I. Cruise Report

A.Cruise Narrative

A.1 Highlights

Expedition Designation

A.v.Humboldt Cruise 991

Chief Scientist

Leg 1-4: Eberhard Hagen, IfMW

Abbrevations:
IfMW: Institut fuer Meereskunde Warnemuende, Germany (until 31.12.1991)

on January 1, 1992 renamed after:
IOW: Institut fuer Ostseeforschung Warnemuende

Ship

R/V A.V.Humboldt

Ports of Call

Leg 1: Rostock, Germany to Lisboa, Portugal
Leg 2: Lisboa to Casablanca, Marocco
Leg 3: Casablanca to Lisboa
Leg 4: Lisboa to Rostock

Cruise Dates

Leg 1: August 20 to August 30, 1991
Leg 2: September 2 to September 13, 1991
Leg 3: September 17 to October 15, 1991
Leg 4: October 18 to October 25, 1991

A.2 Cruise Summary

Cruise summary report and station locations - see annexed paper.
Station maps also on floppy:
\AvHumbol.991\map1.bmp
\map2.bmp(mesoscale)

Measurements

During the cruise a total of 196 CTD/rosette stations were

occupied using a CTDO equipped with a rosette of 12*2.7 l teflon-type water sampling bottles.

.CTDO and sound speed;
.salinity and oxygen of water samples;
.temperature and pressure by reverse deep sea thermometers
.air-pressure,-temperature,-humidity up to an attitude of about 30 km by radiosondes: 56 starts
.stepwise current meter profiling (0-500m) using 6 PS navigation system : 58 stations
.temperature/salinity in 2 m depth between stations continuously : 54 days
.skin-SST by means of Heiman KT4 radiometer (10-12 *10**-6m): 54 days
.meteorological standard parameters : 54 days
.pyranometer : 54 days

A.3 Principal Investigators

E. Hagen	CTDO,S,O2, Current Profiles	IfMW
R.Feistel	SST	IfMW
E.Mittelstaedt	Currents	BSH

A.4 Preliminary Results

are described in annexed paper: Wissenschaftlich-technischer Fahrtbericht...

A.5 Major Problems

The CTD data of station 252-253 were disturbed and have been discarded.

At station 276 the OM-87 probe No 1 was lost during the up cast when the cable teared.
From station 277 to 434 the OM-87 probe No 2 was used.

A.7 List of Cruise Participants

Name	Responsibility	Affiliation
Leg 1 - 4		
Eberhard Hagen	Chief Scientist radiosondes starts	IfMW

Stefan Weinreben	CTD-Software	IfMW
Henry Will	CTD Hardware	
	Current Profiling	IfMW
Rainer Feistel	Skin-Bulk-SST	IfMW
Christoph Zuelicke	Skin-Bulk-SST	HUB
Guenter Plueschke	Salts, CTD Winch	IfMW
Wolfgang Hub	Oxygen, CTD Winch	IfMW
Dieter Fritsch	Precision Mechanics	IfMW
Leg 1 - 2		
Holger Klein	Moorings	BSH
Holger Giese	Moorings	BSH
Leg 4		
Guido Schmuck	Skin-Bulk-SST	IRSA

Abbreviations:

HUB: Humboldt Universitaet Berlin, Germany.
BSH: Bundesamt fuer Seeschiffahrt und Meteorologie, Hamburg, Germany.
IRSA:(Joint Research Centre) Institut for Remote Sensing Applications, Marine Enviroment, Ispra, Italia.

B. Measurement Techniques and Calibrations

B.1 CTDO

B.1.a Equipment and Techniques

During the cruise two CDTO probes (No1 and No2) 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 = Oceanological 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 develope oceanological measuring systems in the 60th. 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.

CTD - Sensor Configuration List

CTD No/ Stat.No.	parameter	sensor	resolution	precision

1/ 240-276	pressure	P251	0.1 dbar	2 dbar
2/ 277-311		P600	0.2 dbar	5 dbar
2/ 312-342		P252	0.1 dbar	2 dbar
2/ 343-434		P601	0.2 dbar	5 dbar
1/ 240-276	temperature	T102	0.0015 K	0.01 K
2/ 277-434		T106	0.0015 K	0.01 K
1/ 240-251	conductivity	C854	0.0008mS/cm	
1/ 254-276		C858	0.0008mS/cm	
2/ 277-311		C854		
2/ 312-434		C884	0.0008mS/cm	
1/ 240-276	oxygen	O022	0.01 ml/l	0.1ml/l
2/ 277-295		O027 demaged		
2/ 312-325		O023 demaged		
1/ 240-276	sound speed	V216	0.025 m/s	0.3m/s
2/ 277-279		V217	0.025 m/s	0.3m/s
2/ 280-311		V217 demaged		

B.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 :1 s
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 mesurements of CTDO and water sample data (in situ comparisions)were used for calculating the post-cruise corrections.

