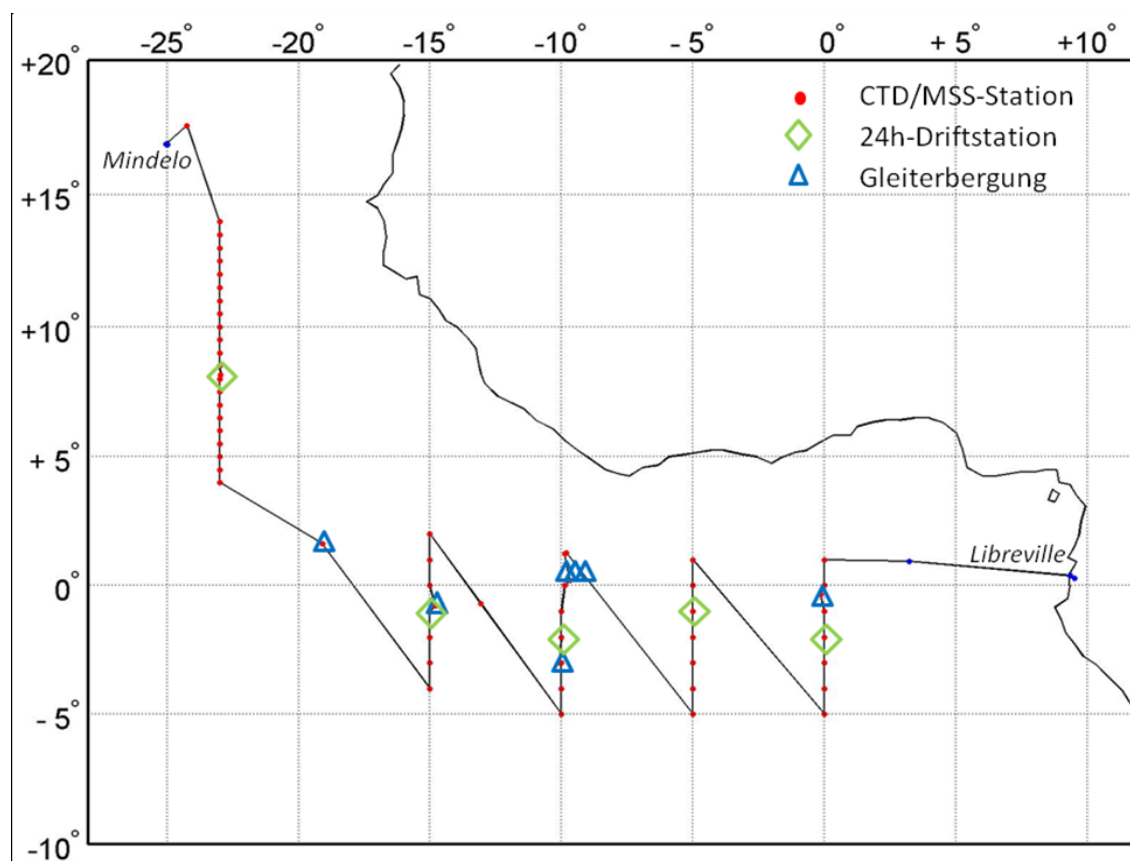


Prof. Dr. Arne Körtzinger  
Leibniz-Institut für Meereswissenschaften  
Chemische Ozeanographie  
Düsternbrooker Weg 20  
24105 Kiel

Tel.: +49-431-600-4205  
Fax: +49-431-600-4202  
email: [akoertzinger@t-online.de](mailto:akoertzinger@t-online.de)

## Short Cruise Report RV MARIA S. MERIAN Cruise MSM18-3

Mindelo – Libreville  
22 June – 21 July 2011  
Chief Scientist: Arne Körtzinger  
Captain: Ralf Schmidt



Ship track of RV Maria S. Merian cruise MSM18-3 with locations of hydrographic stations.

## Objectives

Cruise MSM 18/3 to the subtropical and equatorial Atlantic was a joint activity of the Kiel Collaborative Research Centre SFB 754 (Climate-Biogeochemistry Interactions in the Tropical Ocean) and the collaborative BMBF projects SOPRAN II (Surface Ocean Processes in the Anthropocene) and NORDATLANTIK.

