Preliminary data report
March 28, 1995

A.Cruise Narrative

A.1 Highlights

A.1.a WOCE Designation AR16

A.1.b Expedition Designation: EXPOCODE 06HF2092/1
06HF2092/2
06HF2092/3

A.1.c Chief Scientist: Leg 1-3: John Hans-Christian
Biologische Anstalt Helgoland
Martin-Luther-King-Platz 3
Hamburg, Germany 20146

A.1.d Ship: R/V Heincke

A.1.e Ports of Call: Leg 1: Cuxhaven,Germany to Lisboa,Portugal
Leg 2: Lisboa to Leixoes,Portugal
Leg 3: Leixoes to Cuxhaven

A.1.f Cruise Dates: Leg 1: January 3 to January 20, 1992
Leg 2: January 21 to January 29, 1992
Leg 3: January 31 to February 6, 1992

A.2 Cruise Summary

A.2.a Text giving georgraphic boundaries

A.2.b Total Number of Stations Occupied During the cruise a total of 114 CTD/rosette stations were occupied using a CTDO equipped with a 12 position rosette with 2.7 l Teflon-type water sampling bottles.

- ° CTDO and Speed of Sound
- ° Salinity and oxygen of water samples
- ° Temperature and pressure by reverse deep sea thermometers

A.2.c Floats and drifters deployed

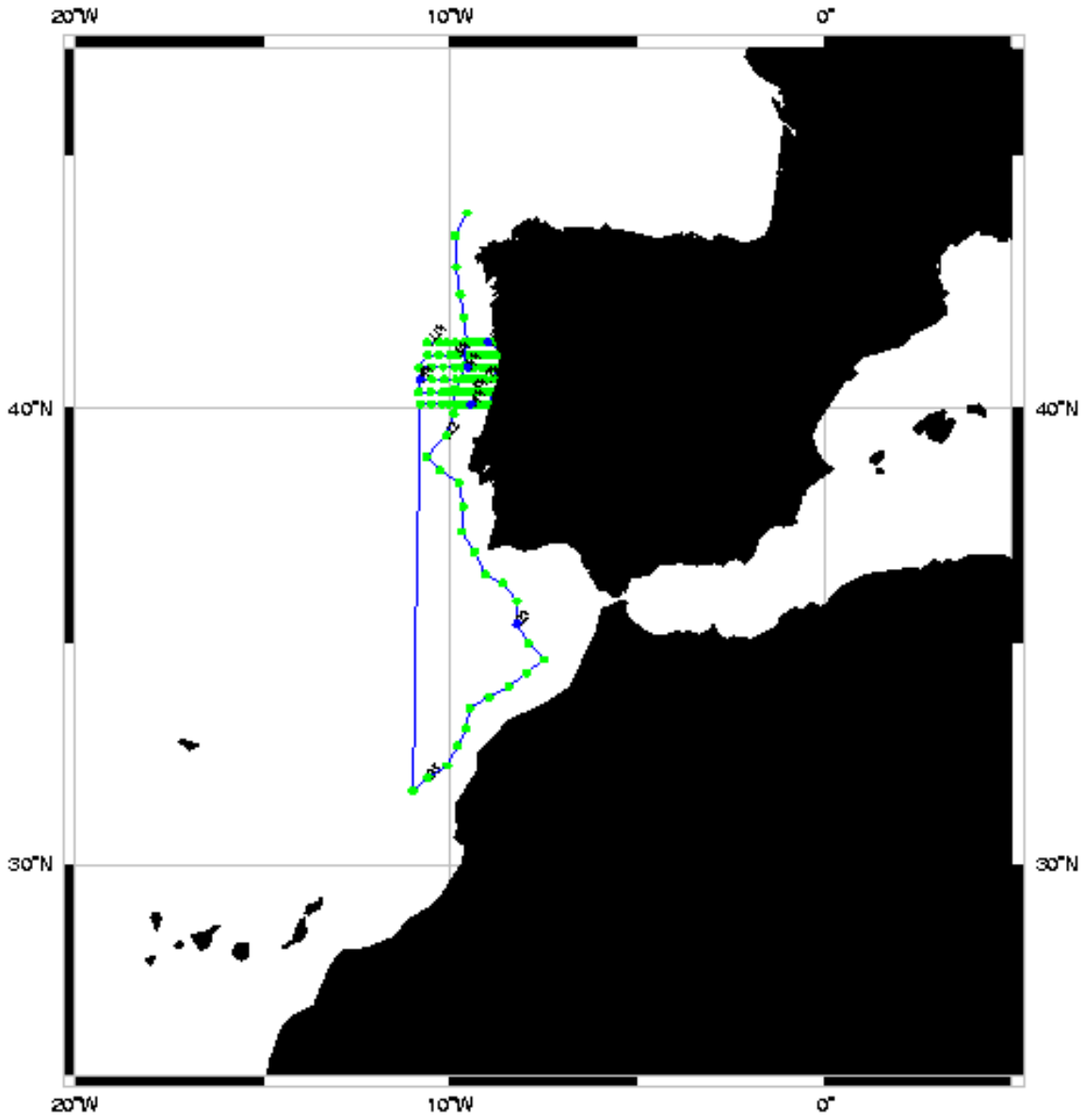
A.2.d Moorings deployed or recovered

A.3 Principal Investigators

Name	Responsibility	Institution
E. Hagen	CTDO,S,O2,	IOW*

*See table 1 for address of Institution

Station locations for AR16 : JOHN



A.4 Scientific Programme and Methods
A.5 Major Problems and Goals not Achieved
A.6 Other incidents of Note
A.7 List of Cruise Participants

Table 1: List of Cruise Participants

Name	Responsibility	Institution
Stefan Weinreben	CTD-Software	IOW
Rainer Bahlo	CTD Hardware	IOW
Wolfgang Hub	Salts, Oxygen	IOW

IOW Institut fuer Ostseeforschung
Warnemuende, Germany
d-18119

B Underway Measurements

B.1 Navigation and Bathymetry
B.2 Acoustic Doppler Current Profiler (ADCP)
B.3 Thermosalinograph and underway dissolved oxygen, fluorometer, etc.
B.4 XBT and XCTD
B.5 Meteorological Observations
B.6 Atmospheric Chemistry

C Measurement Techniques and Calibrations

During the cruise one CDTO probe was used.

Description of the CTDO (WLOST 1993):The CTDOs and the sensors are manufactured at the Institut fuerMeereskunde Warnemuende (IfMW), Germany. The CTDO is an OM-87 =Oceanolographic Measuring System, consisting of an expandable dividingCTDO-probe, interfaced through a special designed slave-computer, ameteorological subsystem interfaced by a second slave-computer and amaster-PC. The IfMW began to develop oceanographic measuring systemsin the 60s. The first computer controlled CTD-system, OM-75 (MOECKEL1980) was taken into service in 1976. The new generation: OM-87 hasbeen used since 1988.

