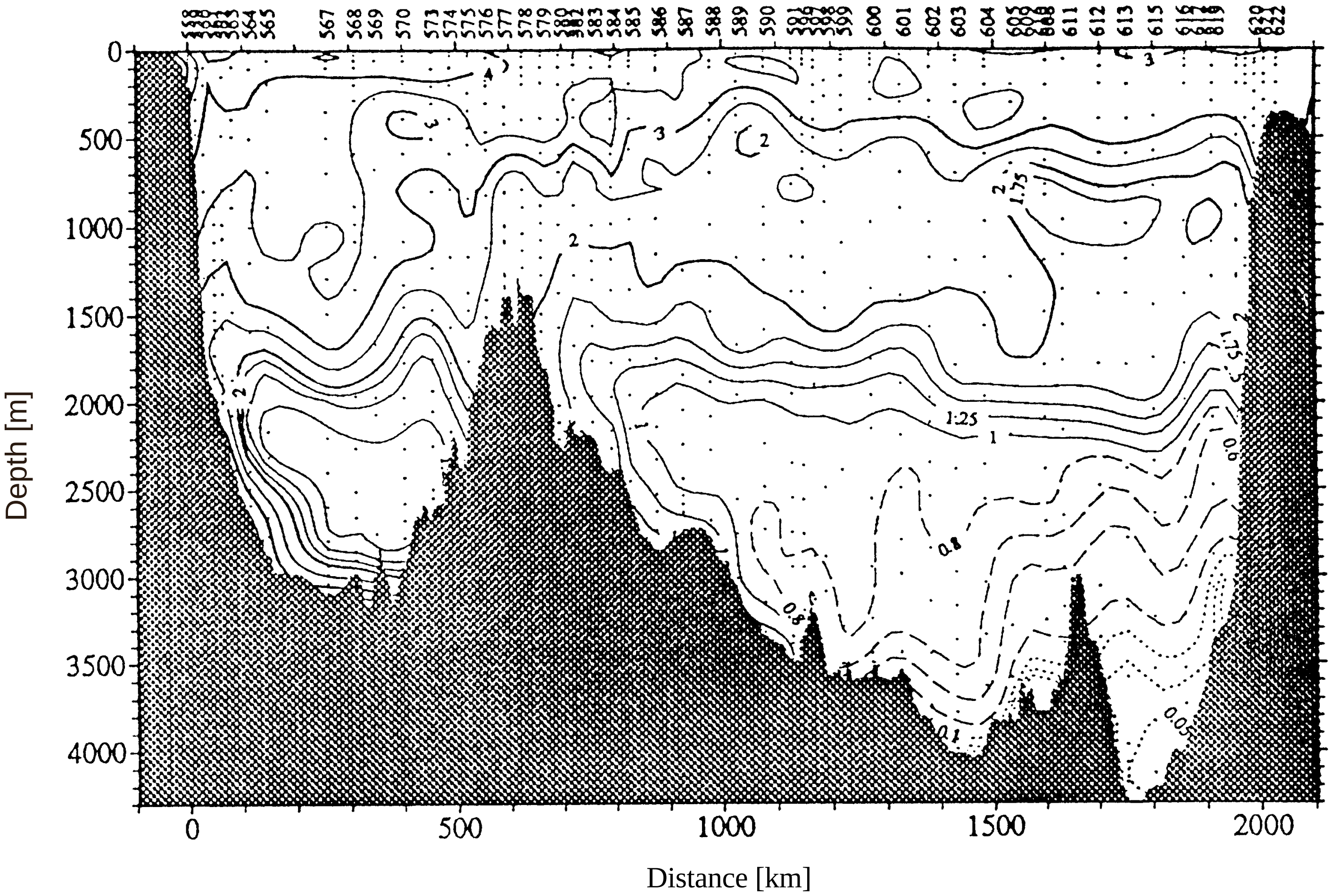


Figure 17: CFC F-11 section. Values given in pmol/kg

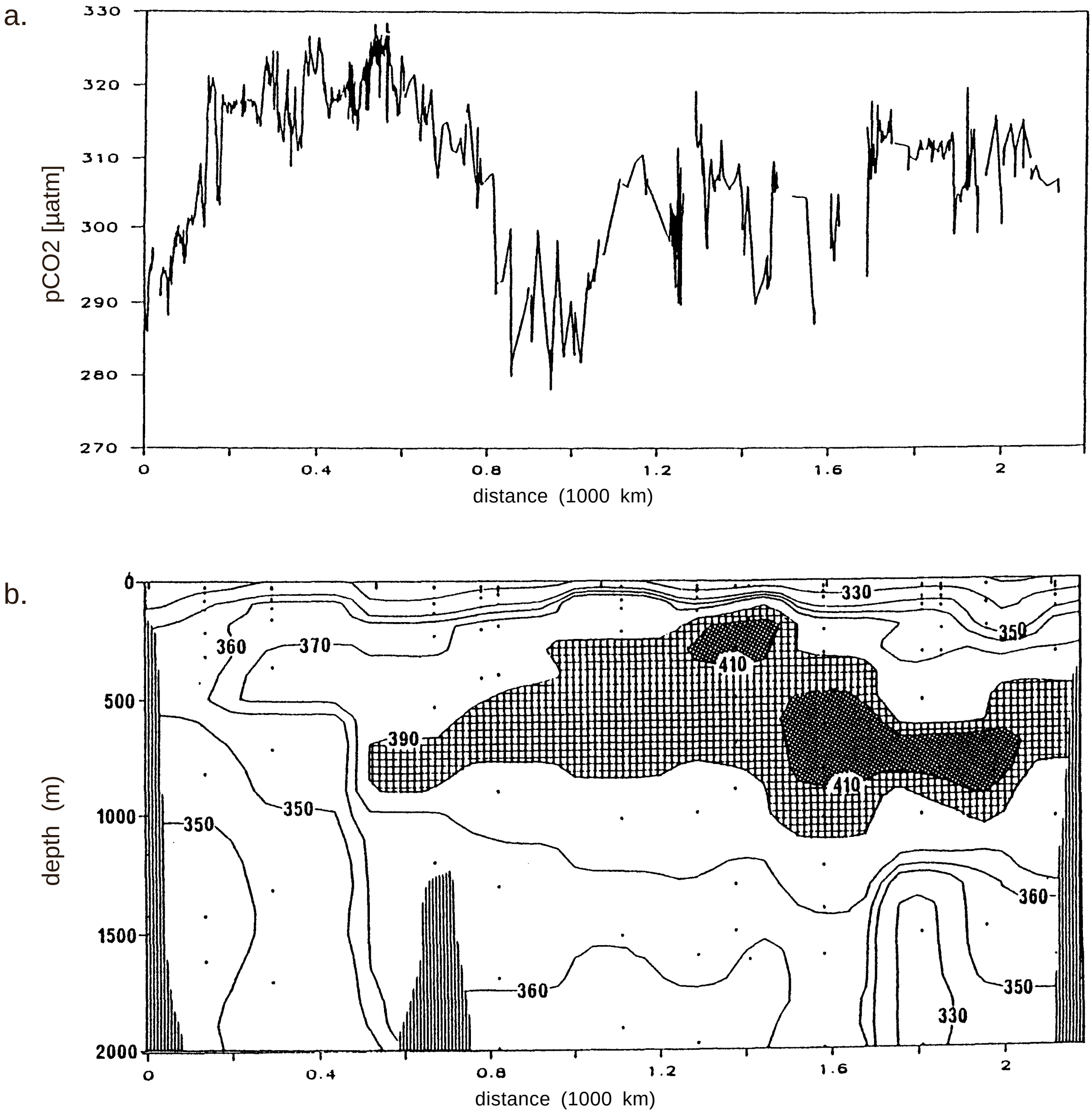


Figure 18 ab: Surface PC02 (a) and depth distribution Of PC02 (b) along the WOCE-line between Cape Farvel and Ireland.

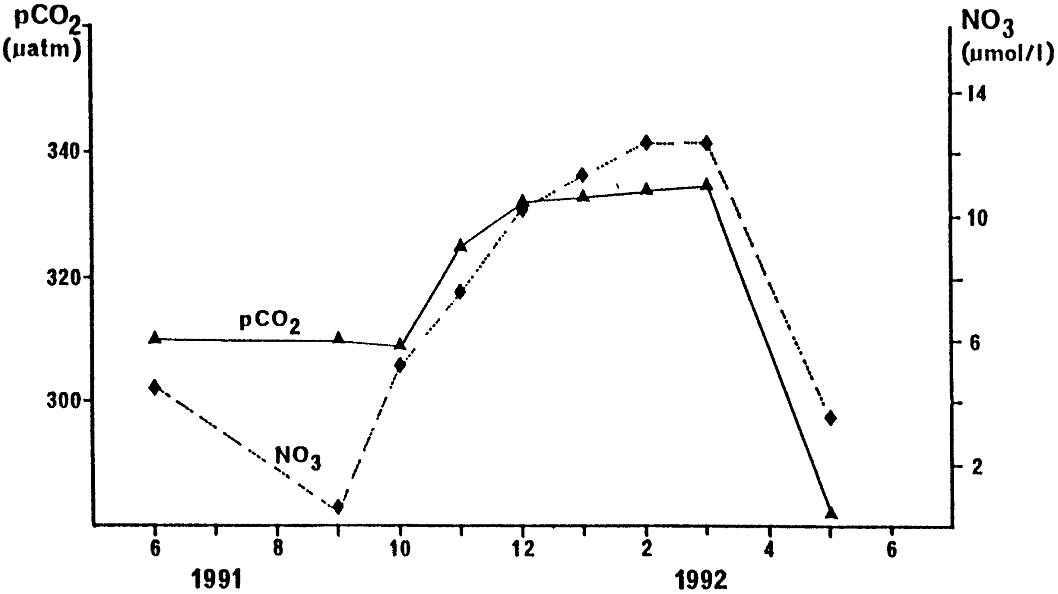


Figure 19: The seasonal cycle Of PC02 at 52.5° N/20.0° W. the values for June, September and May are based on direct measurements. The data for October to March are computed from measurements in September.

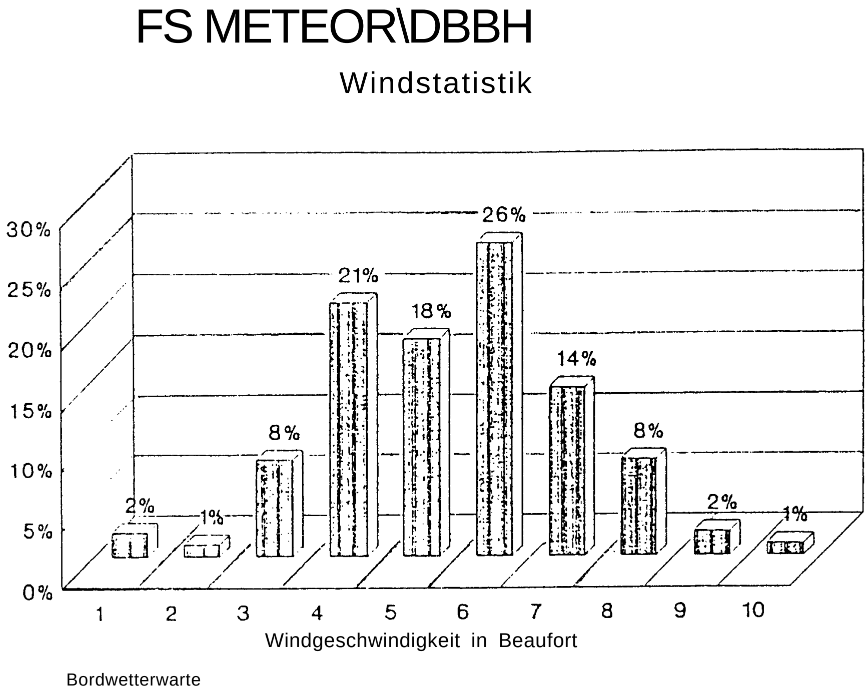


Figure 20: Percentage of windspeeds (in Beaufort) for the period Sept. 2 to Sept. 25, 1991.

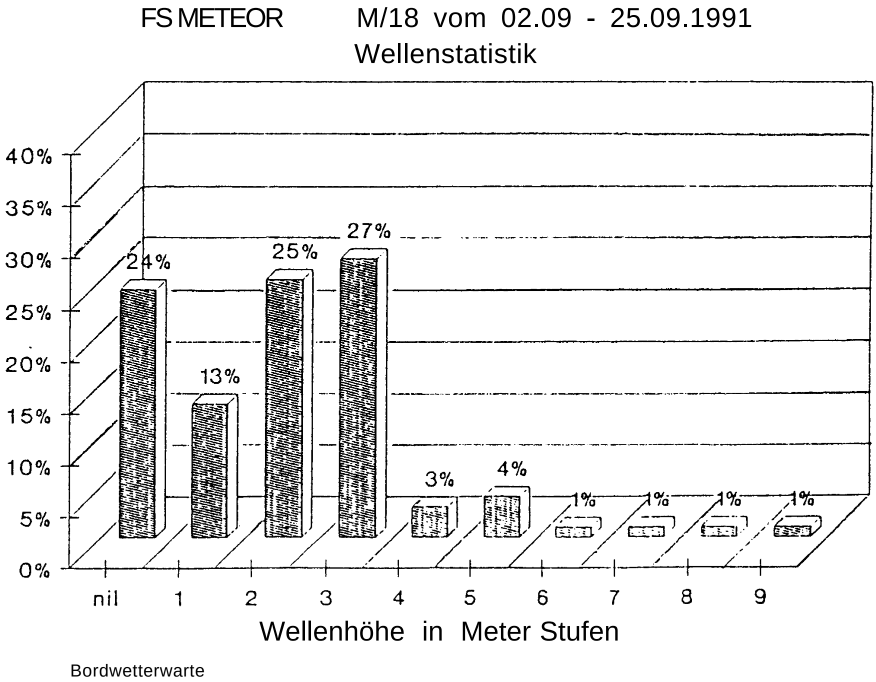


Figure 21: Percentage of the wave heights (in Meter) for the period Sept. 2 to Sept. 25, 1991.

7 Lists

Station list for METEOR cruise no. 18. The listing is prepared according to the WOCE-format (ANON, 1991). Explanations are given at the end of the table.

EXPO-CODE	WOCE ID	Stat. No.	Cast No.	Cast Type	Date	Time UTC	Code	Position Latitude	Longitude	Code	Bottom Depth	Meter Wheel	Max. Pres.	# of Btls	Parameters *	Comments
06MT18	A1/E	558	1	ROS	090591	1340	BE	60 00.0 N	042 30.3 W	GPS						
06MT18	A1/E	558	1	ROS	090591	1346	BO	60 00.0 N	042 30.4 W	GPS	185	170	175	14	1-10,12,23-25	
06MT18	A1/E	558	1	ROS	090591	1414	EN	60 00.0 N	042 30.6 W	GPS						
06MT18	A1/E	559	1	ROS	090591	1548	BE	59 58.0 N	042 10.4 W	GPS						
06MT18	A1/E	559	1	ROS	090591	1607	BO	59 58.0 N	042 10.5 W	GPS	504	479	483	18	1-10	
06MT18	A1/E	559	1	ROS	090591	1652	EN	59 58.0 N	042 11.0 W	GPS						
06MT18	A1/E	560	1	ROS	090591	1815	BE	59 55.9 N	041 51.1 W	GPS						
06MT18	A1/E	560	1	ROS	090591	1855	BO	59 55.8 N	041 51.2 W	GPS	1823	1825	1811	24	1-10,25	
06MT18	A1/E	560	1	ROS	090591	2000	EN	59 55.8 N	041 51.4 W	GPS						
06MT18	A1/E	561	1	ROS	090591	2200	BE	59 53.7 N	041 30.5 W	GPS						
06MT18	A1/E	561	1	ROS	090591	2242	BO	59 53.7 N	041 30.6 W	GPS	1898	1872	1885	23	1-10,23	
06MT18	A1/E	561	1	ROS	090691	0016	EN	59 53.2 N	041 30.0 W	GPS						
06MT18	A1/E	562	1	ROS	090691	0210	BE	59 52.0 N	041 12.0 W	GPS						
06MT18	A1/E	562	1	ROS	090691	0251	BO	59 51.8 N	041 12.0 W	GPS	2042	2013	2031	24	1-10,12	
06MT18	A1/E	562	1	ROS	090691	0417	EN	59 51.3 N	041 11.8 W	GPS						
06MT18	A1/E	563	1	ROS	090691	0609	BE	59 50.1 N	040 52.0 W	GPS						
06MT18	A1/E	563	1	ROS	090691	0657	BO	59 50.0 N	040 52.0 W	GPS	2330	2302	2322	24	1-10,12	
06MT18	A1/E	563	1	ROS	090691	0818	EN	59 50.1 N	040 52.0 W	GPS						
06MT18	A1/E	564	1	ROS	090691	1043	BE	59 47.2 N	040 13.2 W	GPS						
06MT18	A1/E	564	1	ROS	090691	1138	BO	59 47.2 N	040 12.3 W	GPS	2631	2600	2629	23	1-10,23-25	
06MT18	A1/E	564	1	ROS	090691	1306	EN	59 47.6 N	040 11.5 W	GPS						
06MT18	A1/E	565	1	ROS	090691	1528	BE	59 42 3 N	039 35.3 W	GPS						CTD signal noise & offset
06MT18	A1/E	565	1	ROS	090691	1624	BO	59 42:3 N	039 35.4 W	GPS	2807	2782	2808	23	1-10,12	at 2480-2595 dbar downcast
06MT18	A1/E	565	1	ROS	090691	1816	EN	59 42.4 N	039 34.9 W	GPS						
06MT18	A1/E	566	1	CTD	090691	2104	BE	59 35.4 N	038 35.9 W	GPS						
06MT18	A1/E	566	1	CTD	090691	2205	BO				3013	2870	2875			CTD signal breakdown at 2875 dbar
06MT18	A1/E	566	1	CTD	090691	2253	EN									downcast (under water unit)
06MT18	A1/E	567	1	ROS	090791	1038	BE	59 30.5 N	037 37.7 W	GPS						