For the Kiel SFB 754 ([www.sfb754.de](http://www.sfb754.de)), this cruise represented the final Atlantic field campaign within the first funding period 2008-2011. The main goals of SFB 754 for this cruise were:

- Occupation of the meridional 23°W section which has been defined as the standard section for detection of temporal variability scales and trends of the oxygen inventory;
- Recovery of seven gliders from previous cruise leg MSM 18/2 which were deployed as a joint activity of SFB 754 and the BMBF project NORDATLANTIK.

In the BMBF project SOPRAN II ([sopran.pangaea.de](http://sopran.pangaea.de)), the regional field work focus in the Atlantic is primarily placed on the equatorial upwelling. The cruise MSM 18/3, which represents the central (and only major) Atlantic field activity of the second phase, featured the following scientific projects:

- The contribution of physical processes to the emissions of trace gases in upwelling areas of the equatorial Atlantic Ocean: A N<sub>2</sub>O case study;
- Combined CO<sub>2</sub> and O<sub>2</sub> dynamics and air-sea fluxes, with additional emphasis on diel cycles;
- Influence of Saharan dust on phytoplankton productivity and N<sub>2</sub> fixation;
- Influence of near-surface processes on the production of "Oxygenated Volatile Organic Compounds" (OVOC) and dimethylsulfide (DMS);
- Production and air-sea fluxes of organic iodine and bromine compounds (VHOC);
- Aerosol-ocean interaction: import of dust into the ocean and export of organic matter from the ocean;
- Quantification of upwelling rates by helium disequilibrium;
- Quantitative investigation of marine halogen sources.

## Narrative

All 21 scientists embarked on R/V Maria S. Merian in the morning of June 21 and without much ado started unpacking the containers and setting up their instruments in the various laboratories. This process was essentially finished in the late afternoon of June 22 when the vessel sailed from Mindelo for the third leg of its 18<sup>th</sup> voyage.

Just over 5 h after departure the first station, the Cape Verde Ocean Observatory at 17°35.37'N and 24°14.65'W, was already reached and a full depth CTD cast and microstructure profiles were taken. The Cape Verde Ocean Observatory is a joint project between the IFM-GEOMAR and its partner institute Instituto Nacional de Desenvolvimento das Pescas (INDP) based in Mindelo, Cape Verde.

The first major component of the work plan of MSM 18/3 was a re-occupation of the 23°W hydrographic section which has been defined as the SFB 754 standard section for detection of temporal variability scales and trends of the oxygen inventory. Hydrographic casts with a CTD-rosette system of IFM-GEOMAR were carried out down to a maximum depth of 1300 m followed by three profiles down to a target depth of 500 m with the freefalling microstructure profiler. The 23°W section was sampled at ½° spacing from 14°N to 4°N thereby overlapping at three stations (4°N, 4°30'N, 5°N) with the southward continuation of the section which had been occupied during cruise leg MSM 18/2. This overlap will assure full data consistency among these two cruises which had been designed from the beginning as counterpart legs serving the same research projects. At 8°N, the Lagrangian surface drifter with sensor package (T, S, pCO<sub>2</sub>, O<sub>2</sub>, chlorophyll, nitrate, gas tension) was deployed for the first time and a 24h drift station was carried at the drifter. The station work along 23°W started just before midnight on June 23 and was finished in the morning of June 29.

During the short transit from the southern end of the 23°W section to the first meridional section in the equatorial cold tongue region, the first out of seven gliders of IFM-GEOMAR's glider swarm experiment was successfully recovered on June 30 at 1°35'N and 19°5'W.

