Preliminary Data Report
March 28, 1995

A. Cruise Narrative

A.1 Highlights

A.1.a Woce Designation: AR16/AR06
A.1.b Expedition Designation: EXPOCODE 07AL692/1, 07AL692/2,

A.1.c Chief Scientist: Leg 1-2: Eberhard Hagen, IOW
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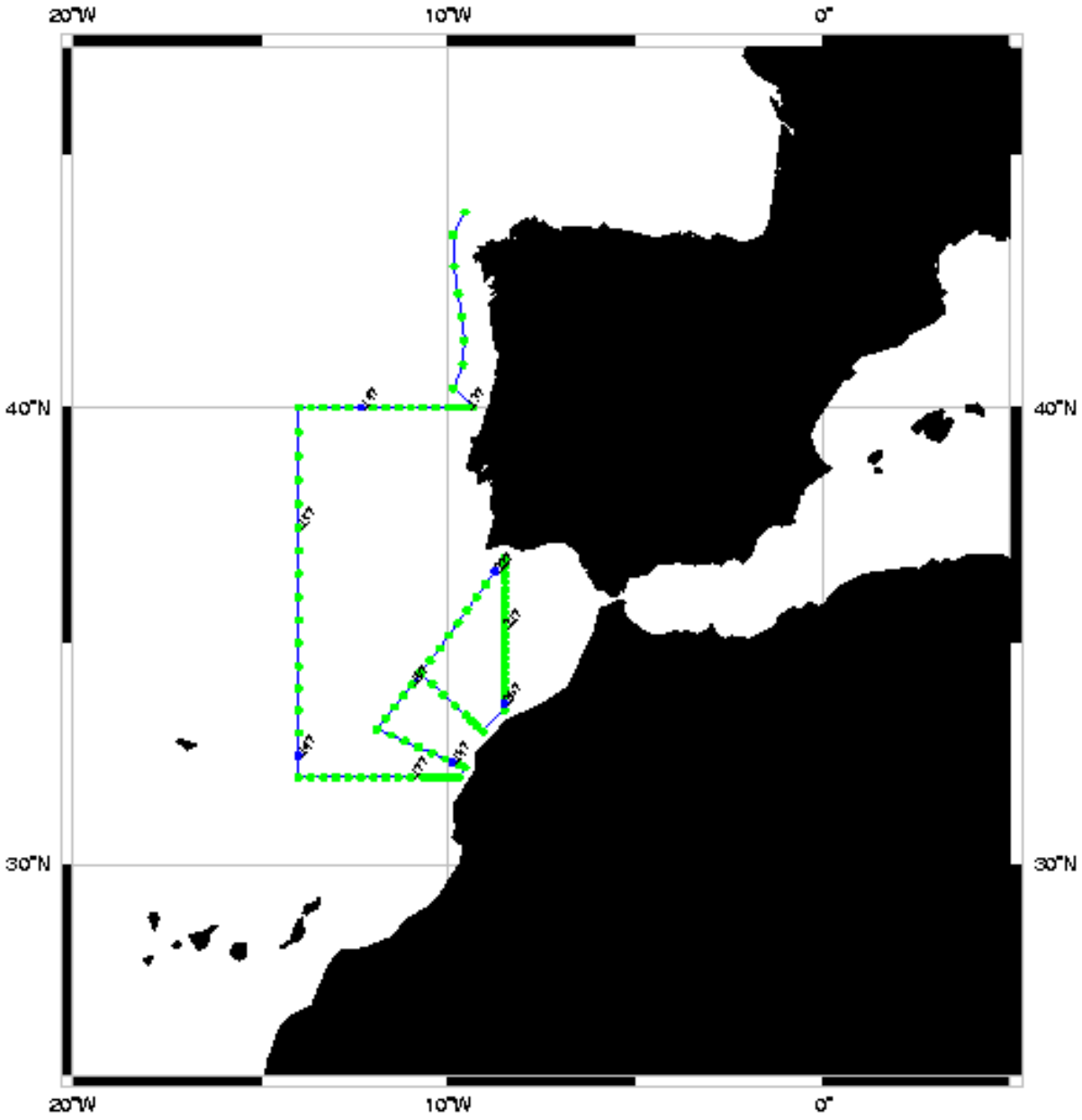
A.1.d Ship: R/V A.V.Humboldt

A.1.e Ports of Call: Leg 1: Rostock, Germany to Las Palmas,Canaries
Leg 2: Las Palmas to Las Palmas, Canaries