EXPO-CODE	WOCE ID	Stat. No.	Cast No.	Cast Type	Date	Time UTC	Code	Position Latitude	Longitude	Code	Bottom Depth	Meter Wheel	Max. Pres.	# of Btls	Parameters *	Comments
06MT18	A1/E	567	1	ROS	090791	1139	BO	59 30.3 N	037 32.9 W	GPS	3129	3109	3139	22	1-10,12,23-25	
06MT18	A1/E	567	1	ROS	090791	1336	EN	59 30.4 N	037 31.9 W	GPS						
06MT18	A1/E	568	1	ROS	090791	1610	BE	59 24.5 N	036 39.1 W	GPS						
06MT18	A1/E	568	1	ROS	090791	1701	BO	59 24.1 N	036 38.9 W	GPS	3130	3088	3130	24	1-10,12,23	
06MT18	A1/E	568	1	ROS	090791	1858	EN	59 23.5 N	036 38.1 W	GPS						
06MT18	A1/E	569	1	ROS	090791	2106	BE	59 20.4 N	035 57.3 W	GPS						
06MT18	A1/E	569	1	ROS	090791	2210	BO	59 20.1 N	035 56.6 W	GPS	3116	3101	3128	23	1-10	
06MT18	A1/E	569	1	ROS	090791	2356	EN	59 20.4 N	035 55.7 W	GPS						
06MT18	A1/E	570	1	ROS	090891	0241	BE	59 14.2 N	034 59.6 W	GPS						
06MT18	A1/E	570	1	ROS	090891	0348	BO	59 14.0 N	035 00.1 W	GPS	2861	2788	2820	23	1-10,23	
06MT18	A1/E	570	1	ROS	090891	0533	EN	59 13.9 N	035 01.0 W	GPS						
06MT18	ACM8	571		MOR	090891	1113		59 08.8 N	034 01.0 W	GPS						Mooring "A1" deployed
06MT18	A1/E	571	1	ROS	090891	1155	BE	59 08.7 N	034 02.0 W	GPS						
06MT18	A1/E	571	1	ROS	090891	1222	BO	59 08.7 N	034 02.2 W	GPS	2855	1959	1962	24	1-8,10,23,24	ROS test #1 (multi-trips)
06MT18	A1/E	571	1	ROS	090891	1302	EN	59 08.8 N	034 02.3 W	GPS						at 1960 dbar
06MT18	ACM8	572		MOR	090891	1829		59 00.1 N	032 48.6 W	GPS						Mooring “B1” deployed
06MT18	A1/E	573	1	ROS	090891	2327	BE	59 08.3 N	033 59.6 W	GPS						
06MT18	A1/E	573	1	ROS	090991	0035	BO	59 08.2 N	033 59.6 W	GPS	2734	2703	2736	23	1-10,23	CTD trip recording probs
06MT18	A1/E	573	1	ROS	090991	0212	EN	59 08.3 N	033 59.3 W	GPS						CTD trip recording probs
06MT18	A1/E	574	1	ROS	090991	0405	BE	59 04.5 N	033 24.1 W	GPS						
06MT18	A1/E	574	1	ROS	090991	0453	BO	59 04.6 N	033 24.2 W	GPS	2521	2504	2529	24	1-10	
06MT18	A1/E	574	1	ROS	090991	0641	EN	59 04.6 N	033 24.3 W	GPS						
06MT18	A1/E	575	1	ROS	090991	0843	BE	59 00.7 N	032 46.1 W	GPS						CTD signal noise & offset at
06MT18	A1/E	575	1	ROS	090991	0920	BO	59 00.8 N	032 46.3 W	GPS	2063	2041	2066	23	1-10,23	434-638 dbar downcast
06MT18	A1/E	575	1	ROS	090991	1058	EN	59 01.0 N	032 47.1 W	GPS						CTD trip recording probs
06MT18	A1/E	576	1	ROS	090991	1331	BE	58 56.6 N	032 07.8 W	GPS						
06MT18	A1/E	576	1	ROS	090991	1401	BO	58 56.5 N	032 07.7 W	GPS	1752	1722	1742	23	1-10,12	
06MT18	A1/E	576	1	ROS	090991	1518	EN	58 56.6 N	032 07.5 W	GPS						
06MT18	A1/E	577	1	ROS	090991	1719	BE	58 52.6 N	031 30.0 W	GPS						
06MT18	A1/E	577	1	ROS	090991	1754	BO	58 52.8 N	031 30.0 W	GPS	1538	1510	1532			ROS failed
06MT18	A1/E	577	1	ROS	090991	1928	EN	58 53.4 N	031 30.0 W	GPS						
06MT18	A1/E	577	1	ROS	090991	2008	BE	58 52.5 N	031 29.8 W	GPS						
06MT18	A1/E	577	1	ROS	090991	2040	BO	58 52.9 N	031 29.4 W	GPS	1550	1537	1537	22	1-10,23,25	

EXPO-CODE	WOCE ID	Stat. No.	Cast No.	Cast Type	Date	Time UTC	Code	Position Latitude	Longitude	Code	Bottom Depth	Meter Wheel	Max. Pres.	# of Btls	Parameters *	Comments
06MT18	A1/E	577	1	ROS	090991	2202	EN	58 53.9 N	031 29.8 W	GPS						
06MT18	A1/E	578	1	ROS	091091	0013	BE	58 47.8 N	030 49.9 W	GPS						
06MT18	A1/E	578	1	ROS	091091	0041	BO	58 47.9 N	030 49.9 W	GPS	1272	1262	1255	19	1-8	
06MT18	A1/E	578	1	ROS	091091	0157	EN	58 48.0 N	030 50.0 W	GPS						
06MT18	A1/E	579	1	ROS	091091	0406	BE	58 33.7 N	030 23.2 W	GPS						
06MT18	A1/E	579	1	ROS	091091	0437	BO	58 33.7 N	030 23.2.W	GPS	1736	1700	1721	24	1-10,12	
06MT18	A1/E	579	1	ROS	091091	0607	EN	58 33.7 N	030 23.1 W	GPS						
06MT18	A1/E	580	1	ROS	091091	0815	BE	58 19.5 N	029 56.6 W	GPS						
06MT18	A1/E	580	1	ROS	091091	0858	BO	58 19.3 N	029 56.5 W	GPS	2369	2361	2370	23	1-10,23,25	
06MT18	A1/E	580	1	ROS	091091	1034	EN	58 20.2 N	029 56.3 W	GPS						
06MT18	ACM8	581		MOR	091091	1443		58 10.9 N	029 37.9 W	GPS						Mooring "C1" deployed
06MT18	A1/E	581	1	ROS	091091	1513	BE	58 11.1 N	029 37.1 W	GPS						
06MT18	A1/E	581	1	ROS	091091	1547	BO	58 11.1 N	029 37.1 W	GPS	2070	2023	2039	22	1-10,23	ROS test #2 (multi-trips)
06MT18	A1/E	581	1	ROS	091091	1641	EN	58 11.0 N	029 37.1 W	GPS						at 2036 dbar
06MT18	A1/E	582	1	ROS	091091	1901	BE	58 05.2 N	029 30.0 W	GPS						
06MT18	A1/E	582	1	ROS	091091	1944	BO	58 05.1 N	029 30.0 W	GPS	2252	2220	2248	24	1-10,23-25	
06MT18	A1/E	582	1	ROS	091091	2125	EN	58 05.2 N	029 30.4 W	GPS						
06MT18	A1/E	583	1	ROS	091091	2337	BE	57 51.1 N	029 04.2 W	GPS						
06MT18	A1/E	583	1	ROS	091191	0020	BO	57 51.5 N	029 03.4 W	GPS	2333	2318	2341	24	1-8	
06MT18	A1/E	583	1	ROS	091191	0200	EN	57 52.1 N	029 02.3 W	GPS						
06MT18	A1/E	584	1	ROS	091191	0428	BE	57 36.9 N	028 38.1 W	GPS						
06MT18	A1/E	584	1	ROS	091191	0519	BO	57 37.0 N	028 38.1 W	GPS	2420	2398	2422	24	1-10,12	
06MT18	A1/E	584	1	ROS	091191	0723	EN	57 37.0 N	028 38.1 W	GPS						
06MT18	ACM8	585		MOR	091191	1153		57 22.4 N	028 11.4 W	GPS						Mooring "D1" deployed
06MT18	A1/E	585	1	ROS	091191	1230	BE	57 22.2 N	028 09.6 W	GPS						
06MT18	A1/E	585	1	ROS	091191	1321	BO	57 22.2 N	028 09.5 W	GPS	2645	2614	2647	24	1-10,23	
06MT18	A1/E	585	1	ROS	091191	1515	EN	57 22.2 N	028 09.1 W	GPS						
06MT18	A1/E	586	1	ROS	091191	1916	BE	56 54.7 N	027 50.7 W	GPS						
06MT18	A1/E	586	1	ROS	091191	2005	BO	56 54.7 N	027 50.4 W	GPS	2922	2897	2926	24	1-10	
06MT18	A1/E	586	1	ROS	091191	2205	EN	56 56.0 N	027 49.6 W	GPS						
06MT18	A1/E	587	1	ROS	091291	0150	BE	56 27.3 N	027 30.0 W	GPS						
06MT18	A1/E	587	1	ROS	091291	0242	BO	56 27.6 N	027 29.6 W	GPS	2779	2758	2781	13	1-8	CTD signal loss (cable), no
06MT18	A1/E	587	1	ROS	091291	0441	EN	56 28.0 N	027 29.0 W	GPS						bottles above 1271 dbar

EXPO-CODE	WOCE ID	Stat. No.	Cast No.	Cast Type	Date	Time UTC	Code	Position Latitude	Longitude	Code	Bottom Depth	Meter Wheel	Max. Pres.	# of Btls	Parameters *	Comments
06MT18	A1/E	588	1	ROS	091291	0849	BE	55 59.5 N	027 08.6 W	GPS						
06MT18	A1/E	588	1	ROS	091291	0950	BO	55 59.5 N	027 07.5 W	GPS	2819	2793	2832	24	1-10,12,23-25	
06MT18	A1/E	588	1	ROS	091291	1113	EN	55 59.9 N	027 07.1 W	GPS						
06MT18	A1/E	589	1	ROS	091291	1441	BE	55 32.0 N	026 48.0 W	GPS						
06MT18	A1/E	589	1	ROS	091291	1545	BO	55 32.0 N	026 48.0 W	GPS	3194	3185	3213	24	1-10	
06MT18	A1/E	589	1	ROS	091291	1724	EN	55 31.8 N	026 47.7 W	GPS						
06MT18	A1/E	590	1	ROS	091291	2045	BE	55 04.3 N	026 27.5 W	GPS						
06MT18	A1/E	590	1	ROS	091291	2159	BO	55 04.1 N	026 27.6 W	GPS	3378	3376	3376	18	1-10,23	CTD cable problem
06MT18	A1/E	590	1	ROS	091291	2345	EN	55 04.6 N	026 27.7 W	GPS						
06MT18	A1/E	591	1	ROS	091391	0400	BE	54 36.6 N	026 07.5 W	GPS						
06MT18	A1/E	591	1	ROS	091391	0505	BO	54 36.6 N	026 07.1 W	GPS	3420	3398	3445	23	1-10,24,25	
06MT18	A1/E	591	1	ROS	091391	0652	EN	54 36.6 N	026 06.3 W	GPS						
06MT18	A1/E	592	1	CTD	091491	0125	BE	53 52.5 N	026 16.1 W	GPS						
06MT18	A1/E	592	1	CTD	091491	0256	BO	53 51.9 N	026 17.1 W	GPS	3643	3638	3670			
06MT18	A1/E	592	1	CTD	091491	0406	EN	53 51.9 N	026 17.2 W	GPS						
06MT18	A1/E	593	1	CTD	091491	0547	BE	54 02.0 N	026 00.8 W	GPS						
06MT18	A1/E	593	1	CTD	091491	0256	BO	54 02.0 N	026 01.1 W	GPS	3319	3295	3338			
06MT18	A1/E	593	1	CTD	091491	0745	EN	54 01.9 N	026 01.5 W	GPS						
06MT18	A1/E	594		MOR	091491	1135		54 19.9 N	025 51.4 W	GPS						Mooring "E1" deployed
06MT18	A1/E	595	1	CTD	091491	1318	BE	54 15.9 N	025 36.1 W	GPS						
06MT18	A1/E	595	1	CTD	091491	1407	BO	54 15.9 N	025 36.0 W	GPS	2554	2529	2562			
06MT18	A1/E	595	1	CTD	091491	1506	EN	54 16.0 N	025 35.9 W	GPS						
06MT18	A1/E	596	1	ROS	091491	1639	BE	54 22.6 N	025 57.0 W	GPS						CTD signal noise & offset
06MT18	A1/E	596	1	ROS	091491	1741	BO	54 22.6 N	025 57.0 W	GPS	3229	3210	3249	21	1-10,12,23	at 830-859 dbar downcast
06MT18	A1/E	596	1	ROS	091491	1952	EN	54 22.5 N	025 57.0 W	GPS						***: ROS mechanism problems
06MT18	A1/E	597	1	ROS	091491	2155	BE	54 09.0 N	025 46.4 W	GPS						
06MT18	A1/E	597	1	ROS	091491	2254	BO	54 09.3 N	025 45.7 W	GPS	3156	3147	3186	13	1-10	***
06MT18	A1/E	597	1	ROS	091591	0053	EN	54 09.4 N	025 45.7 W	GPS						
06MT18	A1/E	598	1	ROS	091591	0225	BE	53 55.0 N	025 38.2 W	GPS						
06MT18	A1/E	598	1	ROS	091591	0334	BO	53 55.2 N	025 38.2 W	GPS	3622	3612	3658	11	1-10,23-25	***
06MT18	A1/E	598	1	ROS	091591	0600	EN	53 55.0 N	025 38.0 W	GPS						
06MT18	A1/E	599	1	ROS	091591	1010	BE	53 40.3 N	025 25.6 W	GPS						
06MT18	A1/E	599	1	ROS	091591	1120	BO	53 40.3 N	025 25.5 w	GPS	3626	3584	3632	24	1-10,23-25	***

EXPO-CODE	WOCE ID	Stat. No.	Cast No.	Cast Type	Date	Time UTC	Code	Position Latitude	Longitude	Code	Bottom Depth	Meter Wheel	Max. Pres.	# of Btls	Parameters *	Comments
06MT18	A1/E	599	1	ROS	091591	1333	EN	53 40.3 N	025 25.3 W	GPS						+++: CTD trip recording probs
06MT18	A1/E	600	1	ROS	091591	1610	BE	53 27.9 N	024 41.0 W	GPS						
06MT18	A1/E	600	1	ROS	091591	1715	BO	53 27.8 N	024 41.1 W	GPS	3570	3565	3605	24	1-10,23	***, +++
06MT18	A1/E	600	1	ROS	091591	1939	EN	53 28.0 N	024 41.0 W	GPS						
06MT18	A1/E	601	1	ROS	091591	2226	BE	53 16.0 N	023 54.2 W	GPS						
06MT18	A1/E	601	1	ROS	091591	2340	BO	53 16.0 N	023 53.9 W	GPS	3718	3703	3749	24	1-10	***, +++
06MT18	A1/E	601	1	ROS	091691	0206	EN	53 16.0 N	023 54.0 W	GPS						
06MT18	A1/E	602	1	ROS	091691	0444	BE	53 04.0 N	023 07.7 W	GPS						Jellyfish in C-sensor at 2360
06MT18	A1/E	602	1	ROS	091691	0559	BO	53 04.1 N	023 07.8 W	GPS	3875	3884	3923	24	1-10,12,23-25	dbar downcast
06MT18	A1/E	602	1	ROS	091691	0825	EN	53 04.0 N	023 07.3 W	GPS						***, +++
06MT18	A1/E	603	1	ROS	091691	1111	BE	52 52.0 N	022 23.2 W	GPS						
06MT18	A1/E	603	1	ROS	091691	1236	BO	52 51.5 N	022 22.6 W	GPS	4005	4001	4057	24	1-10,12,23	***, +++
06MT18	A1/E	603	1	ROS	091691	1450	EN	52 50.5 N	022 21.6 W	GPS						
06MT18	A1/E	604	1	ROS	091691	1728	BE	52 40 0 N	021 36.8 W	GPS						
06MT18	A1/E	604	1	ROS	091691	1846	BO	52 39.3 N	021 36.8 W	GPS	3990	3996	4045	24	1-8,10	***, +++
06MT18	A1/E	604	1	ROS	091691	2106	EN	52.37.8 N	021 36.6 W	GPS						
06MT18	A1/E	605	1	ROS	091791	0006	BE	52 28.0 N	020 51.9 W	GPS						
06MT18	A1/E	605	1	ROS	091791	0114	BO	52 28.0 N	020 51.8 W	GPS	3739	3739	3787	23	1-10,12	***, +++
06MT18	A1/E	605	1	ROS	091791	0300	EN	52 28.2 N	020 50.9 W	GPS						
06MT18	A1/E	606	1	ROS	091791	1136	BE	52 39.8 N	020 00.1 W	GPS						
06MT18	A1/E	606	1	ROS	091791	1226	BO	52 39.6 N	019 59.6 W	GPS	2593	2573	2594			
06MT18	A1/E	606	1	ROS	091791	1325	EN	52 39.3 N	019 59.3 W	GPS						
06MT18	A1/E	607	1	ROS	091791	1503	BE	52 29.9 N	020 00.0 W	GPS						
06MT18	A1/E	607	1	ROS	091791	1601	BO	52 29.8 N	020 00.0 W	GPS	2803	2782	2816	12	23-25	***, +++
06MT18	A1/E	607	1	ROS	091791	1710	EN	52 30.0 N	020 00.0 W	GPS						
06MT18	A1/E	608	1	ROS	091791	2000	BE	52 10.1 N	020 00.0 W	GPS						
06MT18	A1/E	608	1	ROS	091791	2123	BO	52 10.5 N	019 59.6 W	GPS	3783	3776	3826	12	1-18,10	ROS test #3 (multi-trips)
06MT18	A1/E	608	1	ROS	091791	2300	EN	52 10.3 N	019 59.3 W	GPS						at 3815 dbar
06MT18	A1/E	609	1	ROS	091891	0231	BE	52 21.8 N	020 27.8 W	GPS						
06MT18	A1/E	609	1	ROS	091891	0345	BO	52 21.5 N	020 28.1 W	GPS	3646	3588	3627	15	1-8	***, +++
06MT18	A1/E	609	1	ROS	091891	0606	EN	52 21.9 N	020 28.3 W	GPS						leaking bottles (rough sea)
06MT18	A1/E	610	1	ROS	091891	0809	BE	52 20.0 N	020 00.0 W	GPS						
06MT18	A1/E	610	1	ROS	091891	0920	BO	52 20.2 N	020 00.0 W	GPS	3308	3275	3309	22	1-10,23	***, +++