The CTD is equipped with frequency-analogous sensors at standard ports,developed and manufactured by IfMW; the oxygen sensor together with FSI"Kurt Schwabe", Meinsberg, Germany.

Table 2: CTDO - Sensor Configuration List

CTD	Stat. No.	Parameter	sensor	resolution	precision
2	124	pressure	p250	0.1 dbar	2 dbar
		temp	t121	0.0015 K	0.01 K
		conductivity	c884	0.0008mS/cm	
		speed of sound	v218	0.025 m/s	0.3 m/s
2	113	oxygen	o020	0.01 ml/l	0.1 ml/l
114	124	oxygen	o028	0.01 ml/l	0.1 ml/l

C.1.b CTDO Sampling procedure and data processing

Sampling procedure

CTDO was recorded on hard disk during the down casts.

sampling rate:	1 record in 1.2 s =0.83 Hz.
integration time of sensors:	1s
lowering speed of CTD:	1.0 m/s
time constants:	pressure and temperature sensors = 0.1 s
	conductivity sensor = 0.1 s at 1 m/s lowering speed

The precalibration constants of pressure, temperature, conductivity,sound speed sensors and the recalibration constants of the oxygensensors were used over the whole cruise. The check measurements ofCTDO and water sample data (in situ comparisons) were used forcalculating the post-cruise corrections.

Post-Cruise Data Processing

The raw data are digitized frequencies, which had been converted tophysical units of pressure, temperature, conductivity, oxygen and soundspeed.

A validation routine was applied to the CTDO down cast data (Lass et.al. 1983), to eliminate:

- Data values, which are not physically realizable
- Random errors by recursive low-pass filtering (Acheson 1975)
- Systematic errors: Caused by the effect of the ship's rolling and pitching on the lowering rate of CTD. Records acquired while CTD is moving down too slowly have been discarded to enforce a strick monotonic sequence in pressure.

The so called eddy-algorithm in connected view with the values of sensorintegration time and lowering rate reduced the effect of different timelags of the sensors to minor importance.

The calculation of salinity from conductivity and conversion ofdissolved oxygen from volumetric to weight concentration were done lastafter correcting the data as described below. Dissolved oxygen wasconverted according to WOCE O.M. (1991).

The data have not been averaged finally in 2 dbar increments because ofthe low sampling rate of the CTD and a great amount of discardedrecords in the course of data processing up to 50 pc on average.

