Preliminary data Report
May 4, 1992

A. Cruise Narrative

A.1 Highlights

A.1.a WOCE designation: AR4E/AR4W/AR15

A.1.b EXPOCODE 06mt14/2

A.1.c Chief Scientist: Dr. Fritz Schott
Institut Fuer Meereskunde
Universitat Kiel
Dusternbrooker Weg 20
24105 Kiel Germany

A.1.d Ship name: R/V METEOR

A.1.e Ports of call : Mindelo (Cape Verde Islands) - Recife (Brazil)

A.1.f Cruise Dates: Oct. 1 - Oct. 27, 1990

A.2 Cruise Summary

A.2.a Georgraphic Boundaries

A.2.b Total number of stations Occupied

A.2.c Floats and drifters deployed

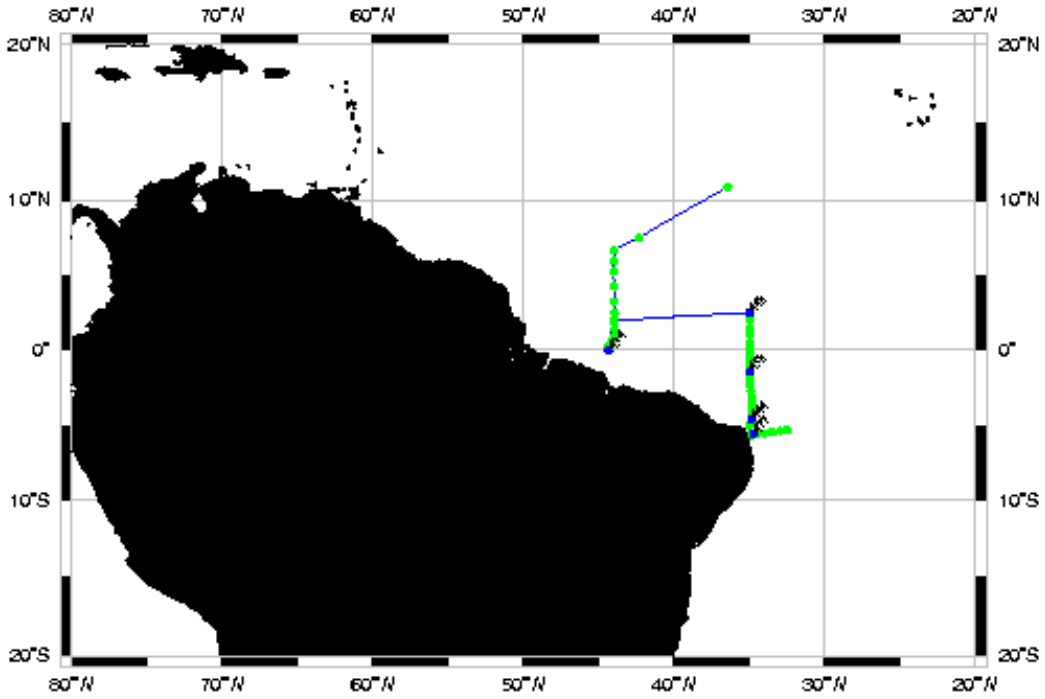
A.2.d Moorings deployed or recovered

A.3 List of Principal Investigators

A.4 Scientific Programme and Methods

Leg 2 of METEOR cruise 14 focused on the investigation of the circulation and the water mass exchange in the western tropical Atlantic.

Station locations for ar15xa



METEOR headed towards the North Brazilian coast. During this transit the instruments were set up and prepared. On October 4 a first CTDtest-station was done. The same day the XBT-program started. TheCTD-measurement program began on October 6, at 7 30'N, 42 25'W. From thislocation a hydrographic section with CTDs, XBTs and Pegasus-drops along 44W was done until October 8, when the 200-mile zone of Brazil was reached.One mooring (K329) just outside the 200-mile zone was recovered. From herethe ship sailed to the Brazilian coast near Salinopolis, where the officialBrazilian observer, who was not able to reach the ship on the Cape VerdeIsland in time, joined the cruise.