EXPO-CODE	WOCE ID	Stat. No.	Cast No.	Cast Type	Date	Time UTC	Code	Position Latitude	Longitude	Code	Bottom Depth	Meter Wheel	Max. Pres.	# of Btls	Parameters *	Comments
06MT18	A1/E	610	1	ROS	091891	1140	EN	52 21.1 N	019 58.7 W	GPS						
06MT18	A1/E	611	1	ROS	091891	1348	BE	52 20.3 N	019 24.7 W	GPS						
06MT18	A1/E	611	1	ROS	091891	1459	BO	52 20.2 N	019 24.7 W	GPS	3600	3630	3651	22	1-8,10,25	***, +++
06MT18	A1/E	611	1	ROS	091891	1715	EN	52 19.7 N	019 24.3 W	GPS						
06MT18	A1/E	612	1	ROS	091891	1942	BE	52 19.9 N	018 37.8 W	GPS						Offset in S at 4034 dbar downcast
06MT18	A1/E	612	1	ROS	091891	2103	BO	52 19.4 N	018 37.2 W	GPS	4329	4331	4391	22	1-10,12	***, +++
06MT18	A1/E	612	1	ROS	091891	2351	EN	52 19.4 N	018 37.4 W	GPS						
06MT18	A1/E	613	1	ROS	091991	0240	BE	52 20.1 N	017 49.8 W	GPS						Offset in S at 3974 dbar downcast
06MT18	A1/E	613	1	ROS	091991	0402	BO	52 19.9 N	017 48.9 W	GPS	4292	4331	4370	22	1-8,10,24-25	***, +++
06MT18	A1/E	613	1	ROS	091991	0632	EN	52 19.3 N	017 48.0 W	GPS						
06MT18	ACM8	614		MOR	091991	1253		52 20.5 N	016 20.1 W	GPS						
06MT18	A1/E	615	1	ROS	091991	1740	BE	52 20.0 N	016 59.8 W	GPS						Mooring "F1" deployed
06MT18	A1/E	615	1	ROS	091991	1859	BO	52 19.6 N	016 59.3 W	GPS	3931	3927	3981	22	1-10,12,23	
06MT18	A1/E	615	1	ROS	091991	2121	EN	52 18.4 N	016 58.0 W	GPS						
06MT18	A1/E	616	1	ROS	092091	0008	BE	52 20.0 N	016 12.0 W	GPS						
06MT18	A1/E	616	1	ROS	092091	0119	BO	52 19.5 N	016 12.1 W	GPS	3465	3451	3492	23	1-8	
06MT18	A1/E	616	1	ROS	092091	0337	EN	52 19.0 N	016 11.0 W	GPS						
06MT18	A1/E	617	1	ROS	092091	0552	BE	52 20.1 N	015 47.0 W	GPS						
06MT18	A1/E	617	1	ROS	092091	0706	BO	52 20.3 N	015 46.3 W	GPS	3273	3264	3305	23	1-10,23-25	
06MT18	A1/E	617	1	ROS	092091	0912	EN	52 21.2 N	015 46.7 W	GPS						
06MT18	A1/E	618	1	ROS	092091	1110	BE	52 20.1 N	015 30.0 W	GPS						
06MT18	A1/E	618	1	ROS	092091	1207	BO	52 20.1 N	015 30.1 W	GPS	2839	2805	2830	20	1-10,23	
06MT18	A1/E	618	1	ROS	092091	1358	EN	52 20.6 N	015 29.7 W	GPS						
06MT18	A1/E	618	2	ROS	092091	1611	BE	52 20.0 N	015 30.0 W	GPS						
06MT18	A1/E	618	2	ROS	092091	1657	BO	52 20.1 N	015 30.0 W	GPS	2834	1955	1978	23	1-8	ROS test #4 (multi-trips)
06MT18	A1/E	618	2	ROS	092091	1748	EN	52 20.2 N	015 29.9 W	GPS						at 1855 dbar
06MT18	A1/E	619	1	ROS	092091	2223	BE	52 20.0 N	015 13.0 W	GPS						
06MT18	A1/E	619	1	ROS	092091	2251	BO	52 19.9 N	015 13.1 W	GPS	1262	1250	1259	12	1-8,10,23	
06MT18	A1/E	619	1	ROS	092091	2353	EN	52 20.3 N	015 13.3 W	GPS						
06MT18	A1/E	620	1	ROS	092191	0154	BE	52 20.1 N	014 56.0 W	GPS						
06MT18	A1/E	620	1	ROS	092191	0220	BO	52 20.0 N	014 55.9 W	GPS	839	832	839	12	1-8,23	
06MT18	A1/E	620	1	ROS	092191	0312	EN	52 19.8 N	014 55.7 W	GPS						
06MT18	A1/E	621	1	ROS	092191	0452	BE	52 20.0 N	014 38.7 W	GPS						

EXPO-CODE	WOCE ID	Stat. No.	Cast No.	Cast Type	Date	Time UTC	Code	Position Latitude	Longitude	Code	Bottom Depth	Meter Wheel	Max. Pres.	# of Btls	Parameters *	Comments
06MT18	A1/E	621	1	ROS	092191	0508	BO	52 20.2 N	014 38.6 W	GPS	417	391	404	10	1-8,23	
06MT18	A1/E	621	1	ROS	092191	0530	EN	52 20.1 N	014 38.6 W	GPS						
06MT18	A1/E	622	1	ROS	092191	0715	BE	52 19.8 N	014 15.4 W	GPS						
06MT18	A1/E	622	1	ROS	092191	0737	BO	52 20.0 N	014 15.2 W	GPS	335	314	320	10	1-8,10,25	
06MT18	A1/E	622	1	ROS	092191	0805	EN	52 19.8 N	014 15.2 W	GPS						

*** ROS mechanism problems (multiple uncontrolled, mis-, or double trips) Stat #569 through 613

+++ CTD trip recording problems (CTD values not recorded in bottle file for multiple trips) Stat #599 through 613

* Parameter numbers according WOCE Operations Manual, WOCE Office Report 90-1, July 1991, Rev. 1, Table 3.5.

Oxygen and Nutrient measurements

The oxygen and nutrient data were entered into ODF's ship board data system and processed as the analyses were completed. Pressure and temperature information were given to ODF by the German group. The bottle data were brought to a useable, though perhaps not final, state at sea. ODF data checking procedures included verification that the sample was assigned to the correct level. This was accomplished by checking the raw data sheets, which included the raw data value and the water sample bottle, versus the sample log sheets. Any comments regarding the water samples were investigated. The raw data computer files were also checked for entry errors. Investigation of the data included reviewing plots of the station profiles and comparing these to nearby stations.

If a data value did not agree with other nearby data, then analyst and sampling notes, plots, and nearby data were reviewed.

If any problem was indicated the data value was flagged. The Bottle Data Processing Notes section includes comments regarding investigation of flagged samples.

The WOCE codes were assigned to the oxygen and nutrient data using the criteria:

code 9 = Sample not drawn.

code 5 = Data value deleted. Value did not fit station profile or adjoining station data comparison. Comments were made that clearly indicated a leak and contamination of the samples. This code was not assigned to any of the data in the .sea file. The data that has been deleted from the .sea files are included in a separate file.

code 4 = Does not fit station profile and/or adjoining station comparisons. There are analytical notes indicating a problem, but data values were reported. ODF recommends deletion of these data values.

code 3 = Does not fit station profile or adjoining station comparisons and no analytical notes indicate a problem. The data could possibly be real, but decision as to whether it is acceptable needs to be made by a scientist rather than ODF's technicians.

code 2 = Acceptable measurement.

code 1 = Sample for this measurement was drawn from the bottle, but data was not received and is not recoverable.

The following table is a tabulation of the number of ODF samples with a count for each of the different codes.
Stations 558-622

	Reported Levels	Water Sample Codes					
		1	2	3	4	5	9
Oxygen	1183	0	1163	4	16	63	15
Silicate	1183	0	1176	0	7	63	15
Nitrate	1137	0	1031	45	107	63	15
Nitrite	1183	0	1073	2	62	63	61
Phosphate	1183	0	1073	23	87	63	15

Number of reported sampling levels: 1198

Samples were collected for dissolved oxygen analyses soon after the sampler was brought on board and after CFC and Helium were drawn. Nominal 125 ml volume iodine flasks were rinsed carefully with minimal agitation, then filled via a drawing tube, and allowed to overflow for at least 2 flask volumes. The sample water temperature was measured immediately before the sample was drawn for most samples. Reagents were added to fix the oxygen before stoppering. The flasks were shaken twice; immediately, and after 20 minutes, to assure thorough dispersion of the $Mn(OH)_2$ precipitate. The samples were analyzed within 4-36 hours.

Dissolved oxygen analyses, reportable in both milliliters per liter and micromoles per kilogram, were performed via titration in the volume-calibrated iodine flasks with a 1 ml microburet, using the whole bottle Winkler titration following the technique of Carpenter (1965) with modifications by Culberson et al. (1991) except that standards and blanks were run in seawater.

A German copy of Culberson's manuscript (no reference to publication) was made available during the cruise which stated distilled water should be used for standards and blanks. Unfortunately, the ODF technician was not aware of the manuscript at the beginning of the cruise.

Some comparisons between seawater and distilled water standards and blanks were run at the end of the cruise. A technician from BSH drew samples from most of the test rosette stations and ran them on the BSH Dosimat dead stop indicator titration system using distilled water with commercially prepared standard. She consistently got lower values, from .20 ml/l on the first test cast to about .11 on the others. We exchanged standards but the difference in standards was much less than the difference in data. The reason for the difference was never conclusively determined. Lab temperature stayed within 20 to 22˚C in the hood where the O_2 rig was set up based on periodic checks with the draw temp thermometer. Standardizations were performed with 0.01N potassium iodate solutions prepared from pre-weighed potassium iodate crystals. Standards were run at the beginning of each session of analyses, which typically included from 1 to 3 stations. Several standards were made up and compared to assure that the results were reproducible, and to preclude basing the entire cruise on one standard. A correction was made for the amount of oxygen added with the reagents. Combined reagent/seawater blanks were determined to account for oxidizing or reducing materials in the reagents. The oxygen thionormality values and blanks have been reviewed for possible problems and smoothed as necessary.

The temperature of the samples was measured at the time the sample was drawn from the bottle, and are included in this data submission. On several stations, the thermometer used to measure the draw temperature failed to operate properly. On these stations the in situ temperature is reported and comments to this effect are in the data remarks section documentation.

Nutrients

Nutrients (phosphate, silicate, nitrate and nitrite) analyses, reported in micromoles/liter, were performed on a Techni- con® AutoAnalyzer®. The procedures used are described in Hager et al. (1972) and Atlas et al. (1971). Standardizations were performed with solutions prepared aboard ship from pre-weighed standards; these solutions were used as working standards before and after each cast (approximately 36 samples) to correct for instrumental drift during analyses. Sets of 4-6 different concentrations of shipboard standards were analyzed periodically to determine the linearity of colorimeter response and the resulting correction factors. Phosphate was analyzed using hydrazine reduction of phosphomolybdic acid as described by Bernhardt & Wilhelms (1967). Silicate was analyzed using stannous chloride reduction of silicomolybdic acid. Nitrite was analyzed using diazotization and coupling to form dye; nitrate was reduced by copperized cadmium and then analyzed as nitrite. These three analyses use the methods of Armstrong et al. (1967).

Sampling for nutrients followed that for the tracer gases, CFC's, He, tritium, and dissolved oxygen. Samples were drawn into ~45 cc high density polyethylene, narrow mouth, screw-capped bottles which were rinsed twice before filling. The samples may have been refrigerated at 2 to 6˚C for a maximum of 15 hours.

DATA COMPARISONS

The oxygen and nutrient data were compared by ODF with those from the adjacent stations.

DATA COMMENTS

Remarks for deleted and/or missing samples or WOCE codes other than 2 from WOCE NORD A1/E. Investigation of data may include review of data plots of station profile and adjoining stations, rereading of charts (i.e., nutrients). Comments from the Sample Logs and ODF's results of investigation of oxygen and nutrients are included in this report.

Station 556

1all Test station, no final CTD data was submitted. ODF has included the oxygen and nutrients in a separate file.
106 O_2 .13 high on calib station (all bottles tripped same level). Calc ok. Note on data sheet "strong blue return" Nutrient ok so probably over titrated, not bottle trip problem. Footnote oxygen bad.
118 O_2 .27 high on calib station (all bottles tripped same level). Calc ok. Note on data sheet "slight blue return" Nutrient ok so probably over titrated, not bottle trip problem. Footnote oxygen bad.
122 Sample Log: "No samples taken."
123 Sample Log: "No samples taken."

Station 557

1all Test station, no final CTD data was submitted. ODF has included the oxygen and nutrients in a separate file.
108 108-110 Appears .07 low on calib cast (all bottles tripped same level). PO_4 calc ok, peaks poor, no notes. Other nutrients & oxygens ok. Footnote PO_4 bad.
109 See 108 comments, footnote PO_4 bad.
110 See 108 comments, footnote PO_4 bad.
123 Sample Log: No samples taken.
124 Sample Log: No samples taken.

Station 558

1all 14 bottles.
101 @ 171db - Nutrient: "Begin End NO_2, NO_3, PO_4 must be SSW being used - too much bio activity!" Same problem Stations 558 through 560. Footnote NO_2 bad. Footnote PO_4 bad. Footnote NO_3 bad.
102 @ 171db - Didn't trip as scheduled per final data submission. Oxygen agrees with duplicate trip data. See 101 comment, footnote NO_2 bad. See 101 comment, footnote NO_3 bad. See 101 comment, footnote PO_4 bad.
103 @ 151db - See 101 comment, footnote #2 bad. See 101 comment, footnote NO_3 bad. See 101 comment, footnote PO_4 bad.
104 @ 131db - See 101 comment, footnote #2 bad. See 101 comment, footnote NO_3 bad. See 101 comment, footnote PO_4 bad.
105 @ 111db - See 101 comment, footnote NO_2 bad. See 101 comment, footnote NO_3 bad. See 101 comment, footnote PO_4 bad.
106 @ 99db - See 101 comment, footnote NO_2 bad. See 101 comment, footnote NO_3 bad. See 101 comment, footnote PO_4 bad.
107 @ 86db - See 101 comment, footnote NO_2 bad. See 101 comment, footnote NO_3 bad. See 101 comment, footnote PO_4 bad.
108 @ 66db - See 101 comment, footnote NO_2 bad. See 101 comment, footnote NO_3 bad. See 101 comment, footnote PO_4 bad.

109 @ 47db - See 101 comment, footnote NO_2 bad. See 101 comment, footnote NO_3 bad. See 101 comment, footnote PO_4 bad.
110 @ 27db - See 101 comment, footnote NO_2 bad. See 101 comment, footnote NO_3 bad. See 101 comment, footnote PO_4 bad. Oxygen: "Noticed a very small bubble in burette." Data looks ok.
111 @ 9db - See 101 comment, footnote NO_2 bad. See 101 comment, footnote NO_3 bad. See 101 comment, footnote PO_4 bad.
112 @ 8db - See 101 comment, footnote NO_2 bad. See 101 comment, footnote NO_3 bad. See 101 comment, footnote PO_4 bad.
113 @ 8db - See 101 comment, footnote NO_2 bad. See 101 comment, footnote NO_3 bad. See 101 comment, footnote PO_4 bad.
114 @ 9db - See 101 comment, footnote NO_2 bad. See 101 comment, footnote NO_3 bad. See 101 comment, footnote PO_4 bad.

