

30 December 2004

Cruise Summary Report

Ship: **FS METEOR**

Dates: **16 February – 6 March 2004**

Port Calls: **Fort-de-France – Fort-de-France, Martinique, France**

Institute: IFM-GEOMAR
*Leibniz Institute of Marine Sciences
at the University of Kiel*

Number of Scientists: 17

Chief Scientist Officer: Uwe Send

Principal Project: Contribution to the national German CLIVAR programme

Support: *Bundesministerium für Bildung und Forschung, Berlin*

Research area: Tropical Atlantic
– off Antilles Arc, Guiana Basin,
Researcher Rise, Middle Atlantic Ridge

Scientific Team

		Function
1. Send, Uwe, Prof. Dr.	IfMK	Chief scientist
2. Avsic, Tom	IfMK	Tomo/RAFOS sources
3. Begler, Christian	IfMK	Tomography, mooring work
4. Busack, Michael	IfMK	Telemetry
5. Kanzow, Torsten, Dr.	IfMK	Evaluation
6. Karstensen, Johannes, Dr.	IfMK	Evaluation
7. Koy, Uwe	IfMK	CTD, ADCP
8. Lankhorst, Matthias	IfMK	CTD, mooring work
9. Link, Rudolf	IfMK	Tomography, mooring work
10. Neumann, Uta	IfMK	Student helper
11. Niehus, Gerd	IfMK	Mooring work
12. Pinck, Andreas	IfMK	CTD, Telemetry
13. Scharffenberg, Martin	IfMK	Student helper
14. Bailey, John	WHOI	Research specialist
15. Möller, Helmut	SIO/WHOI	Research specialist
16. Morozov, Andrey K.	WRC	Research specialist
17. Ochsenhirt, Wolf-Thilo	DWD	Meteorological observations

Abbreviations: DWD - Deutscher Wetterdienst, Hamburg
 IfMK – Leibniz-Institut für Meereswissenschaften, Kiel
 SIO – Scripps Institution of Oceanography, La Jolla, CA, USA
 WHOI – Woods Hole Oceanographic Institution, Woods Hole, MA, USA
 WRC – Webb Research Corporation, East Falmouth, MA, USA

1 Research Program

The fourth leg of METEOR cruise 60 served a project called MOVE (Meridional Overturning Variability Experiment) which started in January 2000. The long-term observations of fluctuations in the thermohaline circulation of the western Atlantic Ocean were to be continued on a routine base. The array is situated on a zonal section along 16° N between the Antilles Arc in the west and the outskirts of the Middle Atlantic Ridge in the east. Last time the array was exchanged from FS SONNE in June 2003. It comprises moored instruments for recording currents, density, bottom pressure and acoustic tomography signals.

It is our long-term goal to observe interannual fluctuations of the thermohaline circulation with integral methods. Results will be inter-compared with boundary conditions at higher latitudes. Field observations in the tropical / subtropical North Atlantic Ocean in the frame of the German climate variability (CLIVAR) project B1-4 are accompanied by modelling studies of the structure and the variability of the current system and its relation to atmospheric forcing (<http://www.awi-bremerhaven.de/Research/IntCoop/Oce/clivar/projects/projects-index.html>). In co-operation with American agencies calibration works for GRACE (Gravity Recovery and Climate Experiment) was planned with high precision bottom pressure recorders. The latter will provide monthly estimates of the earth's gravity field with extraordinary precision.

The prime objective of the cruise leg contained extended maintenance at the mooring sites along 16° N and an extension of the bottom pressure array perpendicular to the section. In addition the re-occupation of this section was conducted to measure the hydrographic stratification and the instantaneous structure of horizontal currents.

2 Narrative of the Cruise

FS METEOR left Fort-de-France (Martinique) on 16 February 2004 at 10:30 LT and sailed in northward direction towards the first working area off Guadeloupe, which was reached about 12 hours later. In the following two days four moorings (M3,M3.5,M4,M5), a moored echo sounder (PIES- near M3) and three transponders (near M3.5) were recovered successfully. The SIO bottom pressure sensor near M3 could not be located though. It turned out that the tomography sound source (M3.5) had not worked at all due to a broken battery wire. A first CTD/LADCP cast was taken. After repairs M3.5 was re-deployed as well as a SIO bottom pressure sensor. After completion of the work on 19 February at 2:00 LT in this area FS METEOR moved eastward most of that day towards position M2.