A.1.f Cruise Dates: Leg 1: September 2 to September 9, 1992
Leg 2: September 9 to September 26, 1992



A.2 Cruise Summary

A.2.a Geographic Boundaries

A.2.b Total number of Stations occupied

There were 7 CTD stations on Leg 1 and 90 CTD stations on Leg 2.

o CTDO and sound speed;
o salinity and oxygen of water samples;
o temperature and pressure by reverse deep sea thermometers
o stepwise current meter profiling (0-500m) using
o GPS navigation system : 32 stations

o AMOR 92 - Experiment:
skin-bulk-SST by means of Heiman KT4 radiometer
(8-14 *10**-6m): 30 days

air pressure, temperature, humidity up to an average attitude
of about 22 km by radiosondes: 48 starts

underwater radiation 12 stations

pyrometer 30 days

o meteorological standard parameters : 30 days
o chlorophyll filtration 12 stations
o fluorescence down to 300 dbar 12 stations

A.2.c Floats and drifters deployed
A.2.d Moorings deployed or recovered

Subject of Leg 1 and 2: WOCE : Eastern Boundary Currents 5
Subject of Leg 3 and 4: AMOR 92= Atlantic Measurement of Oceanic Radiation : Skin-Bulk-SST-Relationship

A.3 Principal Investigators

Table 1: List of Principal Investigators

Name	Responsibility	Institution
E. Hagen	CTDO, S, O2, Profiles Fluorescence	IOW
R. Feistel	SST	IOW
C. Zuelicke	Meteorology	IRSA
D.v.d.Linde	Underwater radiation	IRSA
N. Hoeffner	Chlorophyll	IRSA
E. Mittelstaedt	Current (moorings)	BSH
* See table 2 for list of institutions		

Table 2: List of Institutions

Institutions	Address
BAH	Biologische Anstalt Helgoland Martin-Luther-King-Platz 3 Hamburg, Germany 20146
BSH	Bundesamt fuer Seeschiffahrt und Hydrographie Postfach 30 12 20 Hamburg, Germany D-20305
IfMW	Institut fuer Meereskunde Warnemunde Seestr. 15 D-18119 Rostock-Warnemande Germany
IRSA	Institut for Remote Sensing Applications Marine Enviroment Ispra, Italy 21020
ISPM	Institut Scientifique des Peches Maritimes Casablance, Marocco
IOW	Institut fuer Ostseeforschung Warnemuende, Germany d-18119

A.4 Preliminary Results

A.5 Major Problems

At station 177 the OM-87 probe No 2 was lost during the up cast when the cable broke. From station 178 to 235 the OM-87 probe No 3 was used.

A.6 Other Incidents of Note

A.7 List of Cruise Participants

Table 3: List of Cruise Participants

Name	Responsibility	Institution
Eberhard Hagen	Chief Scientist radiosondes starts	IOW
Rainer Feistel	Skin-Bulk-SST	IOW
Stefan Weinreben	CTD-Software	IOW
Henry Will	CTD-Hardware Current Profiling	IOW
Christoph Zuelicke	Skin-Bulk-SST	IRSA
Guenter Plueschke	Salts, CTD Winch	IOW
Wolfgang Hub	Oxygen, CTD Winch	IOW
Dieter Fritsch	Precision Mechanics	S-Gmbh-R
Leg 1,3,4		
Dirk Van der Linde	Underwater radiation	IRSA
Leg 3		
Nicolas Hoeffner	Underwater radiation	IRSA
Wolfgang Lange	Moorings	BSH
Holger Giese	Moorings	BSH
A.J. Lakhdar Idrissi	Observer	ISPM
*See Table 2 for institution		

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

C.1 CTDO

C.1.a Equipment and Techniques

During the cruise two CDTO probes (No2 andNo3) were used.