Station 559

1all 18 bottles.
101 @ 477db - Nutrient: "End NO_2 STDs no good, use begin" "SSW affecting stdizations!" 101-118 Same problem Stations 558 through 560. Footnote NO_2 bad. Footnote NO_3 bad. Footnote PO_4 bad.
102 @ 458db - See 101 comments, footnote NO_2 bad. See 101 comments, footnote NO_3 bad. See 101 comments, footnote PO_4 bad.
103 @ 439db - See 101 comments, footnote NO_2 bad. See 101 comments, footnote NO_3 bad. See 101 comments, footnote PO_4 bad.
104 @ 419db - See 101 comments, footnote NO_2 bad. See 101 comments, footnote NO_3 bad. See 101 comments, footnote PO_4 bad.
105 @ 398db - See 101 comments, footnote NO_2 bad. See 101 comments, footnote NO_3 bad. See 101 comments, footnote PO_4 bad.
106 @ 377db - See 101 comments, footnote NO_2 bad. See 101 comments, footnote NO_3 bad. See 101 comments, footnote PO_4 bad.
107 @ 329db - See 101 comments, footnote NO_2 bad. See 101 comments, footnote NO_3 bad. See 101 comments, footnote PO_4 bad.
108 @ 278db - See 101 comments, footnote NO_2 bad. See 101 comments, footnote NO_3 bad. See 101 comments, footnote PO_4 bad.
109 @ 229db - See 101 comments, footnote NO_2 bad. See 101 comments, footnote NO_3 bad. See 101 comments, footnote PO_4 bad.
110 @ 198db - See 101 comments, footnote NO_2 bad. See 101 comments, footnote NO_3 bad. See 101 comments, footnote PO_4 bad.
111 @ 156db - See 101 comments, footnote NO_2 bad. See 101 comments, footnote NO_3 bad. See 101 comments, footnote PO_4 bad.
112 @ 97db - See 101 comments, footnote NO_2 bad. See 101 comments, footnote NO_3 bad. See 101 comments, footnote PO_4 bad.
113 @ 57db - See 101 comments, footnote NO_2 bad. See 101 comments, footnote NO_3 bad. See 101 comments, footnote PO_4 bad.
114 @ 26db - See 101 comments, footnote NO_2 bad. See 101 comments, footnote NO_3 bad. See 101 comments, footnote PO_4 bad.

115 @ 8db - See 101 comments, footnote NO_2 bad. See 101 comments, footnote NO_3 bad. See 101 comments, footnote PO_4 bad.
116 @ 8db - See 101 comments, footnote NO_2 bad. See 101 comments, footnote NO_3 bad. See 101 comments, footnote PO_4 bad.
117 @ 8db - See 101 comments, footnote NO_2 bad. See 101 comments, footnote NO_3 bad. See 101 comments, footnote PO_4 bad.
118 @ 8db - See 101 comments, footnote NO_2 bad. See 101 comments, footnote NO_3 bad. See 101 comments, footnote PO_4 bad.

Station 560

101 @ 1805db - Nutrient: "New batch SSW - try to alleviate STDs jumping around. Didn't help much. We need to have a supply of filtered sterilized low nut. water for universal use!!. Use be NO_2 F1 for end. Bugs screwing up NO_2 too fast!! NO_3, PO_4 use begin F1 for F1E." 101-124 Same problem Stations 558 through 560. NO_3 values about 1.0 high. Using original F1E would make values even higher. Possibly standard was deteriorating when 1st set run. PO_4 values about 0.08 high. Using original F1E would make values even higher. Possibly standard was deteriorating when 1st set run. Footnote NO_2 bad. Footnote NO_3 bad. Footnote PO_4 bad.
102 Sample log: "No oxygen, no Nitrate, no Phosphate, no Silicate, no Nitrite."
103 @ 1744db - See 101 comments, footnote NO_2 bad. See 101 comments, footnote NO_3 bad. See 101 comments, footnote PO_4 bad.
104 @ 1693db - See 101 comments, footnote NO_2 bad. See 101 comments, footnote NO_3 bad. See 101 comments, footnote PO_4 bad.
105 @ 1642db - See 101 comments, footnote NO_2 bad. See 101 comments, footnote NO_3 bad. See 101 comments, footnote PO_4 bad.
106 @ 1592db - See 101 comments, footnote NO_2 bad. See 101 comments, footnote NO_3 bad. See 101 comments, footnote PO_4 bad.
107 @ 1493db - See 101 comments, footnote NO_2 bad. See 101 comments, footnote NO_3 bad. See 101 comments, footnote PO_4 bad.
108 @ 1395db - See 101 comments, footnote NO_2 bad. See 101 comments, footnote NO_3 bad. See 101 comments, footnote PO_4 bad.
109 @ 1297db - See 101 comments, footnote NO_2 bad. See 101 comments, footnote NO_3 bad. See 101 comments, footnote PO_4 bad.
110 @ 1198db - See 101 comments, footnote NO_2 bad. See 101 comments, footnote NO_3 bad. See 101 comments, footnote PO_4 bad.
111 @ 1100db - See 101 comments, footnote NO_2 bad. See 101 comments, footnote NO_3 bad. See 101 comments, footnote PO_4 bad.
112 @ 997db - See 101 comments, footnote NO_2 bad. See 101 comments, footnote NO_3 bad. See 101 comments, footnote PO_4 bad.
113 @ 902db - See 101 comments, footnote NO_2 bad. See 101 comments, footnote NO_3 bad. See 101 comments, footnote PO_4 bad.
114 @ 803db - See 101 comments, footnote NO_2 bad. See 101 comments, footnote NO_3 bad. See 101 comments, footnote PO_4 bad.

115 @ 692db - See 101 comments, footnote NO_2 bad. See 101 comments, footnote NO_3 bad. See 101 comments, footnote PO_4 bad.
116 @ 591db - See 101 comments, footnote NO_2 bad. See 101 comments, footnote NO_3 bad. See 101 comments, footnote PO_4 bad.
117 @ 493db - See 101 comments, footnote NO_2 bad. See 101 comments, footnote NO_3 bad. See 101 comments, footnote PO_4 bad.
118 @ 397db - See 101 comments, footnote NO_2 bad. See 101 comments, footnote NO_3 bad. See 101 comments, footnote PO_4 bad.
119 @ 297db - See 101 comments, footnote NO_2 bad. See 101 comments, footnote NO_3 bad. See 101 comments, footnote PO_4 bad.
120 @ 196db - See 101 comments, footnote NO_2 bad. See 101 comments, footnote NO_3 bad. See 101 comments, footnote PO_4 bad.
121 @ 97db - See 101 comments, footnote NO_2 bad. See 101 comments, footnote NO_3 bad. See 101 comments, footnote PO_4 bad.
122 @ 58db - See 101 comments, footnote NO_2 bad. See 101 comments, footnote NO_3 bad. See 101 comments, footnote PO_4 bad.
123 @ 29db - See 101 comments, footnote NO_2 bad. See 101 comments, footnote NO_3 bad. See 101 comments, footnote PO_4 bad.
124 @ 9db - See 101 comments, footnote NO_2 bad. See 101 comments, footnote NO_3 bad. See 101 comments, footnote PO_4 bad.

Station 561

101 @ 1879db - 101-123 All nitrates appear 0.5 low compared to adjacent stations. Calc ok. Changed N-1-N & Sulfanilimide after this cast.
102 @ 1831db - See 101 comments, footnote NO_3 bad.
103 @ 1814db - See 101 comments, footnote NO_3 bad.
104 @ 1748db - See 101 comments, footnote NO_3 bad.
105 @ 1647db - See 101 comments, footnote NO_3 bad.
106 @ 1596db - See 101 comments, footnote NO_3 bad.
107 @ 1545db - See 101 comments, footnote NO_3 bad.
108 @ 1496db - See 101 comments, footnote NO_3 bad.
109 @ 1395db - See 101 comments, footnote NO_3 bad.
110 @ 1294db - See 101 comments, footnote NO_3 bad.
111 @ 1193db - See 101 comments, footnote NO_3 bad.
112 @ 1092db - See 101 comments, footnote NO_3 bad.
113 @ 990db - See 101 comments, footnote NO_3 bad.
114 @ 890db - See 101 comments, footnote NO_3 bad.
115 @ 789db - See 101 comments, footnote NO_3 bad.
116 @ 688db - See 101 comments, footnote NO_3 bad.
117 See 101 comments, footnote NO_3 bad. NB24 came up open, sample log indicates probably forgot to trigger one bottle after NB16. 117-124, No CTD trip data for NBs17&19. ODF has included the oxygen and nutrients in a separate file.
118 @ 388db - See 101 comments, footnote NO_3 bad. See 117 comment, bottles did not trip as scheduled.

119 See 101 comments, footnote NO_3 bad. See 117 comment, bottles did not trip as scheduled.
120 @ 236db - See 117 comment, bottles did not trip as scheduled. See 101 comments, footnote NO_3 bad.
121 @ 236db - See 101 comments, footnote NO_3 bad. See 117 comment, bottles did not trip as scheduled.
122 @ 100db - See 117 comment, bottles did not trip as scheduled. See 101 comments, footnote NO_3 bad.
123 @ 60db - See 101 comments, footnote NO_3 bad. See 117 comment, bottles did not trip as scheduled.
124 See 117 comment, bottles did not trip as scheduled.

Station 562

101 @ 2027db - 101-124 Preliminary data appears 1.0 high. Note on data sheet says "only 10ml std added" with concentration of 8.75 used from calc on data sheet "NO_3 = 8 + .75 = 8.75" Believe calc should be NO3 conc = 11.25*2/3 + .75 = 8.25. Recalculated data looks much better.
124 @ 9db - Delta-S .130 high at 9db. All water samples indicate NB24 closed near 790db (NB14). Leave for now. Foot- note oxygen and nutrients bad. Inform PI that bottle tripped incorrectly. ODF suggests this be coded leaky bottle and samples bad.

Station 563

1all Nutrient: "NO_2 STD - only 10ml? =(.5)" 101-124 "NO_2 pipet not delivering right - use 1.62 for F1B & F1E" NO_2 appears to be okay, agrees with Stations 562-565.

Station 564

1all Nutrient: "NO_2 pipet wrong, use 1.62 for F1B & F1E" 101-123. NO_2 appears to be okay, agrees with Stations 562-565.
107 @ 2323db - Phosphate .1 too high. Analyst suspects contamination. Footnote PO_4 bad.
117 @ 508db - Bottle leaked as per final data submission. Oxygen and nutrients do not indicate a leak.
124 Sample log: "No oxygen, no Nitrate, no Phosphate, no Silicate, no Nitrite." No CTD trip information.

Station 565

114 @ 1195db - Sample log: "No oxygen (o-ring problem)" Bottle leaked as per final data submission. Nutrients agree with duplicate trip data.
117 @ 496db - Bottle leaked as per final data submission. Oxygen appears .07 high, footnote o_2 bad, leak affected the sample. Nutrients appear to be okay.

121 @ 58db - O_2 appears .5 low at 58db. Calc ok, no notes. Other water samples ok. Footnote o_2 uncertain.
124 Sample log: "No oxygen, no Nitrate, no Phosphate, no Silicate, no Nitrite." No CTD trip information.

Station 566

1all No German trip information as of 27 May 92 kms. ODF has included the oxygen and nutrients in a separate file.

Station 567

102 Sample log: "No samples taken."
103 @ 3141db - Bottle leaked as per final data submission. Oxygen and nutrients appear to be okay.
117 @ 1007db - Bottle leaked as per final data submission. Oxygen and nutrients appear to be okay.
124 Sample log: "No samples taken."

Station 568

102 @ 3132db - Didn't trip as scheduled per final data submission. Oxygen agrees with duplicate trip data.

Station 569

103 @ 3103db - Didn't trip as scheduled per final data submission. Oxygen and nutrients data appears okay.
105 @ 2947db - Didn't trip as scheduled per final data submission. Oxygen and nutrients agree with duplicate trip data.
113 Sample log: "No samples taken."

Station 570

117 Sample log: "No oxygen, no Nitrate, no Phosphate, no Silicate, no Nitrite."

Station 571

101 @ 1956db - 101-124 No NO_2 run, calib cast, all samples at same level. Footnote NO_2 not analyzed.
102 @ 1956db - See 101 comment, footnote NO_2 not analyzed.
103 @ 1957db - See 101 comment, footnote NO_2 not analyzed.
104 @ 1956db - See 101 comment, footnote NO_2 not analyzed.
105 @ 1957db - See 101 comment, footnote NO_2 not analyzed.
106 @ 1957db - See 101 comment, footnote NO_2 not analyzed.
107 @ 1957db - See 101 comment, footnote NO_2 not analyzed.

108 @ 1957db - See 101 comment, footnote NO_2 not analyzed.
109 @ 1957db - See 101 comment, footnote NO_2 not analyzed.
110 @ 1957db - See 101 comment, footnote NO_2 not analyzed.
111 @ 1957db - See 101 comment, footnote NO_2 not analyzed.
112 @ 1958db - See 101 comment, footnote NO_2 not analyzed.
113 @ 1957db - See 101 comment, footnote NO_2 not analyzed.
114 @ 1958db - See 101 comment, footnote NO_2 not analyzed.
115 @ 1957db - See 101 comment, footnote NO_2 not analyzed.
116 @ 1957db - See 101 comment, footnote NO_2 not analyzed.
117 @ 1958db - See 101 comment, footnote NO_2 not analyzed.
118 @ 1958db - See 101 comment, footnote NO_2 not analyzed.
119 @ 1958db - See 101 comment, footnote NO_2 not analyzed. Oxygen: "Apparent overtitration." Added 1ml std and did normal overtitration procedure. Oxygen okay.
120 @ 1958db - See 101 comment, footnote NO_2 not analyzed.
121 @ 1958db - See 101 comment, footnote NO_2 not analyzed.
122 @ 1958db - See 101 comment, footnote NO_2 not analyzed.
123 @ 1958db - See 101 comment, footnote NO_2 not analyzed.
124 @ 1958db - See 101 comment, footnote NO_2 not analyzed.

Station 573

123 @ 13db - Didn't trip as scheduled per final data submission. Oxygen and nutrients appear to be okay.
124 Sample log: "No oxygen, no Nitrate, no Phosphate, no Silicate, no Nitrite." No CTD trip information.

Station 574

114 @ 794db - Didn't trip as scheduled per final data submission. Oxygen and nutrients agree with duplicate trip data.

Station 575

101 Sample log: "No oxygen, no nitrate, no phosphate, no silicate, no nitrite."
103 @ 1899db - Didn't trip as scheduled per final data submission. Oxygen and nutrients agree with duplicate trip data.
114 @ 847db - Didn't trip as scheduled per final data submission. Oxygen and nutrients agree with duplicate trip data.
116 @ 538db - Didn't trip as scheduled per final data submission. Oxygen and nutrients agree with duplicate trip data.

Station 576

101 Sample log: "No oxygen, no nitrate, no phosphate, no silicate, no nitrite."
102 @ 1687db - NO_3 appears .7 (3%) high compared to adjacent stations. 102-124 Calc & peaks ok. No notes. Leave for now. Footnote NO_3 uncertain.

103 @ 1637db - See 102 comments, footnote NO_3 uncertain.
104 @ 1586db - See 102 comments, footnote NO_3 uncertain.
105 @ 1535db - See 102 comments, footnote NO_3 uncertain.
106 @ 1484db - See 102 comments, footnote NO_3 uncertain.
107 @ 1435db - See 102 comments, footnote NO_3 uncertain.
108 @ 1333db - See 102 comments, footnote NO_3 uncertain.
109 @ 1233db - See 102 comments, footnote NO_3 uncertain.
110 @ 1132db - See 102 comments, footnote NO_3 uncertain.
111 @ 1031db - See 102 comments, footnote NO_3 uncertain.
112 @ 829db - See 102 comments, footnote NO_3 uncertain.
113 @ 728db - See 102 comments, footnote NO_3 uncertain.
114 @ 569db - See 102 comments, footnote NO_3 uncertain. Didn't trip as scheduled per final data submission. Oxygen and nutrients agrees with duplicate trip data.
115 @ 569db - See 102 comments, footnote NO_3 uncertain. Oxygen: "Small bubble in sample." Oxygen agrees with duplicate trip bottle 14. However, o_2 does not agree with Station 577, but it does agree with Station 574. Will leave data as is, not even footnoting.
116 @ 468db - See 102 comments, footnote NO_3 uncertain.
117 @ 368db - See 102 comments, footnote NO_3 uncertain.
118 @ 303db - See 102 comments, footnote NO_3 uncertain.
119 @ 203db - See 102 comments, footnote NO_3 uncertain.
120 @ 173db - See 102 comments, footnote NO_3 uncertain.
121 @ 127db - See 102 comments, footnote NO_3 uncertain.
122 @ 90db - See 102 comments, footnote NO_3 uncertain.
123 @ 40db - See 102 comments, footnote NO_3 uncertain.
124 @ 12db - See 102 comments, footnote NO_3 uncertain.

Station 577

201-203 Sample log: "No oxygen, no nitrate, no phosphate, no silicate, no nitrite." No CTD trip information.
223-224 Sample log: "No oxygen, no nitrate, no phosphate, no silicate, no nitrite." No CTD trip information.