From Salinopolis the ship sailed to 0 05'N, 44 23'W to continue themeasurements along 44 W. Two more moorings along this section (K327, K328)were recovered and three new moorings (K339 - K341) were deployed. Thework along 44 W was finished on October 13 at about 2 N. From here theship sailed to 35 W, 2 30'N with XBT-drops as the only measurements. Asecond hydrographic section with CTD, Pegasus and XBT-measurements wasdone along 35 W from 2 30'N to 5 S with deployment of 7 surface driftersbetween l 25'S and 4 S. This section was completed on October 11. Anothershort hydrographic section was done along 5 30'S from the Brazilian shelfto 32 30'W, reaching the endpoint of the section on October 25. The shipthen sailed southward to 9 43'S, 33 40'W and then west to 9 05'S, 34 53'W. During this time only XBTs were dropped and 13 drifting buoys were put intothe water. The location at 9 05'S was reached in the evening of October 27and the last station on which measurements were carried out. From here theship sailed to Recife, where the cruise terminated.

A.5 Major Problems and Goals not Achived
A.6 Other Incidents of NoteA.7 List of Cruise Participants

B. Underway Measurements

B.1 Navigation and bathymetry
B.2 Acoustic Doppler Current Profiler (ADCP)
B.3 Thermosalinograph
B.4 XBT and XCTD
B.5 Meteorological observations
B.6 Atmospheric chemistry

C. Hydrographic Measurements

D. Acknowledgments

E. References

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

Unesco, 1991. Processing of Oceanographic Station Data, 1991. By JPOTSeditorial panel.

F. WHPO Summary

Several data files are associated with this report. They are the metr14l2.sum, metr14l2.hyd, metr14l2.csl and *.wct files. The metr14l2.sum file contains a summary ofthe location, time, type of parameters sampled, and other pertientinformation regarding each hydrographic station. The metr14l2.hyd file contains thebottle data. The *.wct files are the ctd data for each station. The *.wct files are zipped into one file called metr14l2wct.zip. The metr14l2.csl file is a listingof ctd and calculated values at standard levels.

The following is a description of how the standard levels andcalculated values were derived for the metr14l2.csl file:

Salinity, Temperature and Pressure: These three values were smoothedfrom the individual CTD files over the N uniformly increasingpressure levels 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 notcontained within the ctd values, the value was linearly interpolatedto 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 thesurface 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 theleast squares slope between two levels, where the standard level is thecenter of the interval. The interval being the smallest of the twodifferences between the standard level and the two closest values.The slope is first determined using CTD temperature and then theadiabatic lapse rate is subtracted to obtain the gradient potentialtemperature. Equations and Fortran routines are described in Unescopublication 44.

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

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

Bouyancy Frequency (B-V: cph) is calculated using the adiabaticleveling method, Fofonoff (1985) and Millard, Owens and Fofonoff(1990). Equations and Fortran routines are described in Unescopublication 44.

Potential Energy (PE: J/M2: 10-5) and Dynamic Height (DYN-HT: M) arecalculated by integrating from 0 to the level of interest. 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.

G. Data Quality Evaulation

Hydro (Affonso Mascarenhas)

The data, I was asked for to evaluate, comprise CTD and bottle data(salinity and oxygen) collected on two cruises from AR15/ar4. Thefirst one, leg 2 of Meteor cruise 14, was from Cape Verde Island toSalinopolis and Recife, Brazil. No CTD oxygen was reported for thiscrise due to problems with the tittration of dissolved oxygen and hecalibration of the CTD oxygen sensors, accordin gto an additional noteot the cruise report.

A figure showed the histogram for the differences (Bottle-CTD)salinity, for leg 2 Meteor cruise 14. The standard deviation is0.0024, that is the expected acccuracy attained with altosalsalinometers, in spite of the WOCE requirement of 0.001. Also 66percent of the differences are within this range definign the sample asa reasonable data set since the didstribution is no Gaussian. Manyplots were performed in order to evaluate their quality and in all ofthen the distribution of the points indicate the data set as a goodquality one. As an example a figure showed (bottle-CTD) salinityversus station number and a figured showed (bottle-CTD) salinity verussalinity. Another figured showed an intriguin distrbution of points inthe trace, that was also observedc in others stations. I checked thedata set and reploted the TS on difference scale range, and iit is hardto affirm if they are real or caused by shed wakes, pressure reversalsor ship heave.