Post-Cruise CTD 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 eleminate:
- data values, which are not physically realizable
- random errors by recursive low-pass filtering(ACHESON 1975)
- systematic errors: caused by the effect of ship's rolling and pitching on the lowering rate of CTD. Records aquired while CTD is moving down too slowly have been discarded to enforce a strict monotonic sequence in pressure.

The so called eddy-algorithm in connected view with the values of sensor integration time and lowering rate reduse the effect of different time lags of the sensors to minor importance.

The calculation of salinity from conductivity and convertion 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:

CTDO-Stat.No.	Sensor	Fitting Param.		Fitting Polynoms
	pressure: linear fit:			$PRES_{fitted}$=A0+A1*PRES
		A0	A1	
240-251	P251	3.8	1.006	
254-276	P251	3.8	1.006	
	pressure: data discarded			
252-253	P251			
	pressure: temperature correction			$PRES_{corr.}$=PRES+A0+A1*TEMP
		A0	A1	
277-311	P600	-36.2	1.38	
	pressure: linear fit:			$PRES_{fitted}$=A0+A1*PRES
		A0	A1	
312-342	P252	1.41	1.019	
343-434	P601	30.44	0.96943	

CTDO-Stat.No.	Sensor	Fitting Param.		Fitting Polynoms
	temperature: no fit ; sensor measured data were of higher quality than the			
240-251	T102			thermometer data
254-276	T102			
277-434	T106			
	temperature: data discarded			
252-253	T102			
	conductivity: pressure correction:			$COND_{corr.}$=COND+A0+A1*PRES
		A0	A1	
240-251	C854	-7.315E-2	7.409864E-5	
	conductivity: data discarded			
252-253	C853			

conductivity: time dependend correction
$COND_{corr.}$=COND+A0+A1*TIME
TIME/hours=Beginning time of cast(in continuously caunted hours of the year: January 1; 0 o'clock: TIME=0 hours)

		A0	A1
254-268	C858	13.03789	-2.20388E-2
269-276	C858	-1.30243	2.178216E-4

conductivity: quadratic fit:
$COND_{fitted}$=A0+A1*COND+A2*COND**2

		A0	A1	A2
277-311	C854	1.8108	0.921699	8.507983E-4

conductivity: time dependend correction
$COND_{corr.}$=COND+A0+A1*TIME
TIME/hours=Beginning time of cast(in continuously caunted hours of the year: January 1; 0 o'clock: TIME=0 hours)

		A0	A1
312-339	C884	9.41769	-1.496255E-3
340-350	C884	-42.25939	6.661E-3
351-381	C884	1.72513	-2.265E-4
382-426	C884	-2.18171	3.68E-4
427-434	C884	-1.410598	2.52E-4

oxygen: linear fit: $OXYG_{fitted}$=A0+A1*OXYG

	(ml/l) A0	A1
240-251	O022	0.654	0.9744

oxygen: pressure correction
$OXYG_{corr.}$=$OXYG_{fitted}$+A0+A1*PRES

	(ml/l) A0	A1
254-276	O022	0.694	1.3549E-4

CTDO-Stat.No.	Sensor	Fitting Param.	Fitting Polynoms
	oxygen: data discarded		
252-253	O022		
277-295	O027		
312-325	O023		
	sound speed: no fit		
240-251	V216		
254-276	V216		
277-279	V116		
	sound speed: data discarded		
252-253	V216		
280-311	V217		

B.1.c Calibration

All sensors were precalibrated at the calibration laboratory of IfMW.

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 comparisions of p, T, C, O2.

B.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 277-434
sound speed	from station 280 311

B.2 Water Sampling for In Situ Comparisions

B.2.a,b Techniques and sampling procedures

After finishing the down cast (CTDO-recording),the CTD was liftet 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 CTDO data.

Salinity

The water sample salinities 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 111. Differences in standardization readings were less than 3.

The salinometer manufacturer claims a precision of 0.0002 and an accuracy of better than 0.003;better than 0.001 when the laboratory temperature is constant (+-1 K) and about 1-2 K below the bath temperature of the salinometer.

Oxygen

The dissoloved oxygen samples were analysed by the Winkler Titration Method modificated by CARRITT and CARPENTER (1966).

Temperature (reverse thermometers)

The following reverse thermometers were used:

manufactured by: VEB Thermometerwerk Geraberg,Germany

	scale	graduated in
pressure protected	-2...+30degC	0.1K
unprotected	-2...+30degC	0.1K

Duplicate Water Samples

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

	average differenz between samples	maximum diff.	standard deviation of all differences
salinity	0.0015 PSU	0.009 PSU	0.0018
oxygen	0.011 ml/l	0.03 ml/l	0.0189

B.2.f Laboratory and Sample Temperatures

The laboratory was temperature controlled :24...26 degC.
The bath temperature of the Autosal salinometer was set to 27 degC.
Salinity and oxygen samples had been tempered at room temperature when measured.

B.2.i Standards used

I.A.P.S.O Standard Seawater ,Batch P111 , 7.2.89
During the cruise this batch was used only.

C. References

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