Station 578

1all 19 bottles.

Station 579

103 @ 1615db - Bottle leaked as per final data submission. Oxygen and nutrients do not indicate a leak.

Station 580

114 @ 698db - Didn't trip as scheduled per final data submission. Oxygen agrees with duplicate trip data.
224 Sample log: "No oxygen, no nitrate, no phosphate, no silicate, no nitrite." No CTD trip information.

Station 581

101 Sample log: "No samples taken."
102 @ 2033db - 102-123 No NO_2 run, calib cast, all samples at same level. Footnote NO_2 not analyzed.
103 @ 2033db - See 102 comment, footnote NO_2 not analyzed.
104 @ 2033db - See 102 comment, footnote NO_2 not analyzed.
105 @ 2034db - See 102 comment, footnote NO_2 not analyzed.
106 @ 2033db - See 102 comment, footnote NO_2 not analyzed.
107 @ 2033db - See 102 comment, footnote NO_2 not analyzed.
108 @ 2033db - See 102 comment, footnote NO_2 not analyzed. Oxygen: "OT". Sample okay after overtitration procedure.
109 @ 2033db - See 102 comment, footnote NO_2 not analyzed.
110 @ 2033db - See 102 comment, footnote NO_2 not analyzed.
111 @ 2033db - See 102 comment, footnote NO_2 not analyzed.
112 @ 2034db - See 102 comment, footnote NO_2 not analyzed.
113 @ 2033db - See 102 comment, footnote NO_2 not analyzed.
114 @ 2034db - See 102 comment, footnote NO_2 not analyzed.
115 @ 2034db - See 102 comment, footnote NO_2 not analyzed. Bottle leaked as per final data submission. Oxygen and nutrients do not indicate a leaky bottle.
116 @ 2033db - See 102 comment, footnote NO_2 not analyzed.
117 @ 2033db - See 102 comment, footnote NO_2 not analyzed.
118 @ 2034db - See 102 comment, footnote NO_2 not analyzed.
119 @ 2034db - See 102 comment, footnote NO_2 not analyzed.
120 @ 2034db - See 102 comment, footnote NO_2 not analyzed.
121 @ 2034db - See 102 comment, footnote NO_2 not analyzed.
122 @ 2034db - See 102 comment, footnote NO_2 not analyzed.
123 @ 2035db - See 102 comment, footnote NO_2 not analyzed. Oxygen .03 high with duplicate data, nutrients appear okay. Footnote oxygen bad.
124 Sample log: "No samples taken."

Station 582

101 @ 2245db - NO_3 appears 1.0 high. Calc & peaks ok. Note on Chart "Probe stuck" during first set standards, no apparent harm to data. NO_3 & PO_4 F1s higher than adjacent stations. SIL F1s & data ok. 101-123 Reason for high values unknown. Footnote NO_3 uncertain. PO_4 appears 0.1 high. Footnote PO_4 uncertain.
102 @ 2194db - See 101 comment, footnote NO_3 uncertain. See 101 comment, footnote PO_4 uncertain.

103 @ 2144db - See 101 comment, footnote NO_3 uncertain. See 101 comment, footnote PO_4 uncertain.
104 @ 2103db - See 101 comment, footnote NO_3 uncertain. See 101 comment, footnote PO_4 uncertain.
105 @ 2053db - See 101 comment, footnote NO_3 uncertain. See 101 comment, footnote PO_4 uncertain.
106 @ 2002db - See 101 comment, footnote NO_3 uncertain. See 101 comment, footnote PO_4 uncertain.
107 @ 1952db - See 101 comment, footnote NO_3 uncertain. See 101 comment, footnote PO_4 uncertain.
108 @ 1901db - See 101 comment, footnote NO_3 uncertain. See 101 comment, footnote PO_4 uncertain.
109 @ 1698db - See 101 comment, footnote NO_3 uncertain. See 101 comment, footnote PO_4 uncertain.
110 @ 1495db - See 101 comment, footnote NO_3 uncertain. See 101 comment, footnote PO_4 uncertain.
111 @ 1293db - See 101 comment, footnote NO_3 uncertain. See 101 comment, footnote PO_4 uncertain. O_2 appears .1 high at 1293db. Calc ok. No notes. Salinity min. Nutrients have normal gradient. Footnote oxygen uncertain.
112 @ 1091db - See 101 comment, footnote NO_3 uncertain. See 101 comment, footnote PO_4 uncertain. Oxygen: bubble (1/8" dia.)" Oxygen appears to be okay.
113 @ 889db - See 101 comment, footnote NO_3 uncertain. See 101 comment, footnote PO_4 uncertain.
114 @ 637db - See 101 comment, footnote NO_3 uncertain. See 101 comment, footnote PO_4 uncertain.
115 @ 586db - See 101 comment, footnote NO_3 uncertain. See 101 comment, footnote PO_4 uncertain.
116 @ 485db - See 101 comment, footnote NO_3 uncertain. See 101 comment, footnote PO_4 uncertain. Oxygen: "bubble." Oxygen appears to be okay.
117 @ 385db - See 101 comment, footnote NO_3 uncertain. See 101 comment, footnote PO_4 uncertain.
118 @ 284db - O_2 appears .3 low at 284db. Calc ok, no notes. Other water samples including salinity have bump this level. Delta-S .000. ODF suggests this be coded leaky bottle and samples bad. Footnote oxygen and nutrients bad. If tripping is resolved, then code PO_4 and NO_3 as uncertain. Inform PI that bottle tripped incorrectly.
119 @ 184db - See 101 comment, footnote NO_3 uncertain. See 101 comment, footnote PO_4 uncertain.
120 @ 84db - See 101 comment, footnote NO_3 uncertain. See 101 comment, footnote PO_4 uncertain.121 @ 43db - See 101 comment, footnote NO_3 uncertain. See 101 comment, footnote PO_4 uncertain.
122 @ 23db - See 101 comment, footnote NO_3 uncertain. See 101 comment, footnote PO_4 uncertain.
123 @ 13db - See 101 comment, footnote NO_3 uncertain. See 101 comment, footnote PO_4 uncertain.
124 @ 13db - Sample log: "No o_2, NO_3, PO_4, sil or NO_2."

Station 583

103 @ 2242db - See 101 comment. Oxygen: "Bubble - strong blue back(?)" O_2 appears .14 high at 2242db. Calc ok. Other water samples ok. Footnote oxygen bad.
114 @ 702db - Didn't trip as scheduled per final data submission. Oxygen agrees with duplicate trip data.

Station 584

109 @ 1379db - Didn't trip as scheduled per final data submission. Oxygen does not agrees with duplicate trip data. O_2 .05 low. Footnote oxygen bad.
115 @ 596db - Bottle leaked as per final data submission. There is a feature at this level which does not show in the adjoining stations. However, if this is not a real feature then bottle 14 is incorrect also.

Station 586

115 @ 1173db - Didn't trip as scheduled per final data submission. Oxygen and nutrients agree with duplicate trip data.
117 @ 969db - Didn't trip as scheduled per final data submission. Oxygen and nutrients agree with duplicate trip data.
119 @ 470db - Didn't trip as scheduled per final data submission. Oxygen and nutrients agree with duplicate trip data.
124 @ 14db - NO_3 appears 5um/l high at 14db. Calc & peak ok. Delta- S .129 high at 14db. All water samples indicate NB24 tripped just below NB23 at 34db. It did not trip with bottle 23, but rather between bottles 22 and 23. Footnote oxygen and nutrients bad. Inform PI that bottle tripped incorrectly. ODF suggests this be coded leaky bottle and samples bad.

Station 587

111 @ 1465db - Didn't trip as scheduled per final data submission. Oxygen and nutrients agree with duplicate trip data.
124 No CTD trip data available. ODF has included the oxygen and nutrients in a separate file.
114-123 Sample log: No samples taken. No CTD trip information.

Station 588

1all Oxygen draw temperature was not recorded. Used in situ temperature.
114 @ 712db - Didn't trip as scheduled per final data submission. Oxygen and nutrients agree with duplicate trip data.
121 @ 105db - Didn't trip as scheduled per final data submission. Oxygen and nutrients agree with duplicate trip data.

Station 589

101 @ 28db - NO_3 appears 1.5 high. Calc & peaks ok. Notes on nutrient data sheet: "New imidazole buffer". "STDs look low! 4%!" F1s a little higher than adjacent stations.

101-124 Other water samples including silicates ok. Footnote NO_3 bad. PO_4 appears 0.05 high. Footnote PO_4 bad. Didn't trip as scheduled per final data submission. Oxygen agrees with duplicate trip data.

102 @ 28db - See 101 comments, footnote NO_3 bad. See 101 comments, footnote PO_4 bad. Oxygen: "Small bubble." Data okay.

103 @ 3215db - See 101 comments, footnote NO_3 bad. See 101 comments, footnote PO_4 bad.

104 @ 3165db - See 101 comments, footnote NO_3 bad. See 101 comments, footnote PO_4 bad.

105 @ 3111db - See 101 comments, footnote NO_3 bad. See 101 comments, footnote PO_4 bad.

106 @ 3063db - See 101 comments, footnote NO_3 bad. See 101 comments, footnote PO_4 bad.

107 @ 2964db - See 101 comments, footnote NO_3 bad. See 101 comments, footnote PO_4 bad.

108 @ 2802db - See 101 comments, footnote NO_3 bad. See 101 comments, footnote PO_4 bad.

109 @ 2597db - See 101 comments, footnote NO_3 bad. See 101 comments, footnote PO_4 bad.

110 @ 2392db - See 101 comments, footnote NO_3 bad. See 101 comments, footnote PO_4 bad.

111 @ 1986db - See 101 comments, footnote NO_3 bad. See 101 comments, footnote PO_4 bad. Didn't trip as scheduled per final data submission. Oxygen agrees with duplicate trip data.

112 @ 1986db - See 101 comments, footnote NO_3 bad. See 101 comments, footnote PO_4 bad.

113 @ 1784db - See 101 comments, footnote NO_3 bad. See 101 comments, footnote PO_4 bad.

114 @ 1696db - See 101 comments, footnote NO_3 bad. See 101 comments, footnote PO_4 bad. Oxygen: "Bubble." Data okay.

115 @ 1381db - See 101 comments, footnote NO_3 bad. See 101 comments, footnote PO_4 bad.

116 @ 1195db - See 101 comments, footnote NO_3 bad. See 101 comments, footnote PO_4 bad. Oxygen: "Bubble." Data okay.

117 @ 585db - See 101 comments, footnote NO_3 bad. See 101 comments, footnote PO_4 bad. Oxygen: "Bubble." Data okay. Didn't trip as scheduled per final data submission. Oxygen agrees with duplicate trip data.

118 @ 585db - See 101 comments, footnote NO_3 bad. See 101 comments, footnote PO_4 bad.

119 @ 585db - See 101 comments, footnote NO_3 bad. See 101 comments, footnote PO_4 bad.

120 @ 480db - See 101 comments, footnote NO_3 bad. See 101 comments, footnote PO_4 bad. Oxygen: "OT" Data okay.
121 @ 383db - See 101 comments, footnote NO_3 bad. See 101 comments, footnote PO_4 bad.
122 @ 286db - See 101 comments, footnote NO_3 bad. See 101 comments, footnote PO_4 bad. Oxygen: "Bubble." Data okay.
123 @ 188db - See 101 comments, footnote NO_3 bad. See 101 comments, footnote PO_4 bad.
124 @ 99db - See 101 comments, footnote NO_3 bad. See 101 comments, footnote PO_4 bad.

Station 590

1all 18 bottle tripped.
108 @ 1813db - Bottle leaked as per final data submission. Oxygen and nutrients look good and do not indicate leaking bottle.
114 @ 104db - Didn't trip as scheduled per final data submission. Oxygen and nutrients agree with duplicate trip data.
117 @ 19db - Didn't trip as scheduled per final data submission. Oxygen and nutrients agree with duplicate trip data.

Station 591

103 @ 2998db - Didn't trip as scheduled per final data submission. Oxygen and nutrients agree with duplicate trip data.
124 Sample log: "No samples taken."

Station 596

101 Sample log: "No samples taken"
107 Sample log: "No samples taken"
123 Sample log: "No samples taken"
124 Sample log: "No samples taken"

Station 597

102 Sample log: "Bottle didn't close, no samples."
104 Sample log: "Bottle didn't close, no samples."
105 Sample log: "Bottle didn't close, no samples."
106 Sample log: "Bottle didn't close, no samples."
107 Sample log: "Bottle didn't close, no samples."
109 Sample log: "Bottle didn't close, no samples."
110 Sample log: "Bottle didn't close, no samples."
111 Sample log: "Bottle didn't close, no samples."
112 Sample log: "Bottle didn't close, no samples."
113 Sample log: "Bottle didn't close, no samples."
115 Sample log: "Bottle didn't close, no samples."

Station 598

102 Sample log: "Bottle didn't close, no samples."
103 Sample log: "Bottle didn't close, no samples."
104 Sample log: "Bottle didn't close, no samples."
107 Sample log: "Bottle didn't close, no samples."
109 Sample log: "Bottle didn't close, no samples."
110 Sample log: "Bottle didn't close, no samples."
111 Sample log: "Bottle didn't close, no samples."
112 Sample log: "Bottle didn't close, no samples."
115 Sample log: "Bottle didn't close, no samples."
121 Sample log: "Bottle didn't close, no samples."
122 Sample log: "Bottle didn't close, no samples."
123 Sample log: "Bottle didn't close, no samples."
124 Sample log: "Bottle didn't close, no samples."

Station 599

122 @ 64db - Didn't trip as scheduled per final data submission. Oxygen and nutrients agree with duplicate trip data.
123 @ 34db - Sample log: "No nitrate, no phosphate, no silicate, no nitrite."

Station 600

102 @ 3556db - Oxygen: "Bubble." Appears .05 low. Calc ok. Footnote oxygen bad.
122 @ 94db - Didn't trip as scheduled per final data submission. Oxygen and nutrients agree with duplicate trip data.

Station 601

1all Oxygen: Draw temp no good, -0.6 vs 3. Took therm apart to dry out. No oxygen draw temperature, used in situ temperature.
106 Sample log: "No oxygen, no nitrate, no phosphate, no silicate," no nitrite.
113 @ 1412db - Bottle leaked as per final data submission. Oxygen and nutrients do not indicate a bottle leak.
121 @ 205db - Didn't trip as scheduled per final data submission. Oxygen and nutrients agree with duplicate trip data.

Station 602

114 @ 989db - Didn't trip as scheduled per final data submission. Oxygen and nutrients appear okay.
121 @ 103db - Didn't trip as scheduled per final data submission. Oxygen and nutrients agree with duplicate trip data.

Station 603

120 @ 304db - Didn't trip as scheduled per final data submission. Oxygen does not agree with duplicate trip data .0_2 low. Nutrients agree with duplicate trip data.
122 Water samples indicate NB22 tripped near NB13 at 1814db. Leave for now. No trip information received.

Station 604

122 @ 102db - Didn't trip as scheduled per final data submission. Oxygen .03 lower than duplicate trip data. Footnote oxygen bad. Nutrients appear to be okay.

Station 605

1all Oxygen: "No draw temps. therm read 1.6 at 1st NB, T=2.5" No oxygen draw temperatures, in situ temperature used.
119 @ 201db - Didn't trip as scheduled per final data submission. Oxygen and nutrients agrees with duplicate trip data.
122 @ 32db - All water samples appear to be from about 300db instead 32db intended. Delta-S .074 high. Inform PI that bottle tripped incorrectly. ODF suggests this bottle be coded leaky and all samples bad.
124 Sample log: "No samples taken"

Station 608

101 @ 3818db - Sample log: "No samples drawn."
103 @ 3820db - Sample log: "No samples drawn."
105 @ 3820db - Sample log: "No samples drawn."
107 @ 3818db - Sample log: "No samples drawn."
109 @ 3820db - Sample log: "No samples drawn."
110 @ 3820db - Bottle leaked as per final data submission Oxygen and nutrients also indicate that this bottle leaked. Footnote oxygen and nutrients bad.
111 @ 3821db - Sample log: "No samples drawn."
113 @ 3819db - Sample log: "No samples drawn."
115 @ 3819db - Sample log: "No samples drawn."
116 @ 3819db - Bottle leaked as per final data submission Oxygen and nutrients also indicate that this bottle leaked. Footnote oxygen and nutrients bad.
117 @ 3820db - Sample log: "No samples drawn."
119 @ 3818db - Sample log: "No samples drawn."
121 @ 3818db - Sample log: "No samples drawn."
123 @ 3821db - Sample log: "No samples drawn."

Station 609

103 @ 3534db - NO_2 .24 high at 3534db. Calc & peak ok. No obvious relation to spike noted above. See 104 comment. Footnote NO_2 uncertain.
104 @ 3444db - There is a spike after 103 & 104 on NO_2. Analyst did not indicate any mechanical problem. NO_2 .04 high at 3444db. Calc & peak ok. No obvious relation to spike noted above.
110 Sample log: "No samples." No CTD trip information.
114 @ 1180db - Oxygen: "Small bubble." Data okay. PO_4 appears 0.1 low at 1180db. Calc & peak ok. No notes. Footnote PO_4 uncertain.
116 Sample log: "No samples drawn."
117 Sample log: "No samples drawn."
118 Sample log: "No samples drawn."
119 Sample log: "No samples drawn."
120 Sample log: "No samples drawn."
121 Sample log: "No samples drawn."
122 Oxygen: "Small bubble. " Intended to trip at 58db with NB23 but water samples indicate it closed deeper. Nutrients appear to be from about 500db and oxygen from about 1700db. oxy may be bad titration. No CTD trip data or bottle salinity available tho sample log indicates bottle salinity was drawn.
124 Sample log: "No samples drawn."