On July 1 shortly before midnight, the first of four meridional sections (15°W, 10°W, 5°W and 0°) across the equatorial cold tongue was started at 4°S, 15°W. These sections represent the second major component of the work program and consisted of standard CTD-rosette casts down to 700 m followed again by three microstructure profiles down to a maximum of 500 m. On several occasions, additional shallow CTD-rosette casts from the surface or the depth of the deep chlorophyll maximum were taken to provide the high sample volume required by the biological group. Also a number of trace metal clean GO-FLO casts were taken from the upper 30 m with the ship's Kevlar rope. The station work on these four sections ended on July 19 which also concluded the work program of the cruise after a total of just under 250 h of station time.

During the work in the equatorial cold tongue six more gliders (5 from IFM-GEOMAR and 1 from INSU/France) were successfully recovered. Also four additional 24h drift stations were carried out, the first one of which had to be finished prematurely because the detection of a leak in the surface drift element which provides the entire buoyancy for the drifter. This leakage was then sealed and the drifter worked very reliably during the following deployments. A 24h drift station would typically consist of one deep (700 m) and six shallow (100 m) CTD-rosette casts at 4-hour intervals always followed by three microstructure profiles. Slight modifications were made to this schedule on a few

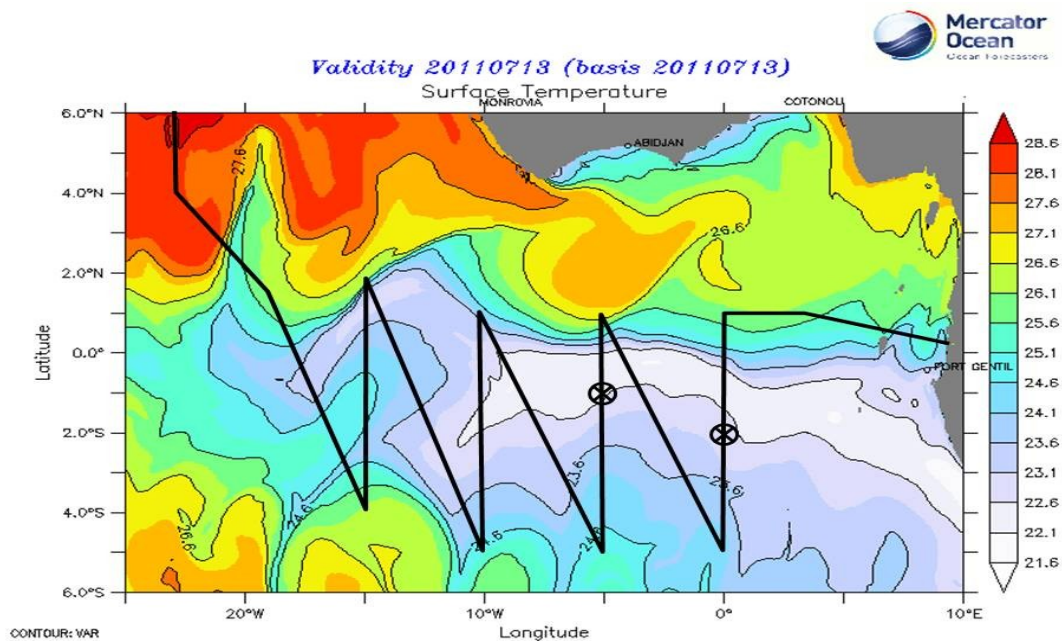
occasions.

During the entire cruise a whole suite of continuous underway measurements as well as discrete underway sampling were carried out. The water flow was provided by means of a submersible pump installed in the port side moon pool of the vessel. A small CTD sensor was installed next to the water intake for measurement of in situ temperature and salinity. The continuous flow of water was provided to two separate gas equilibrator system as well as two insulated flow-through sensor containers. Underway measurements were carried out between June 22 and July 19. Between the meridional sections, the cruise track was modified with respect to the original plans to allow for better spatial coverage of the equatorial cold tongue by the underway measurements. This turned out to be very useful as a total of 8 north-south transects were accomplished.

Further continuous operations included the vessel-mounted 37.5 kHz and 75 kHz ADCPs, two aerosol impactors, pyranometer, pyrgeometer, an automatic full-sky imaging system, a MAX-DOAS system for atmospheric trace gases, light sensors installed above the bow etc. all of which were essentially operated throughout the entire cruise. Full account of all measurement taken will be given in the final cruise report.