Post-Cruise CTD Data Corrections

In order to get the CTDO to match the water sample data, following fitswere applied to CTDO:

Table : 3

CTDO	Sta.No.	Sensor	Fitting Param.		Fitting Polynoms
		Pressure	Linear fit		Pres(fitted)=A0+A1*PRES
			A0	A1	
2	124	P250	-1.5	0.99768	
		Temp.	Linear Fit		Temp(fitted)=A0+A1*TEMP
			A0	A1	
2	124	T121	0.01156	0.997985	
		conductivity time depended correction			
					Cond(corr)=COND+A0+A1*time
		Time/hours=beginning time of cast (in continuously			
		counted hours of the year: Jan 1; 0 o'clock:Time=0hrs)			
			A0	A1	
2	11	C884	0.07203	-6.08E-4	
12	36		-0.27562	6.59E-4	
40	118		0.13979	-3.53E-4	
		Conductivity:	Linear fit		cond(fitted)=A0+A1*cond
119	124	C884	-5.77E-2	1.0	
		Oxygen	Linear fit		oxyg(fitted)=A0+A1*oxyg
		(ml/l)	A0	A1	
2	112	o020	0.0	0.1677	
		oxygen pressure correction			
		ml/l			Oxyg(corr)=Oxyg(fitted)+A0+A1*pres
			A0	A1	
2	112	o022	-0.66	0.1677	
114	118	o028	-0.6926	4.1E-4	
		Oxygen:	data discarded		
113		o020			
119	124	o028			
		speed of sound:	no fit		
2	124	V218			

C.1.d Errors and Noise

During the cruise located faulty sensors were replaced as listed above in the CTD sensor configuration list. Station 113 o020 sensor failed and was changed. Station 119-124 o028 sensor also failed.

C.2 Water Sampling for In Situ Comparisions

C.2.a,b Techniques and sampling procedures

After finishing the down cast (CTDO-recording), the CTD was lifted and stopped within well mixed layers. After 10 minutes waiting to let the deep-sea thermometers adapt to the surrounding temperature two water bottles were tripped while a short time CTDO recording. The deep sea thermometers (2 protected and 2 unprotected) were reversed simultaneously with the first bottle tripping.

When the first bottle of each sampling depth tripped correctly the water samples (2 dissolved oxygen and 2 salinity) were drawn from these bottles, otherwise from the second ones.

The S and O data of the water samples so as the reverse temperature and -pressure data were used for the post- cruise corrections of the CTDO data.

Salinity

The water sample salinity were measured with a Guildline Autosal Modell 8400A salinometer, manufactured by Guildline Instruments Ltd., Smiths Falls, Canada. The salinometer was standardized weekly with I.A.P.S.O. Standard Seawater (SSW) Batch P 115. Differences in standardization readings were less than 3.

The salinometer manufacturer claims a precision 0.002 and an accuracy of better than 0.003; better than 0.001 when the laboratory temperature is constant (+/- K) and about 1-2 K below the bath temperature of the salinometer.

Oxygen

The dissolved oxygen samples were analyzed by the Winkler Titration Method modified by Carritt and Carpenter (1966).

Temperature (reverse thermometers)

The following reverse thermometers were used

VEB Thermometerwerk Geraberg, Germany		
	Scale	Graduated in
pressure protected	-2...+30deg C	0.1K
unprotected	-2...+30degC	0.1K
Gohla-precision, Kiel, Germany		
	Scale	Graduated in
pressure protected	-1...+35degC	0.1K

Duplicate Water Samples

Two or three duplicate salinity and oxygen samples were drawn from bottle. The differences between the salinity and oxygen measurements of the duplicate water samples and the standard deviation of the differences are shown in the table 4.

Table 4:

	average differences between samples	**max diff**	**std. Dev of all differences**
salinity	0.0019 psu	0.014 psu	0.0022
oxygen	0.027 ml/l	0.1 ml/l	0.0228

C.2.f Laboratory and Sample Temperatures

The laboratory was temperature controlled : 19...22 deg C. The bath temperature of the Autosal salinometer was set to 24 degC. Salinity and oxygen samples had been tempered at room temperature when measured.

C.2.I Standards used

I.A.P.S.O Standard Seawater, Batch p115, 6.2.91 during the cruise this was the only batch used.

D. Acknowledgments

E. References

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WOCE Operations Manual, Vol. 3, Sec 3.1, Part 3.1.3: WHP Operations and Methods; C.H. Culberson: Dissolved Oxygen, WHP Office Report WHPO 91-1, WOCE Report No. 68/91,1991, Woods Hole, Mass., USA.

F. WHPO Summary

Several data files are associated with this report. They are the ebc4.sum, ebc4.hyd, ebc4.csl and *.wct files. The ebc4.sum file contains a summary of the location, time, type of parameters sampled, and other pertient information regarding each hydrographic station. The ebc4.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 ebc4.wct.zip. The ebc4.csl file is a listing of ctd and calculated values at standard levels.

NOTE The preliminary *.csl files were not created due to the CTD data being provided in non-uniform levels

G. Data Quality Evaulation