Station 610

110 Sample log: "No samples taken"
118 @ 304db - Oxygen: "Bubble." Sample log says flask 1041 for this sample as well as 116. Other stations using this box indicate 1043 as shown on data sheet is correct. Value appears high based on gradient but vertical sections indicate it is probably good. Footnote o_2 uncertain.
122 Sample log: "No samples taken"

Station 611

119 @ 100db - Didn't trip as scheduled per final data submission. Oxygen and nutrients agrees with duplicate trip data.
122 Sample log: "No samples drawn."
123 @ 11db - Delta-S .237 high at 11db. All water samples indicate bottle close between 100 & 200db.
124 Sample log: "No samples drawn."

Station 612

119 @ 63db - Didn't trip as scheduled per final data submission. Oxygen and nutrients agrees with duplicate trip data.
122 Sample log: "No samples drawn."
124 Sample log: "No samples drawn."

Station 613

110 @ 2078db - Oxygen: "Small bubble." Oxygen high compared with station profile, but agrees with Stations 602-611. Footnote oxygen uncertain.
119 @ 90db - Oxygen: "Bubble." Appears .07 high. All other water samples same as NB19. Footnote oxygen bad.
120 @ 90db - Didn't trip as scheduled per final data submission. Nutrients agrees with duplicate trip data.
121 Oxygen: "Small bubble." Data okay. All water samples indicate NB21 closed near 1000db rather than intended 22db level. No CTD trip information. Footnote Oxygen and nutrients bad because bottle did not trip correctly.
122 Sample log: "No samples drawn."
124 Sample log: "No samples drawn."

Station 615

113 Sample log: "No samples drawn."
119 Sample log: "No samples drawn."

Station 616

116 Sample log: "No samples drawn."

Station 617

116 Sample log: "No samples drawn.

Station 618

203 @ 1850db Oxygen: "Small bubble." Data okay. Bottle leaked as per final data submission. Oxygen and nutrients do not indicate a bottle leak. Data agrees with duplicate trip.
121-124 Sample log: "No samples drawn. No CTD trip information.
215 Sample log: "No samples taken"

Station 619

101 Sample log: "No oxygen or nutrients drawn."
103 Sample log: "No oxygen or nutrients drawn."
105 Sample log: "No oxygen or nutrients drawn."
106 @ 797db - Didn't trip as scheduled per final data submission. Oxygen and nutrients agrees with duplicate trip data.
107 @ 797db - Sample log: "No oxygen or nutrients drawn."

108 @ 797db - Wrong pressure assigned. Suspect this tripped with 106. Send inquiry to J.Swift. Done, and data changed. Didn't trip as scheduled per final data submission. Data looks good with corrected pressure. Oxygen and nutrients agrees with duplicate trip data.
109 Sample log: "No oxygen or nutrients drawn."
111 Sample log: "No oxygen or nutrients drawn."
113 Sample log: "No oxygen or nutrients drawn."
115 Sample log: "No oxygen or nutrients drawn."
117 Sample log: "No oxygen or nutrients drawn."
119 Sample log: "No oxygen or nutrients drawn."
121 Sample log: "No oxygen or nutrients drawn."
123 Sample log: "No oxygen or nutrients drawn."

Station 620

1all 12 bottles tripped.

Station 621

1all 9 bottles tripped.
107 @ 98db - Oxygen: "Small bubble." Possibly a little low per %sat. Footnote o_2 bad. Leak must have affected the oxygen. Nutrients appear to be okay. Bottle leaked as per final data submission.

References

Unesco, 1983. International Oceanographic tables. Unesco Technical Papers in Marine Science, No. 44.

Unesco, 1991. Processing of Oceanographic Station Data. Unesco memograph By JPOTS editorial panel.

WHPO Summary

Several data files are associated with this report. They are the a1e.sum, a1e.hyd, a1e.csl and *.wct files. The a1e.sum file contains a summary of the location, time, type of parameters sampled, and other pertinent information regarding each hydrographic station. The a1e.hyd file contains the bottle data. The *.wct files are the CTD data for each station. The *.wct files are zipped into one file called a1e.wct.zip. The a1e.csl file is a listing of CTD and calculated values at standard levels.

The following is a description of how the standard levels and calculated values were derived for the a1e.csl file:

Salinity, Temperature and Pressure: These three values were smoothed using the following binomial filter-

$$t(j) = 0.25ti(j-1) + 0.5ti(j) + 0.25ti(j+1) \quad j=2....N-1$$

When a pressure level is represented in the *.csl file that is not contained within the CTD values, the value was linearly interpolated to the desired level after applying the binomial filtering.

Sigma-theta (SIG-TH:KG/M3), Sigma-2 (SIG-2: KG/M3), and Sigma-4(SIG-4: KG/M3): These values are calculated using the practical salinity scale (PSS-78) and the international equation of state for seawater (EOS-80) as described in the Unesco publication 44 at reference pressures of the surface for SIG-TH; 2000 dbars for Sigma-2; and 4000 dbars for Sigma-4.

Gradient Potential Temperature (GRD-PT: C/DB 10-3) is calculated as the least squares slope between two levels, where the standard level is the center of the interval. The interval being the smallest of the two differences between the standard level and the two closest values. The slope is first determined using CTD temperature and then the adiabatic lapse rate is subtracted to obtain the gradient potential temperature. Equations and FORTRAN routines are described in Unesco publication 44.

Gradient Salinity (GRD-S: 1/DB 10-3) is calculated as the least squares slope between two levels, where the standard level is the center of the standard level and the two closes values. Equations and FORTRAN routines are described in Unesco publication 44.

Potential Vorticity (POT-V: 1/ms 10-11) is calculated as the vertical component ignoring contributions due to relative vorticity, i.e. pv=fN2/g, where f is the coriolius parameter, N is the buoyancy frequency (data expressed as radius/sec), and g is the local acceleration of gravity.

Buoyancy Frequency (B-V: cph) is calculated using the adiabatic leveling method, Fofonoff (1985) and Millard, Owens and Fofonoff (1990). Equations and FORTRAN routines are described in Unesco publication 44.

Potential Energy (PE: J/M2: 10-5) and Dynamic Height (DYN-HT: M) are calculated by integrating from 0 to the level of interest. A constant value of specific volume anomaly is assumed. Equations and FORTRAN routines are described in Unesco publication, Processing of Oceanographic station data.

Neutral Density (GAMMA-N: KG/M3) is calculated with the program GAMMA-N (Jackett and McDougall) version 1.3 Nov. 94.

Directory WOCE0: <HYDATA.ONETIME.A1E>

A1E.BAK; 1	18-JUL-1994 - original from ellett
A1E.DJE; 1	18-JUL-1994 - manually fixed duplicate trips
A1EDJE.CMP; 2	20-JUL-1994 - o/p compqual2
NUTOX.TEM	14-JUN-1994 - temperatures used to convert liters to kg
A1E.STA; 2	22-JUN-1993 - raw sum file
A1E.SUM; 1	2-NOV-1993
A1ECFC.RAW	28-AUG-1996 - raw cfc data ftp'd to sun from
A1E.CFC	28-AUG-1996 - A. Putzka
A1E.CRB	Alex Kozyr =- tcarbn and alkali
METEOR18.SEA; 1	8-SEP-1993 - raw hydro data, needed re-formatting contains nutl and oxyl temp cols.
A1E.HY2; 1	2-NOV-1993 - hydro data
A1EL.HY2; 1	26-OCT-1993 - "" in liters
A1EDQE.OLD	2-AUG-1994 - A1E.HY2 + A1E.DJE (SALNTY, OXYGEN, SILCAT, NITRAT, NITRIT, PHSPHT) 15-SEP-1994 - letter from Sy accepting dqe q2 bytes except for 3 samples. q1 bytes flipped accordingly 25-Jun-95 - reply to Eugenes dqe. modified only what Sy agreed to.
A1E.DQE	13-JUN-1996 - RE-CALIBRATED pgm CTDSAL

```
C CTD-Salinity correction for salinity error:
C
      IF(ISTA .GE. 558 .AND. ISTA .LE. 566)THEN
          SADD1= -0.0177 + 0.000689 * CSAL
      ELSE IF(ISTA .GE. 567 .AND. ISTA .LE. 602)THEN
          SADD1= -0.2116 + 0.006299 * CSAL
      ELSE IF(ISTA .GE. 603 .AND. ISTA .LE. 622)THEN
          SADD1= 0.0793 - 0.002217 * CSAL
      END IF
C CTD-Salinity correction for pressure dependence:
C
      SADD2= 8.3E-5 + 1.374E-6 * PRS - 9.45329E-10 * PRS**2 +
          &       1.117E-13 * PRS**3
C
      SALnew= CSAL +SADD1 + SADD2
```

DQE of CTD data for the 18-th cruise of the r/v "Meteor", WOCE section A1E in the Northern Atlantic.

(Eugene Morozov)

Data quality of 2-db CTD temperature, salinity and oxygen profiles and reference rosette samples were examined. Vertical distributions and theta-salinity curves were compared for individual stations using the data of up and down CTD casts and rosette probes. Data of several neighboring stations were compared. The distance between stations was not less than 20 miles and the stations were often located in different water structures so that comparison of many stations was not reasonable. The data were compared with the 91/1 cruise of the r/v "Tyro" carried out in the same region of the Northern Atlantic. Measurements made in April, 1991.

The data were also compared with the atlases:

- *North Atlantic Ocean Atlas*, vol. 2, L.V. Worthington and W.R. Wright, WHOI, 1970.
- *World Ocean Atlas* (USSR Navy, 1977)

Questionable data in *.hy2 file were marked in QUALT2 word.

It is necessary to calibrate CTD salinities in upcast measurements. They are on the average lower than bottle salinity measurements by 0.01 with lesser differences in deeper waters.

As CTD oxygen measurements are concerned, it is clear that more work is needed to make the data acceptable to the requirements of WOCE. The resolution of the sensor is about 5 Umoles/kg that does not make vertical oxygen profiles smooth. This may be due to truncation of the original data before conversion to Umol/kg. There are serious problems in the measurements in the upper 200 db where the differences between CTDOXY and OXYGEN measurements can be as large as 50 Umoles/kg. Beginning with the station 600 unacceptable differences are found in the entire water depth. These discrepancies can be caused by an incorrect temperature compensation for the oxygen sensor as well as by many other reasons. The oxygen measurements made with bottle samples seem correct. Nevertheless some questionable data were found in these measurements. Duplicate determinations of salinity and oxygen made from rosette samples at the same level indicate that bottle measurements are a high quality data set that match WOCE requirements.

Listing of results from the comparison of salinity and oxygen data. Only those stations are listed which have data remarks.

Sta	Pressure	Remarks
559	56.7	SALNITY low by no less than 0.01 compared with downcast CTDSAL.
	458 db	I do not agree with D.Ellett that OXYGEN is high enough to flag it 4. It is high only by no more than 1.5 so flag 3 - questionable is better.
560	96.8	SALNTY high by no less than 0.01 compared with downcast CTDSAL. Upcast CTDSAL exceeds SALNTY.
	691	1 agree with D. Ellett. OXYGEN data exceed norm by 2, the flag is 3.
561	990	OXYGEN measurements exceed norm by 3.5, and no other data show a maximum here, so I flag it 4.
562	9 db	I agree with D. Ellett that SALNTY is high.
565	58 db	I agree with D. Ellett that OXYGEN is low.
	496 db	I agree with D. Ellett that OXYGEN is high.
568	27.1 db	SALNTY exceeds upcast and downcast CTDSAL by no less than 0.01.
571	1958 db sample 19	I agree with D. Ellett that OXYGEN is high.
	1958 db sample 23	I agree with D. Ellett that OXYGEN is high.
573	2535 db	I agree with D. Ellett that SALNTY is high.
	2586 db	I flag SALNTY 4- Bad, it is lower than downcast CTDSAL.
574	around 566db	CTDOXY low, Changes of temperature are observed near these levels
	around 726db	CTDOXY low, Changes of temperature are observed near these levels
	around 890db	CTDOXY low, CTD data should be checked for temperature compensation or these CTDOXY extrema are caused by intrusions as well as temperature and salinity changes.
	1000-1400 db	CTDOXY high, not supported by bottle measurements.
575	30 db	I agree that SALNTY is high.
	59 db	I agree that SALNTY is high. CTDTMP and CTDSAL in the interval 436 - 636 db seem to be linearly interpolated. It should be flagged in the quality word as 6 - interpolated over 6 db, if not by 4 - bad.
	around 516 db	CTDOXY high, CTD measurements do not repeat OXYGEN minimum registered by bottle measurements.
	around 1200 db	CTDOXY high, the maximum is not supported by OXYGEN measurements, but it may be true. This maximum can also be seen on station 574.
576	around 960 db	CTDOXY high. The minimum is not supported by OXYGEN measurements, nor there are any temperature or salinity extrema that could indicate intrusions.
578	300-380 db	CTDOXY low, this minimum is not supported by OXYGEN measurements, nor by temperature or salinity extrema that could indicate intrusions or bad temperature compensation.
579	8.1 db	SALNTY exceeds upcast and downcast CTDSAL by no less than 0.01.
	300-380 db	CTDOXY low, this minimum is not supported by OXYGEN measurements, nor by temperature or salinity extrema that could indicate intrusions or bad temperature compensation.

Sta	Pressure	Remarks
580	240 - 530 db	CTDOXY low, this minimum is not supported by OXYGEN measurements, nor by temperature or salinity extrema that could indicate intrusions or bad temperature compensation.
581	2034 db sample 23	I agree with D. Ellett that OXYGEN is high.
582	around 1290 db	Unsupported CTDOXY maximum. It could be supported if OXYGEN measurements at 1293 db were not flagged 3.
	below 2198 db	CTDOXY is decreasing to the bottom instead of increasing which is registered by OXYGEN measurements
583	2242 db	I agree with D. Ellett that OXYGEN is high.
584	197 db	SALNTY exceeds upcast and downcast CTDSAL by no less than 0.01.
	2349 db	I do not agree with D. Ellett that SALNTY is high. Downcast CTDSAL agree well with the SALNTY. I flag it 2.
585	200-730db	CTDOXY very low, CTDOXY measurements above 200 db are bad as noted in the text in the beginning of my report.
586	33.7	SALNTY exceeds upcast and downcast CTDSAL by no less than 0.01.
	63.9	SALNTY exceeds downcast CTDSAL by 0.01. Upcast CTDSAL exceeds SALNTY by 0.04. I flag SALNTY 3 - Qble.
	104 db	I agree with D. Ellett that SALNTY is high.
587	2674 db	I agree with D. Ellett that SALNTY is low.
589	1783.5	SALNTY is lower than downcast CTDSAL the flag is 3 – Qble.
591	2998 db, sample 3	If the bottle was not flagged 4, 1 would consider SALNTY acceptable, 34.598 is not so high compared with 34.596 for the duplicate sample and agrees well with downcast CTDSAL - 34.596. I flag it 3 - Qble.
597	38.2 db	SALNTY exceeds downcast CTDSAL by 0.1 and SALNTY is less than upcast CTDSAL by 0.04, the flag is 3 - Qble.
	68.5 db	SALNTY exceeds upcast and downcast CTDSAL by no less than 0.01.
	209 db	SALNTY is less than upcast CTDSAL by 0.02 and SALNTY is less than downcast CTDSAL by 0.05.
600	3556 db	I agree with D. Ellett that OXYGEN is low.
604	101 db, sample 22	I flag SALNTY 3 the bottle was flagged 4. The difference between SALNTY and upcast CTDSAL is not very large, upcast CTDSAL was not calibrated, and the vertical salinity gradient is very high. Anyhow the difference between duplicate samples is acceptable (35.183 and 35.181). OXYGEN seems OK.
616	500-700 db	CTDOXY low
	2120 db sample 8	I agree with D. Ellett that SALNTY is high
	2721 db sample 6	I agree with D. Ellett that SALNTY is high
618	1849.8 db sample 7	1854 db in the report of D.Ellett). The value of OXYGEN is 277 compared with 278 for duplicates. I flag it 3-qble not 4 as D.Ellett does.

Principal Scientist's Response to CTD Data Quality Evaluation (DQE)

(Alexander Sy)
1995.JUN.23

As noted, the CTD oxygen data are truncated. Provided with this document are corrected *.CTD files with oxygen data at a resolution of 0.001 ml/l. All data except oxygen remained unchanged.

However, I disagree with many of Eugene Morozov's further comments concerning salinity and oxygen. CTDSAL is calibrated from upcast and bottle data, CTDOXY is calibrated from downcast and bottle data. That means salinity calibration is sensitive for gradients, and oxygen calibration is very sensitive for gradients and for temporal variability. Strong vertical and horizontal gradients in both salinity and oxygen are dominant features of the upper layer. The eddy structure increases and deepens from west towards east (see vertical section plots attached). A considerable temporal variability does exist in the upper layer.