The only data flaged as questionable in this set were:

Station	sample	bottle	pressure	salinity	630		10	17	698
	34.5490	632	11	16	21			36.0320	

The second data set was from leg 3 of Meteor cruise 16 from Belem,Brazil to Las Palmas, Canary Island. In this case we have CTD andbottle salinities and oxygen, being both parameters not observed insome depths as indicated in files *.hy2. A figure shows the histogramfrom the differences (bottle-CTD) salinity, the distribution has apositive sknewness and a standard deviation of 0.0019 tht is theaccuracy of Autosal salinometers, even though as stated before anaccuracy of 0.001 could be attained.

On the other hand, 56 percent of the differences are within this range,meaning that statistically there is apoor agreeement between the set ofdifferences with their mean. In spite of this, both salinities fitsvery well as well as with the TS relationships of the area.

Other figures display a cluster of dta between +/- 0.005 which is aguaranteee of the goodness of the data set. The additional informationto the data rreport refers to an offset that wuld result by using theupcast bottle data for the calibrations of the meteor 14 and 16salinity profiles. The salinity data set could be considered good evenwith the offset caused by the used of the upcast bottle data.

A histogram for the differnces (Bottle-CTD) Oxygen was done. Thecomparison of the Oxygen Bottles and CTD is impressive. The standarddeviation of the differences is 16.39, and most of the data fell withinit (80%). In the dissolved oxygen data set the differences shows abias being the titration values less than the CTDOX values most of thetimes. The Oxygen values agree with the historical values of theregion the sistematic low values (below the mean for the region)between 200 and 350 m in the station 339 to 343 seems to be real (lprobably need a better oxygen data bank for the region). How the CTDOXvalues should be calibrated it is left to WHP Office.

Notes by T.J Joyce

The water sample -CTD differnces are expectecd to exceed WHPspecifications as both quantities have error. One expects deep valuesto show little difference. However, there is a persistent differencesfor pressures greater than 1500 dbar for groups of stations on bothcrusies (289-297 and 307-316 Meteor 16 and 627-634 on Meteor 14) Thatsuggests that the CTD data could be better 'calibrated '.

This is the extent of the electronic documentation about hydrographic sampling on the the Meteor cruises 14L2, and 16L3 by Schott. This will have to be expanded once we obtain more complete information, such as a scanned version of the cruise report. (TMJ)

Problems occured with the titration of dissolved oxygen and the calibration of the CTD oxygen sensor on Meteor 14-2 and the oxygen values from the CTD are not usable. On Meteor 16-3, CTDOXY data is reported but profiles are flagged questionable. It is not known how well calibrated these data are compared with the water samples prior to sending them off for the DQE process; presumably we will learn AFTER the report (TMJ) (All of the stations were given as falling in AR15, however, they mostly fall along AR4E and AR4W as shown in the corrected 06MT14.SUM file -CEC)

Kiel, June 11, 1993

Information on the bottle files of M E T E O R cruise 14-2 and 16-3:

The file CAL14.SEA and CAL16.SEA [now renamed .hy2, TMJ] contain the corrected files for the bottle data including Freon and oxygen values in the WOCE-format. They replace the ones send earlier. An error was made in the old version as the CTD-salinity was computed with the uncorrected pressure. Note that the calibration is done with the conductivity of the downcast profiles while in CAL14.SEA and CAL16.SEA the upcast bottle data are used which leads to a small offset [how small of an offset???, TMJ] in salinity between CTDSAL and SALINITY, which is not present in the downcast values. Also not all salinity data shown here were used for the calibration, as salinity from the layer below the surface mixed layer and about 1500 m was no used.

-- Lothar Stramma

Cruise Plan

Line AR4E 35∞W - 2∞N to Brazil
Cruise/leg: 06MT14/2

Logistical requirements:
Length (nm): 420
Small Volume Stations: 15
Repeats/Yr: 4x No. of Yrs: 1
Program constraints: Once each season with 30 nm station spacing.

Operator: GERMANY
Chief scientist: Schott/IfMK
Ship: METEOR (POST-7/64)
Cruise date: Oct. 1-Oct. 27 1990
Cruise plan received:
Cruise report received: April 91
ADCP: Unknown
CTD: Schroeder
Chlorofluorocarbons-all types: Unknown
Drifters of any type: Unknown
Moorings - any type: Unknown
Oxygen: Unknown
Pegasus instrument: Send/IfMK
Salinity: Unknown
XBT: Schroeder/AWI
Notes: Divided into E and W and relocated at CP1-4.