Here a SIO bottom pressure sensor was deployed and the second CTD cast was taken. No acoustic contact could be established with the PIES near M2. Nonetheless, the release command was sent but despite an intense search the instrument could not be located at any time. Three transponders were recovered. During the recovery of mooring M2 the ship drifted over the wire with glass spheres, which got stuck in the propeller. It could not be freed by pulling and after a visual inspection (from a Zodiac) had revealed that the wire was not wrapped around the propeller but was just loosely caught, it got free by itself. The Zodiac crew managed to get hold of the drifting spheres just before dark and re-attached the mooring to the ship. The mooring recovery was thus continued without loss of any instruments. Finally a PIES was deployed near the nominal position of M2.

In the following FS METEOR headed eastward and reached the position of the PIES near M1 on 22 February at 4:00 LT. Data from that PIES were dumped via acoustic telemetry. During the subsequent recovery of mooring M1 the telemetry wire was found cut 20 m below the fishing floats nominally at 40 m and most of those floats plus the 40 m MicroCAT (moored CTD recorder) missing, but the loose telemetry wire above was braided to the remaining wire above subsurface float and thus was held in place. The M1 SIO bottom pressure sensor was successfully recovered and in the following the tomography receiver was lowered from the vessel to 1000 m to try to receive acoustic signals from the sound source 1000 km away at M3.5 without success, even though noise sources had been suppressed on ship by shutting down / reducing generators, compressors, hydraulics,

bowthruster and propeller. CTD casts 3-7 were taken in this area with MicroCATs and MTD logger attached to carry out *in situ* calibration of these devices. A SIO bottom pressure sensor and a PIES were deployed. The PIES whose data had been transferred acoustically could be recovered. This was necessary to install an updated firmware. After a successful test of the telemetry of mooring M1 with the MicroCATs lying on deck, that mooring was deployed on 24 February. Soon afterwards first ARGOS transmissions from all MicroCATs even down to 4000 m could be received. Thus, all electric links including the electrically conducting swivels were obviously working.

After that FS METEOR headed west again and a PIES (M1.5) was deployed half way between M1 and M2 on Feb. 25. Subsequently METEOR sailed on a northwestward track to occupy the northern point of the bottom pressure sensor cross (M6). Here a PIES and a SIO bottom pressure sensor were deployed and CTD casts 8-9 with MicroCATs and MTD loggers attached were taken on 26 February. The next day was spent sailing southward towards M2. Two days later the tomography source was lowered from the vessel near M2 to receive signals from the M3.5 sound source roughly 400 km away. All the vessel's sources of noise were shut down completely. This time the signals from M3.5 were received successfully. In the following, mooring M2 (including MicroCATs as well as the tomography receiver) and three tomography transponders were deployed. CTD cast 10 (without MicroCATs attached) was taken.

Upon heading southward to cover the southern positions of the GRACE bottom pressure cross, it was discovered soon that the essential positions of M7 and M7.5 under the track of the GRACE satellites were located in the exclusive economic zone (EEZ) of Barbados and that the diplomatic clearance had not been requested in due time. So it was decided to carry out mooring works in the west (M3) first and at the same time try to obtain diplomatic clearance for M7 and M7.5 from the Bajan authorities.

In the afternoon of 29 February at 30 km from sound source mooring M3.5, the work boat was deployed to lower a newly built listening device to 1000 m at sufficient distance from METEOR, which moved away 5 nm. Signals from the sound source were successfully received. Since the navigator device needed some reprogramming the sound source mooring M3.5 was recovered again. Subsequently the final CTD cast 11 (with MicroCATs) was

taken. The next day (March 1) the POL bottom pressure recorder (near nominal position of M3) was recovered successfully and the MicroCAT mooring M3 was re-deployed. Short time afterwards ARGOS signals from the five MicroCATs in the inductive loop were also received. Data from the tomographic test receptions in 30 km were analysed and the sound source was diagnosed. At night decision was taken to deploy the source and test/prepare two mooring navigators for this purpose. After successful tests with the fully assembled sound source, the current meter mooring M4 was deployed (including the sound source) plus three transponders. Afterwards the sound source transmissions could be received successfully at a distance of 0.5 nm from the mooring.