Description of the CTDO (WLOST 1993):

The CTDOs and the sensors are manufactured at the Institut fuer Meereskunde Warnemuende (IfMW), Germany. The CTDO is an OM-87 = Oceanolographic Measuring System, consisting of an expandable dividing CTDO-probe, interfaced through a special designed slave-computer, a meteorological subsystem interfaced by a second slave-computer and a master-PC. The IfMW began to develop oceanographic measuring systems in the 60s. The first computer controlled CTD-system, OM-75 (MOECKEL 1980) was taken into service in 1976. The new generation: OM-87 has been 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 4: CTDO Sensor Configuration List

CTD NO.	Stat. No.	parameter	sensor	resolution	precision
2	128-177	pressure	p600	0.2 dbar	5 dbar
3	178-235	pressure	p082	0.14 dbar	2 dbar
2	128-177	temperature	T103	0.0015 K	0.01 K
3	178-235	temperature	T124	0.0015 K	0.01 K
2	128-177	conductivity	C884	0.0008mS/cm	
3	178-235	conductivity	C857	0.0008mS/cm	
2	128-177	oxygen	0024	damaged	
3	178-235	oxygen	0023	0.01 ml/l	0.1 ml/l
2	128-159	sound speed	V218	0.025 m/s	0.3 m/s
2	160	sound speed	V218	damaged	
2	161-168	sound speed	V111	0.025 m/s	0.3 m/s
2	169	sound speed	V111	damaged	
2	170-177	sound speed	V212	0.025 m/s	0.3 m/s
3	178-180	sound speed	V210	0.025 m/s	0.3 m/s
3	181-235	sound speed	V218	0.025 m/s	0.3 m/s

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 oxygen sensors were used over the whole cruise. The check measurements of CTDO and water sample data (in situ comparisons) were used for calculating the post-cruise corrections.

Post-Cruise Data Processing

The raw data are digitized frequencies, which had been converted to physical units of pressure, temperature, conductivity, oxygen and sound speed.

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 sensor integration time and lowering rate reduced the effect of different time lags of the sensors to minor importance.

The calculation of salinity from conductivity and conversion of dissolved oxygen from volumetric to weight concentration were done last after correcting the data as described below. Dissolved oxygen was converted according to WOCE O.M. (1991).

The data have not been averaged finally in 2 dbar increments because of the low sampling rate of the CTD and a great amount of discarded records 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 fits were applied to CTDO:

Table 5:

00CTDO	Stat. No.	Sensor	Fitting Param.	Fitting Polynoms
		Pressure	Linear fit	Pres(fitted)=A0+A1*PRES
			A0	A1
128	130	P600	-13.5	1.0
131	160	P600	-1.43	1.01821
161	169	P600	13.74	1.02355
170	177	P600	-1.87	1.02233
178	235	P082	-0.7	1.0
		Temp.	Linear Fit	Temp(fitted)=A0+A1*TEMP
			A0	A1
128	177	T103	0.02373	0.990516
		Temp	Time depended Correction	
			Temp(corr)=Temp+A0+A1*Time	
Time/hours=Beginning time of cast (in continuously counted hours of the year: January 1: 0 o'clock: Time=0 hours)				
			A0	A1
178	253	T124	-1.47842	2.45E-4
		Conductivity	Linear fit	Cond(fitted)=A0+A1*cond
			A0	A1
128	177	C884	4.009E-2	0.991363
178	235	C857	0.1816	0.993873
		Oxygen	Data discarded	
128	177	o024		
		Oxygen	linear fit	OXYG(fitted)=A0+A1*Oxyg
		(ml/l)	A0	A1
178	235	0023	0.0	0.133876
		Oxygen	Pressure correction	
			Oxyg(corr)=Oxyg(fitted)+A0+A1*Press	
178	235	o023	-0.525	6.89E-4
		Sound speed	No fit	
128	235	all used sensors		

All sensors were precalibrated at the calibration laboratory of IOW. Each oxygen sensor was recalibrated with water samples during the cruise at the first station when it was taken in use. The calibration constants of all sensors were checked up by in situ comparisons of p, T, C, O2.

C.1.e Errors and Noise

During the cruise located faulty sensors were replaced as listed above in the CTD sensor configuration list.

After the cruise following sensor failures were detected and the data were discarded: Oxygen from station 128-177

C.2 Water Sampling for In Situ Comparisons

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 (3 dissolved oxygen and 3 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 6.

Table 6:

	average differences between samples	max diff of all differences	std. dev
salinity	0.0012 psu	0.014 psu	0.0023
oxygen	0.023 ml/l	0.1 ml/l	0.0153

C.2.f Laboratory and Sample Temperatures

The laboratory was temperature controlled : 24...26 deg C. the bath temperature of the Autosal salinometer was set to 27 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 ebc5.sum, ebc5.hyd, ebc5.csl and *.wct files. The ebc5.sum file contains a summary of the location, time, type of parameters sampled, and other pertient information regarding each hydrographic station. The ebc5.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 ebc5.wct.zip. The ebc5.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