Because residuals (Bottle - CTD) in the upper layer increase significantly with decreasing depth of the rosette sampler, the in-situ calibration of both salinity and oxygen was carried out by comparing data from a gradient-free domain only, i.e. from deeper layers (at least deeper than 1000 dbar). Thus, as already stated, a definitive decision whether measurements within the upper layer are good or bad must be questionable. WOCE accuracies are essential for measurements taken in the deep layers where conditions are relatively stable in time and space. In the upper layers, however, measurements with a lesser accuracy should be acceptable. Attached you will find copies of the listings with Eugene's QUALT2 recommendations. My comment is either a "Y"(Eugene's flag accepted) or "N" (not accepted).

A gradient zone appears east of the Reykjanes Ridge from top to bottom (see section plots). Consequently Eugene found differences between bottle OXYGEN and CTDOXY (see his comments for M18 stat. # 574 ff. and V129 stat. # 18, 19). I assume these differences are due to a high mesoscale variability caused by the Irminger Current (see also Bersch & Meincke (1995), WOCE Newsletter, 18, 28-31).

Eugene reported about unacceptable differences between CTDOXY and OXYGEN in the entire water depth beginning with M18 stat. # 600. Attached you will also find a X-Y diagram which shows the final fit of the residuals of the in-situ oxygen calibration versus station no. There is no step at stat. # 600 detectable.

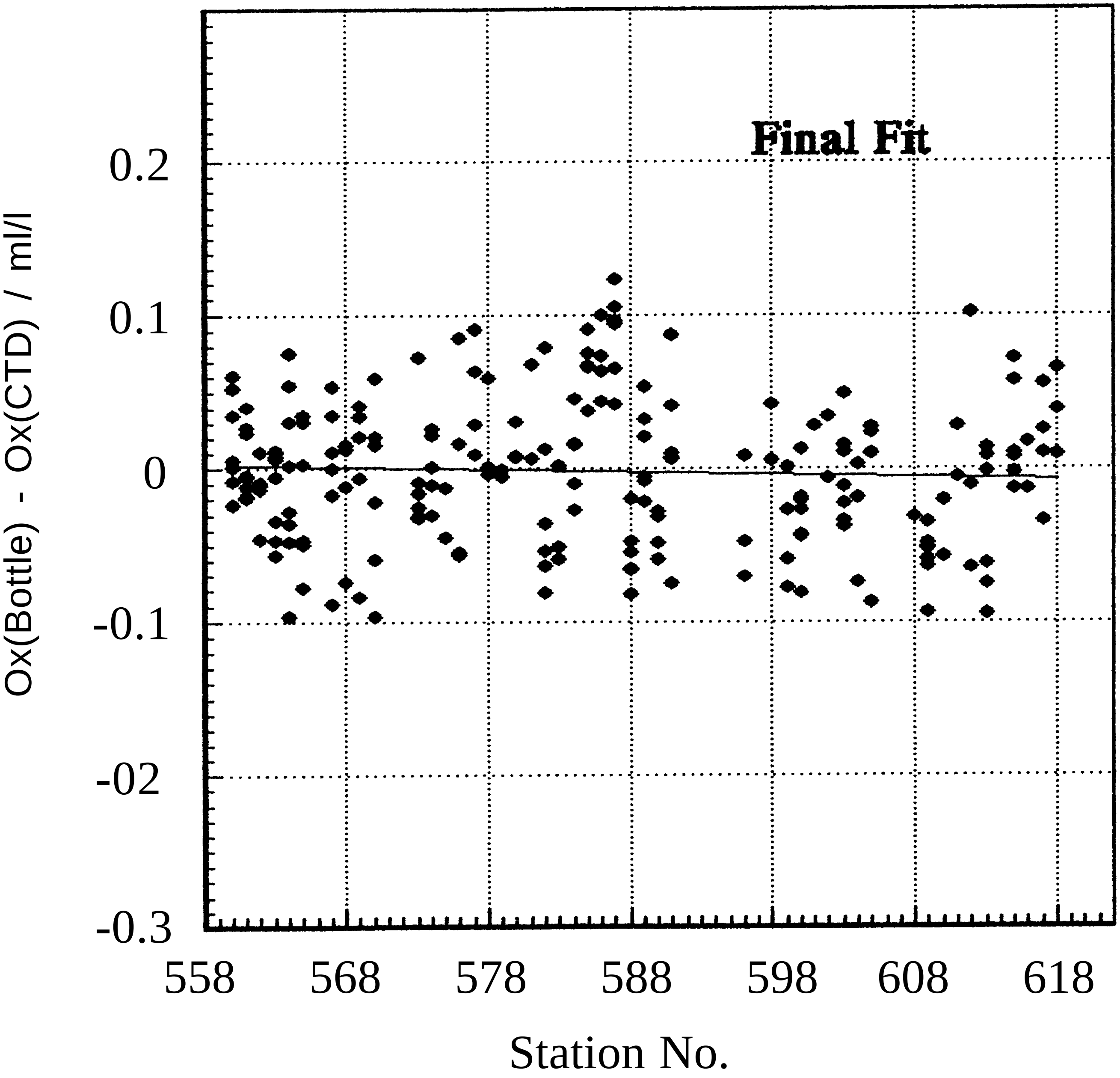
INPUT FILE: A1E.EGM
THE DATE TODAY IS:
21-MAR-95

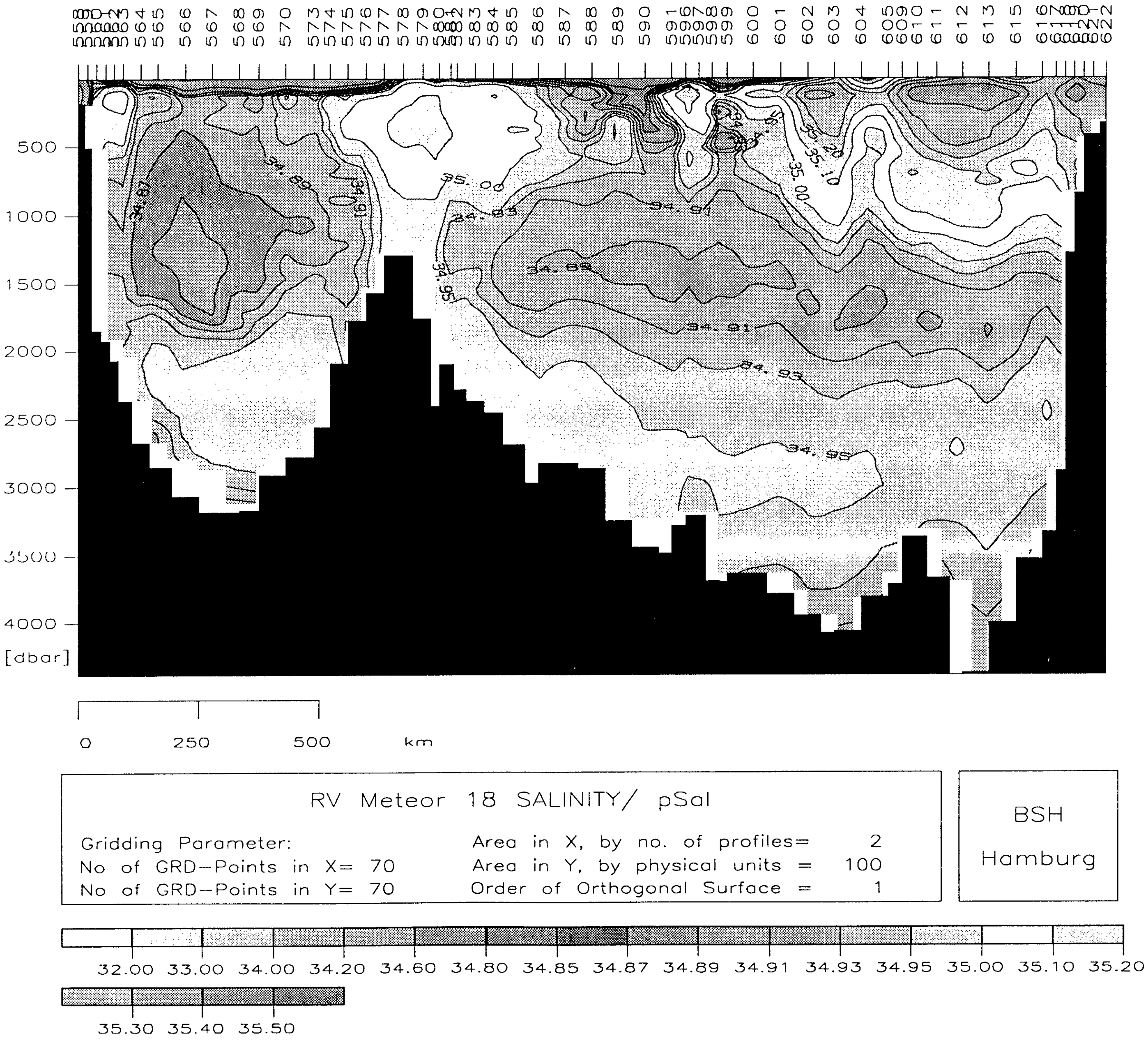
STN NBR	CAST NO	SAMP NO	CTD PRS	CTD SAL	CTD OXY	SALNTY	OXYGEN	QUALT1	QUALT2	
559	1	13	56.7			34.7470		~~2~	~~4~	N
559	1	2	458.3				287.9	~~~2	~~~3	Y
560	1	21	96.8			35.0370		~~2~	~~4~	N
560	1	15	691.5				290.3	~~~2	~~~3	Y
561	1	13	990.1				293.4	~~~ 2	~~~4	Y
562	1	24	9.0			34.8860		~~2~	~~4~	N
565	1	21	58.0				269.3	~~~3	~~~4	Y
568	1	24	27.1			34.7540		~~2~	~~4~	N
571	1	19	1957.6				278.3	~~~2	~~~ 4	Y
571	1	23	1958.1				279.3	~~~ 2	~~~4	Y
573	1	5	2534.6			34.9400		~~2~	~~4~	N
573	1	4	2585.8			34.9370		~~2~	~~4~	Y
575	1	23	29.8			34.8630		~~2~	~~4~	N
575	1	22	58.5			34.8820		~~2~	~~4~	N
579	1	24	8.1			34.9700		~~2~	~~4~	N
582	1	11	1292.8				279.3	~~~3	~~~2	Y
584	1	19	197.2			35.1180		~~2~	~~4~	N
586	1	23	33.7			34.9800		~~2~	~~4~	N
586	1	22	63.9			35.1190		~~2~	~~3~	N
586	1	21	104.1			35.1160		~~2~	~~4~	N
587	1	3	2674.3			34.9590		~~3~	~~4~	Y
589	1	13	1783.5			34.9080		~~2~	~~3~	Y
591	1	3	2997.5			34.9580		~~2~	~~3~	Y
597	1	23	38.2			34.9670		~~2~	~~3~	N
597	1	22	68.5			35.2630		~~2~	~~4~	N
597	1	20	209.0			35.0610		~~2~	~~4~	N
604	1	22	101.5			35.1830		~~2~	~~3~	Y
616	1	8	2120.0			34.9510	265.9	~~22	~~43	Y
16	1	6	2720.7			34.9520		~~2~	~~4~	Y
618	2	7	1849.8				277.0	~~~2	~~~3	Y

EXPOCODE: 06MT18
WHP-ID: A1/E
STNNBR: 622
CASTNO: 1
NO. RECORDS = 157
INSTRUMENT NO: NB3
SAMPLING RATE: 31.25 HZ

CTDPRS	CTDTMP	CTDSAL	CTDOXY	NUMBER	QUALT1
DBAR	DEG C	PSS-78	ML/L		
2.0	14.8242	35.3166	5.259		2222
4.0	14.8251	35.3173	5.268		2222
6.0	14.8267	35.3184	5.275		2222
8.0	14.8259	35.3183	5.273		2222
10.0	14.8252	35.3180	5.269		2222
12.0	14.8260	35.3185	5.259		2222
14.0	14.8269	35.3191	5.250		2222
16.0	14.8289	35.3190	5.244		2222
18.0	14.8294	35.3188	5.237		2222
20.0	14.8264	35.3188	5.227		2222
22.0	14.8234	35.3192	5.193		2222
24.0	14.8219	35.3193	5.145		2222
26.0	14.8198	35.3196	5.113		2222
28.0	14.8185	35.3198	5.119		2222
30.0	14.8129	35.3199	5.161		2222
32.0	14.8048	35.3204	5.202		2222
34.0	14.8035	35.3207	5.228		2222
36.0	14.8096	35.3200	5.241		2222
38.0	14.7849	35.3212	5.245		2222
40.0	14.7137	35.3253	5.241		2222
42.0	14.6527	35.3280	5.229		2222
44.0	14.5664	35.3291	5.209		2222
46.0	14.4222	35.3340	5.172		2222
48.0	14.3506	35.3391	5.160		2222

"Meteor" 18 (WOCE-NORD)
In-situ Oxygen Companson



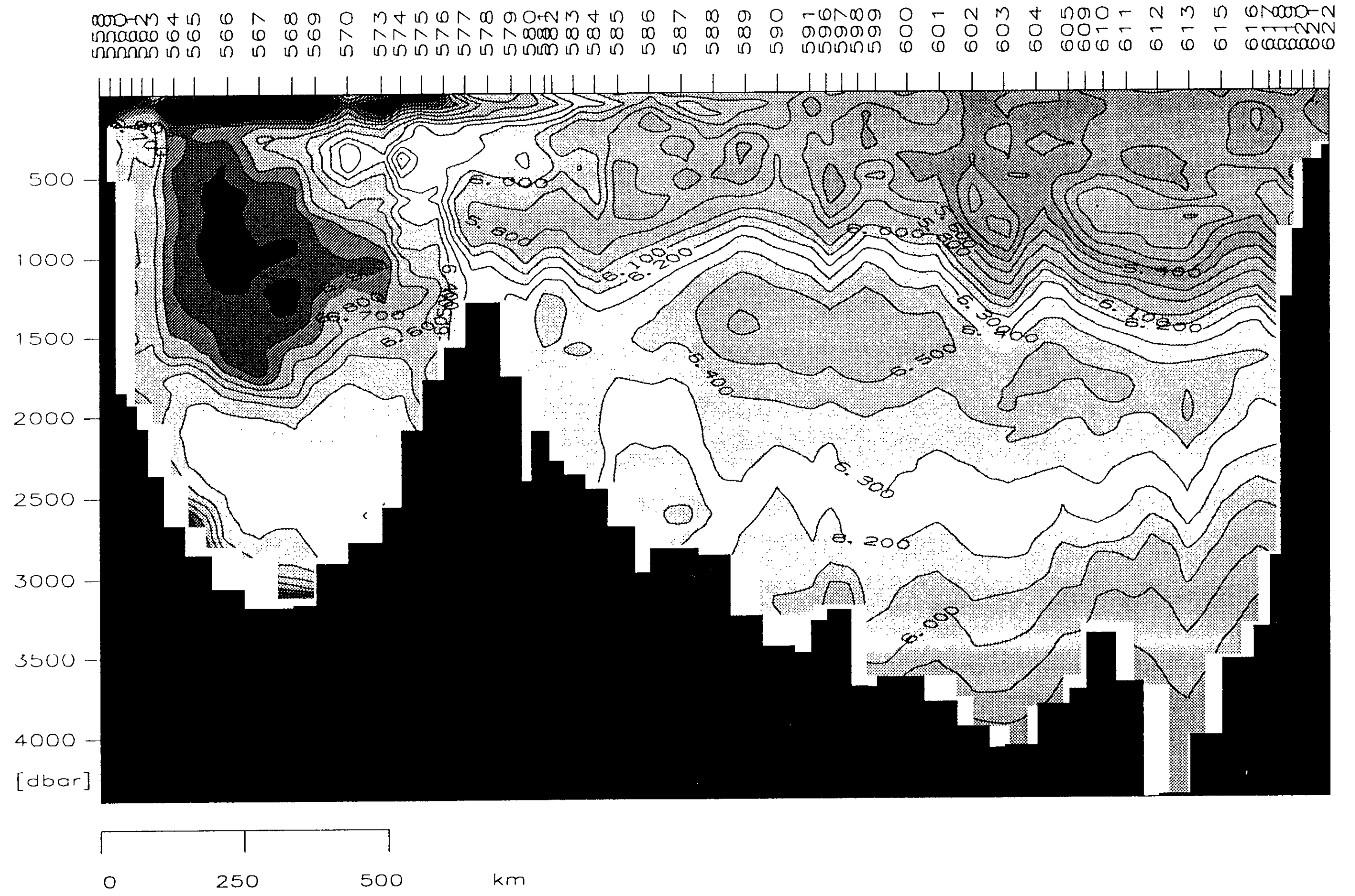


RV Meteor 18 SALINITY/ pSal

Gridding Parameter:
No of GRD-Points in X= 70
No of GRD-Points in Y= 70

Area in X, by no. of profiles= 2
Area in Y, by physical units = 100
Order of Orthogonal Surface = 1

BSH
Hamburg

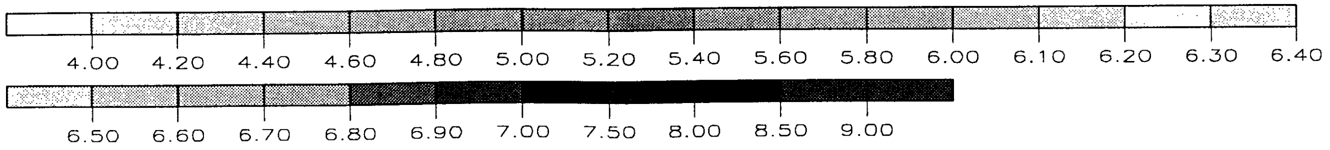


RV Meteor18 18 OXYGEN/ ml/l

Gridding Parameter:
No of GRD–Points in X= 70
No of GRD–Points in Y= 70

Area in X, by no. of profiles= 2
Area in Y, by physical units = 100
Order of Orthogonal Surface = 1

BSH
Hamburg



DQE evaluation for salinity, oxygen, silicate, nitrate, nitrite and phosphate

(D.J. Ellett)
21 June 1994

64 Hydrographic stations were sampled, using a Neil Brown Mk 3 CTD with General Oceanics rosette frames carrying 24 x 10 litre Niskin bottles. Full details of the equipment and sampling methods are given in the cruise report (Meincke, 1993). In the data received, the oxygen and nutrient data Q1 flags had been set as a result of a detailed examination by the Scripps' Oceanographic Data Facility (ODF), whose technicians carried out the analyses on board. The cruise report and ODF report contain no analyses of duplicate determinations, though some information is available from four stations where all sampling bottles were triggered at the same depth, including oxygen determinations by a second method. Both reports should be consulted for full details of the methods used and the corrections applied to the data.