After a transponder survey METEOR started to steam southeastward towards the positions of M7 and M7.5 with no diplomatic clearance yet obtained. On 3 March at 360 km distance from M4, sound source transmissions were received clearly by a freely floating receiver. At 4 March the diplomatic clearance was issued by the foreign ministry of Barbados in the afternoon. M7 was reached several hours later where a PIES and a SIO bottom pressure sensor were deployed. After deploying the last SIO bottom pressure sensor at M7.5 (between M7 and M2) at noon, FS METEOR started to head back eastward to Fort-de-France which was reached one day later.

Throughout the whole cruise thermosalinograph data were acquired for transmission to the CORIOLIS data centre in Brest, France. In summary, the cruise can be regarded as very successful. The losses of one PIES and one SIO bottom pressure sensor will not affect the overall performance of the ongoing MOVE experiment.

3 Acknowledgements

The chief scientist and his team would like to thank *Kapitän M. Kull* and his crew for the excellent co-operation on board. Financial support came from the *Bundesministerium für Bildung und Forschung* in Berlin. This cruise was a German contribution to the international climate variability and predictability (CLIVAR) programme of the World Meteorological Organisation (WMO). In Germany it is co-ordinated by E. Fahrback from the *Alfred-Wegener-Institut* in Bremerhaven. The expeditious handling of the diplomatic clearance by the authorities of Barbados is especially appreciated.

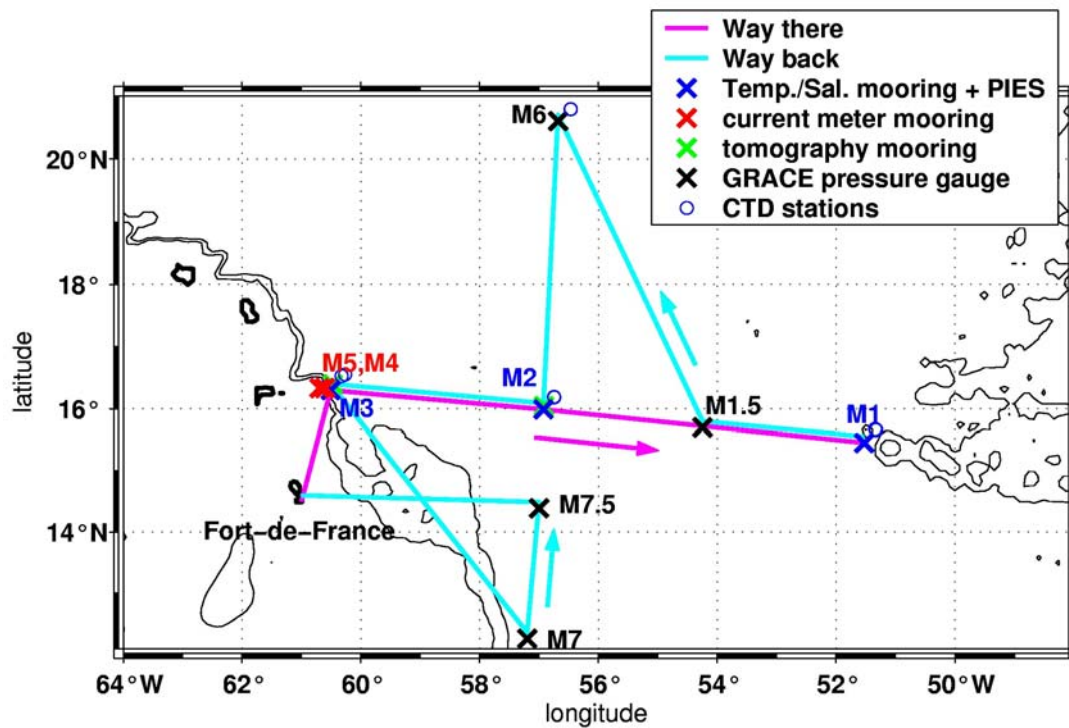


Figure 1: Track chart of METEOR cruise 60/4 between Fort-de-France and Fort-de-France 16 February – 6 March 2004.

Abbreviations: PIES – Inverted echo sounder with pressure sensor
 GRACE – Gravity Recovery and Climate Experiment

Appendix:

Table 1: Mooring activities

Mooring	Deployment	Latitude (N)	Longitude (W)	Water Depth (m)	Date set DD/MM/20YY	Date recovered
M1 ↑	2003-2004	15° 27.00'	51° 31.50'	4984	23/06/03	22/02/04
M1 ↓	2004-2005	15° 27.00'	51° 31.30'	4970	24/02/04	--
M2 ↑	2002-2003	15° 59.20'	56° 55.60'	4985	25/06/03	20/02/04
M2 ↓	2002-2005	15° 59.05'	56° 55.50'	4985	28/02/04	--
M3 ↑	2003-2004	16° 20.30'	60° 30.30'	4960	27/06/03	18/02/04
M3 ↓	2004-2005	16° 20.34'	60° 30.51'	4929	01/03/04	--
M3.5 ↑	2003-2004	16° 20.20'	60° 32.80'	4100	30/06/03	17/02/04
M3.5 ↑↓	2004-2004	16° 20.15'	60° 32.80'	4080	19/02/04	29/02/04
M4 ↑	2003-2004	16° 20.00'	60° 36.45'	3010	27/06/03	17/02/04
M4 ↓	2004-2005	16° 20.01'	60° 36.51'	3010	02/03/04	--
M5 ↑	2003-2004	16° 20.01'	60° 41.75'	1600	28/06/03	17/02/04

Table 2: PIES and bottom pressure sensors

Mooring (code)	Instrument	Latitude (N)	Longitude (W)	Water Depth (m)	Date set DD/MM/20YY	Date recovered
M1 (V404_4)	PIES #057	15° 27.75'	51° 31.90'	4980	19/06/03	23/02/04
M1 (V404_4)	SIO-BPR #03	15° 28.00'	51° 31.60'		22/06/03	22/02/04
M1 (V404_5)	PIES #127	15° 27.01'	51° 31.60'	4965	23/02/04	--
M1 (V404_5)	SIO-BPR #03	15° 27.98'	51° 31.57'		22/02/04	--
M1.5	PIES #012	15° 43.10'	54° 13.50'	5450	25/02/04	--
M2 (V405_4)	PIES #002	15° 59.40'	56° 55.31'	4999	26/06/03	failed
M2 (V405_5)	PIES #123	15° 59.19'	56° 56.59'	5000	21/02/04	--
M2 (V405_5)	SIO-BPR #01	16° 00.17'	56° 56.53'		20/02/04	--
M3 (V406_4)	PIES #012	16° 20.51'	60° 29.30'	5000	26/06/03	18/02/04
M3 (V406_5)	PIES #165	16° 21.30'	60° 29.25'	5000	17/02/04	--
M3 (V406_4)	SIO-BPR #12	16° 21.32'	60° 30.30'		16/06/03	failed
M3 (V406_5)	SIO-BPR #04	16° 21.43'	60° 30.39'		18/02/04	--
M3 (V406_4)	POL-BPR	16° 22.29'	60° 30.32'	4903	28/06/03	01/03/04
M6	PIES #128	20° 36.51'	56° 40.78'	5093	26/02/04	--
M6	SIO-BPR #10	20° 36.00'	56° 40.78'		26/02/04	--
M7	PIES #057	12° 15.03'	57° 12.04'	4451	05/03/04	--
M7	SIO-BPR #02	12° 15.58'	57° 11.99'		05/03/04	--
M7.5	SIO-BPR #07	14° 23.41'	56° 59.41'		05/03/04	--

Abbreviations: PIES Pressure sensor with Inverted Echo Sounder
SIO Scripps Institution of Oceanography
POL Proudman Oceanographic Laboratory
BPR Bottom Pressure Recorder

Table 3: CTD stations

Station	Cast	Start Date	Time (UTC)	Start Position Latitude (N)	Start Position Longitude (W)	Max.Press. (dbar)
99	1	18-Feb-2004	01:26	16° 19.84'	60° 31.43'	4879
107	2	20-Feb-2004	03:24	15° 58.87'	56° 56.64'	5050
119	3	22-Feb-2004	19:45	15° 28.48'	51° 32.46'	5050
121	4	23-Feb-2004	12:03	15° 27.54'	51° 31.87'	5041
125	5	23-Feb-2004	21:15	15° 27.88'	51° 31.85'	3503
126	6	24-Feb-2004	02:20	15° 27.60'	51° 31.44'	990
127	7	24-Feb-2004	04:20	15° 27.45'	51° 31.49'	5045
132	8	26-Feb-2004	18:39	20° 35.23'	56° 40.14'	5460
132	9	27-Feb-2004	00:19	20° 35.33'	56° 39.95'	4005
140	10	28-Feb-2004	19:05	15° 59.38'	56° 56.89'	5050
143	11	01-Mar-2004	00:14	16° 21.18'	60° 27.82'	5171