Salinity:

Salinity was sampled in duplicate, one sample being determined aboard and the other being kept for determination ashore if required for cross-checks. It is assumed that the present set of salinity values is from single determinations and not the means of duplicates. Calibration of the CTD salinity values listed in HY2 is being assessed by another DQE and they have not been examined except as providing a guide to relative changes. Samples were collected in 200ml bottles with polythene stoppers and screw caps and measured 1-2 days after collection with a Guildline Autosal salinometer, using an ampoule of IAPSO standard seawater of batch P 112 per station. No statistics of the reproducibility of salinity determination are given in the cruise report, but the number of samples giving rise to queries is very small. Of the total of 77 samples in the four batches of replicate samples at the stations, where all bottles were fired at the same depth, all outliers of the salinity values fell within +0.001 to -0.OOlpsu of the mean for the depth. And the precision of the salinity data thus appears to adequately meet WOCE standards.

Oxygen:

These were the first samples drawn from the Niskin bottles at each station, and were determined on board within 4 to 36 hours by ODF technicians. The whole-bottle Winkler titration technique described in the WOCE Operations Manual was used with the relevant corrections applied, differing only in that standards and blanks were run in seawater. For the four multi-sampled stations the ranges of values, discarding a small number of outliers, were 0.6 to 1.3 ymol/kg (about 0.015 to 0.030 ml/l). Towards the end of the cruise some comparisons were made between seawater and distilled water standards. Consistently lower values by 0.20 to 0.11ml/1 were obtained by a BSH technician using a BSH Dosimat deadstop indicator titration system. But despite exchanges of standards the reason for the difference could not be determined. It is assumed that no further corrections were applied as a result of this investigation.

Nutrients:

Nutrient samples were collected in 45ml polythene bottles. Some may have been kept in a refrigerator at 2◊ to 6◊ for up to 15 hours. Analyses were performed upon a Technicon® AutoAnalyzer® using the techniques of Hager et al. (1972) and Atlas et al. (1971), silicate, nitrite and nitrate being analyzed by the methods of Armstrong et al. (1967), and phosphate by that of Bernhardt and Williams (1967). Working standards were used before and after the determinations for each cast in order to correct for instrumental drift.

At the multi-sampled stations, silicate replicates, after discarding outliers, had ranges of from 0.20 to 0.29ymol/kg. Similarly, nitrate replicates had ranges at the four stations of 0.00 to 0.20ymol/kg and phosphate of 0.01 to0.03ymol/kg. Nitrite levels at the multi-sampled depths were minimal and thus do not yield useful data about precision.

General remarks:

This is a high quality data set with little for the DQE to query, which has not already been flagged by the originators. Some analysis of duplicate determinations would have been of value for comparison with previous cruises by other laboratories, but the evidence of the four stations where multiple samples were obtained is that the data fully match WOCE standards.

Queries relating to salinity, oxygen, silicate, nitrate, nitrite and phosphate samples

In the following notes, a question mark implies a flag 3 has been entered and flag 4s are specifically noted.

Stn. No.	Sample No.	CTD press.	Query
558		All depths	Nutrients flagged 4 in Q1, so flagged 4 in Q2.
559		All depths	Flag 4 in Q1 adopted also for Q2,
559	2	458	Oxygen high. Flagged 4.
560	15	691	Oxygen high?
562	24	9	Salinity high cf CTD, flagged 4.
564	7	2323	Phspht high, flagged 4.
565	21	58	Oxygen low, flagged 4.
565	17	496	Oxygen high, flagged 4.
565	14	1195	Phspht low?

Stn. No.	Sample No.	CTD press.	Query
568	2	3132	Silcat high?
569	5	2947	Silcat high?
571	1-5	1956	Phspht high?
571	6	1957	Silcat low, flagged 4.
571	8	1957	Phspht high?
571	19	1958	Oxygen high, flagged 4.
571	22	1957	Phspht low?
571	23	1958	Oxygen and silcat high, both flagged 4.
571	24	1958	Phspht low?
573	5	2535	Salnty high cf CTD?
574	14	794	Silcat and nitrat both high?
575	23	30	Salnty high, flagged 4.
575	22	59	Salnty high, flagged 4.
576	2-24	All depths	Ql flagged 3 by originators, so adopted for Q2.
576	14	569	Nitrit high?
581	2	2033	Phspht low?
581	22	2034	Phspht high?
581	23	2034	Oxygen high? Phspht low?
582	1-23	All depths	Nitrat and phspht flagged 3 in Q1, adopted for Q2.
582	11	1293	Oxygen high? Flagged 3 in Q1 and Q2.
583	3	2242	Oxygen high. Flagged 4 in Q1 and Q2.
584	9	1378	Oxygen low, flagged 4 in Ql and Q2, silcat low?
584	3	2349	Salnty high?
586	24	14	Oxygen and nutrients flagged 4 in Q1, adopted for Q2.
586	21	104	Salnty high?
587	3	2674	Salnty low? Flagged 3 in Ql.
588	21	105	Nitrat high?
588	15	712	Silcat high?
588	14	712	Nitrat high, flagged 4 in Q2.
589	1-24	All depths	Nitrat and phspht flagged 4 in Q1, adopted for Q2.
589	17	585	Silcat low, flagged 4 in Q2.
591	1	18	Silcat and phspht high?
591	3	2998	Salnty and silcat high cf duplicates?
596	4	2801	Salnty flagged 4 in Q1 and deleted, flagged 9 in Q2.
596	3	2998	Salnty flagged 4 in Q1 and deleted, flagged 9 in Q2.
599	23	34	Nutrients flagged 9 in Q1, adopted for Q2.
599	22	64	Silcat low?
600	22	94	Salnty high? and silcat low? cf duplicates of samp. 23.
600	2	3556	Oxygen low, flagged 4 in Q1, adopted for Q2.
603	20	304	Oxygen low, flagged 4 in Q1, adopted for Q2.
604	22	101	Salnty high? Oxygen and silcat low, flagged 4 in Q1.

Stn. No.	Sample No.	CTD press.	Query
605	22	32	Sal., oxy. and nutr. flagged 4 in Q1, adopted for Q2.
607	2-24	All depths	Values deleted by originators, flagged 9 in Q1 and Q2.
608	1	3817	Values deleted, flagged 9 in Q1 and Q2.
608	2	3819	Silcat high, flagged 4 in Q2.
608	8	3820	Nitrat high, flagged 4 in Q2.
608	10	3820	Oxygen high, silcat, nitrat & phspht low, flagged 4.
608	16	3817	Oxygen high, nitrat and phspht low, flagged 4 in Q2.
608	24	3819	Silcat low, flagged 4 in Q2.
609	14	1180	Silcat, nitrat & phspht low, nitrit high? Flagged 3.
609	4	3444	Nitrit high, flagged 4 in Q2.
609	3	3534	Nitrit high, flagged 4 in Q2.
610	18	304	Oxygen flagged 3 in Q1, adopted for Q2.
610	1	3311	Nitrat low?
611	23	11	Oxygen & nitrit low, silcat, nitrat & phspht high, all flagged 4 in Q2.
613	19	90	High oxygen? flagged 3 in Q1, adopted for Q2.
613	10	2078	High oxygen? flagged 3 in Q2, adopted for Q2.
616	8	2120	High Salnty, silcat, nitrat, phspht, low oxygen all flagged 4 in Q2.
616	6	2721	Salnty high?
618	3	1850	Silcat low?
618	7	1854	Oxygen low, flagged 4 in Q2.
619	6	797	Nitrit low?
621	7	98	Oxygen flagged 4 in Q1, adopted for Q2.
622	10	22	Oxygen low?

Note for WHP Office of Q2 words needing modification ~ METEOR WOCE AGE

Where two or more bottles fired at the same depth and sample values were identical it was possible to update the Q2 word on the screen, but only one set was updated in HY2.

Stn. No.	Sam #	CTD press.	Q2 should be
558	13	8	11222444
558	12	7.9	11222444
558	11	8.5	11222444
558	1	170.7	11222444
559	18	8.3	11922444
559	17	8.3	11922444
559	16	8.4	11222444
559	15	8.3	11222444
559	14	26.1	11222444
559	13	56.7	11222444

Stn. No.	Sam #	CTD press.	Q2 should be
559	12	97.2	11222444
559	3	438.7	11222444
561	20	235.6	11222422
562	21	97.4	11222222
562	1	2026.6	11222222
563	7	2045.4	11222222
565	16	700.7	11222222
565	14	1195.2	11292223
565	13	1194.9	11222222
568	1	3131.9	11222222

Stn. No.	Sam #	CTD press.	Q2 should be
569	24	28.5	11222222
569	5	2947.2	19223222
571	1-5	1955+	11222293-all
571	6	1957	11224292
571	7	1956.8	11222292
571	8	1957.1	11222293
571	20-21	1957+	11222292
571	19	1957.6	11242292
571	20-21	1957+	11222292
571	22	1957.5	11222293
571	23	1958.1	11244292
571	24	1957.9	11222293
574	14	794.3	19223322
575	16	538.1	19222222
575	14	847.2	19222222
575	3	1899.2	19222222
576	24	11.8	11222322
576	14	569.4	11222332
578	6	998.7	11922222
579	5	1519.5	11222222
580	15	697.6	11222222
580	14	697.6	11222222
581	2	2032.9	11222293
581	3-21	2032+	11222292
581	22	2033.8	11222293
581	23	2034.5	11242293
582	24	13.3	11299999
583	14	702	11222222
583	8	1788.2	11922222
584	23	9.4	11222222
584	22	28.9	11222222
584	9	1378.5	11243222
586	18	470	11222222
586	16	968.6	11222222
586	14	1172.7	11222222
587	11	1470.3	11222222
587	6	2576.8	11222222
588	23-22	105.3	11222222

Stn. No.	Sam #	CTD press.	Q2 should be
588	21	105.3	11222322
588	15	711.8	11223222
588	14	711.8	11222422
588	1	2831.7	11922222
589	1	28	19222424
589	18	584.8	11222424
589	17	584.8	11224424
589	11	1985.9	11222424
590	17	19.1	11222222
590	14	104.2	19222222
591	23	17.7	11923223
591	22	17.6	11222222
591	4	2997.5	11222222
591	3	2997.5	19323222
596	15	594.6	11222222
596	4	2801.4	11922222
596	3	2997.9	11922222
599	23	34	11229999
599	22	63.6	11223222
599	21	63.6	11222222
600	22	93.6	11323222
600	21	93.6	11222222
601	20	204.6	11222222
602	21	102.6	19222222
602	20	102.6	11222222
602	4	3504.8	11922222
603	21	204.9	11222222
603	19	304	11222222
603	7	3425.8	11222222
604	22	101.5	19343222
604	21	101.5	11222222
604	7	2597.3	11222222
605	18	200.7	11222222
607	2-4	various	11999999
608	1	3817.7	11999999
608	2	3819	11224222
608	3	3814.6	11999999
608	4	3816.6	11222222
608	5	3820.4	11999999
608	6	3819.3	11222222

PI Response To BTL Data DQE

The suggestions made by the DQE were accepted by the chief scientist, except for 3 salinity samples: Stn. no 562, 575. According to the chief scientist these three samples existed within a salinity gradient and a decision as to weather or not they were good or bad wasn't possible. The measurements should be marked 3 instead of 4 as suggested by the DQE.

WHPO Data Processing Notes

Date	Contact	Data Type	Data Status Summary
01/21/93	Sy	BTL/SUM	Submitted for DQE
08/27/93	Sy	BTL	Data Update
11/03/93	Ellett	s/o/nuts	DQE Begun
12/16/93	Crease	CTD	DQE Begun
12/29/93	Meincke	DOC	Submitted
06/21/94	Ellett	NUTs/S/O	DQE Report rcvd @ WHPO
08/01/94	Sy	NUTs/S/O	DQE Report sent to PI
09/10/94	Morozov	CTD	DQE Report rcvd @ WHPO
10/14/94	Dunworth-Baker	s/o/nuts	Units converted to umol/kg
	The oxygens and nutrients in the original sea data file were in volumetric units. In August of 1993 a final .sea file was received from Alexander Sy, also volumetric. Two of the columns in that file were NUTLTMP and O2DTMP (nutrient lab temp and o2 draw-temp). The *TMPs were removed from the file, and used to convert the oxygens and nutrients to umol/kg. Occasionally temperatures were missing for samples; when that happened a nominal lab temp of 22 was used for the nutrient conversion, and potential temperature at the depth where the bottle was tripped was used instead of the oxygen draw-temp.		
05/04/95	Meincke	DOC	Final Data Report @ WHPO
03/04/96	Meincke	CTD	Data are Final
08/28/96	Putzka	CFCs	Submitted for DQE
03/09/99	Kappa	DOC	PDF DOC Dir. produced
	a01e_ar7e.memo.pdf a01e_cfc data.pdf a01e_cru_pln.pdf a01e_data.hist.pdf a01e_doc.pdf a01e_odf.rpt.pdf a01e_s/o/nuts.dqe.pdf		
04/30/99	Kappa	DOC	PDF Directory Updated
	a01e_notes.pdf added		
06/10/99	Klein	CFCs	Data are Public
	I now declare our consent to have CFC data public for this cruise.		

09/12/99	Klein	CFC-11/12	Resubmitted
	I was preparing a CFC data file for John Bullister for the North Atlantic CLIVAR activities. While I was checking the hydrography data of the file that you have at the WHPO I noticed that all the CFC-11 and CFC-12 quality flags in qual1 had been set to 1. Therefore I am submitting the CFC-11 and CFC-12 data again together with their quality flags. The only change is that the CFC-11 and CFC-12 concentrations are now reported as SIO93 while the earlier data set was reported as SIO86. The data file is called m18cfc.woc and the corresponding meta information is given in file m18cfcdoc.txt.		
01/24/00	Newton	CFCs	Data Updated, put online
	· Corrected EXPO code from 06MT18/1 to 06MT18_1. · Merged in updated CFC's and CFC QUALT1 flags. · QUALT2 flags unchanged.		
02/14/00	Kozyr	ALKALI/TCARBN	Final Data Rcvd @ WHPO
04/13/00	Huynh	DOC	Updated doc online
04/14/00	Diggs	CFCs	Data again Updated, put online
	Since the original merge was in error, David Newton re-merged the CFCs for A01E (Meteor 18) and I checked them for accuracy. Data checked out fine, and I placed the new file on the web. All files and tables updated.		
03/16/01	Uribe	CTD	Expocodes updated, put online
	Karla and I have edited the expocode in all ctd files to match the underscored expocode in the sum and bottle files. New files were zipped and replaced existing ctd files online. Old files were moved to original directory.		
06/20/01	Uribe	BTL	EXCHANGE File Added to Website
	Bottle file in exchange format has been linked to website.		
06/21/01	Uribe	CTD/BTL	Website updated
	The exchange bottle file name in directory and index file was modified to lower case. CTD exchange files were put online.		
08/09/01	Uribe	BTL	Exchange file corrected, reformatted
	Bottle exchange file was corrected. The wrong file was online. Bottle file was formatted by S. Diggs.		
12/18/01	Uribe	CTD	Exchange file modified, put online
	CTD has been converted to exchange using the new code and put online.		
12/19/01	Hajrasuliha	CTD	Internal DQE run
	produced *check.txt file. Could NOT produce *.ps files.		

<table>
<tr><td>09/19/02</td><td>Anderson</td><td>He/Tr, DELC14</td><td>Data merged into online file</td></tr>
<tr><td></td><td colspan="3">Added TRITIUM, HELIUM, DELHE3, DELC14, TRITER, HELIER, DELHER, and C14ERR to online file. Made new exchange file.

Merge notes for a01e:
Added TRITIUM, HELIUM, DELHE3, DELC14, TRITER, HELIER, DELHER, and C14ERR
from file:
06MT18-1.SEA_NEW
found in /usr/export/html-public/data/onetime/atlantic/a01/a01e/original/
1998.08.03_A01E_ HE.TR.C14.ARNOLD
into online file
20000414SIODMN.</td></tr>
<tr><td>11/12/02</td><td>Kappa</td><td>DOC</td><td>Final PDF, TXT versions compiled</td></tr>
<tr><td></td><td colspan="3">Updated pdf and txt cruise reports now include Eugene Morozov's CTD DQE report and Alexander Sy's response to it; Wolfgang Roether & Birgit Klein's CFC report; and these Data Processing Notes.</td></tr>
</table>