Furthermore, a total of six SOLO-type profiling floats of the Woods Hole Oceanographic Institution (WHOI) were deployed during the cruise.

R/V Maria S. Merian reached Libreville/Gabon in the early morning of July 21. Despite very early planning and contact to the authorities by the master of the vessel the requested berth place was not available on the first 2 days. This required disembarkation and embarkation to be carried out with shuttle boats. It also turned out that refueling was not possible in Libreville so that at sea bunker service will have to be ordered during the following cruise leg.



*Example of the cold tongue in the equatorial Atlantic on 13 July 2011 with the location of the 24h Langrangian drift experiments #4 and #5. The SST field forecast was provided by the Mercator operational oceanography product.*

## **Acknowledgements**

The skillful and competent cooperation with the entire crew of R/V Maria S. Merian is highly appreciated. We are grateful for the great service and the friendly and relaxed work atmosphere provided. Also the scientific party of cruise MSM 18/3 is to be applauded for very concentrated and dedicated work throughout the cruise. Together crew and scientific party made it possible that the scientific program clearly exceeded the 100% mark of the cruise plan.

Furthermore, I would like to thank Dr. Tilman Dinter from AWI for providing composite satellite chlorophyll images of the cold tongue bloom for guidance while the cruise was underway. Also the reliable service provided by MERCATOR operational oceanography program is acknowledged. The quality of the short-term forecasts was found to be very high.

## Cruise Participants

1. Körtzinger, Arne	Chief Scientist	IFM-GEOMAR
2. Baustian, Tina	Nitrogen fixation, bioassays	IFM-GEOMAR
3. Behnke, Jörg	Nitrogen fixation, bioassays	IFM-GEOMAR
4. Fessler, Sebastian	CO <sub>2</sub> chemistry	IFM-GEOMAR
5. Fiedler, Björn	CO <sub>2</sub> chemistry	IFM-GEOMAR
6. Fischer, Tim	CTD, microstructure	IFM-GEOMAR
7. Halm, Hannah	Nitrogen fixation, bioassays	IFM-GEOMAR
8. Hepach, Helmke	Volatile halogenated organic compounds	IFM-GEOMAR
9. Krumbholz, Marita	Nitrous oxide, nutrients, oxygen	IFM-GEOMAR
10. Lampel, Johannes	Max-DOAS measurements	IUP-HD
11. Link, Rudolf	CTD, microstructure	IFM-GEOMAR
12. Lohmann, Martina	Nutrients, oxygen	IFM-GEOMAR
13. Marandino, Christa	Oxygenated volatile organic compounds	IFM-GEOMAR
14. Rabe, René	Aerosols	Ift
15. Raimund, Stefan	Volatile halogenated organic compounds	IFM-GEOMAR
16. Roy, Alexandra-Sophie	Nitrogen fixation, bioassays	IFM-GEOMAR
17. Schlundt, Michael	Gliders, CTD, microstructure	IFM-GEOMAR
18. Schyska, Bruno	Helium, CTD, microstructure	IUP-HB
19. Steinhoff, Tobias	CO <sub>2</sub> chemistry	IFM-GEOMAR
20. Thomsen, Sören	CTD, microstructure	IFM-GEOMAR
21. Wolters, Gabriele	Bordärztin	
22. Zindler, Kathleen	Oxygenated volatile organic compounds	IFM-GEOMAR

IFM-GEOMAR      Leibniz-Institut für Meereswissenschaften  
Kiel, Germany

Ift                      Leibniz-Institut für Troposphärenforschung  
Leipzig, Germany

IUP-HB                Institut für Umweltphysik, Universität Bremen  
Bremen, Germany

IUP-HD                Institut für Umweltphysik, Universität Heidelberg  
Heidelberg, Germany

## Stationsliste

Date UTC	Station No.	Latitude	Longitude	Water depth	Instruments	Duration hh:mm	Comment
22.06.2011		Departure from Mindelo					
23.06.2011	721	17.59	-24.24	3589	CTD/RO, MSS	04:16	CVOO, CTD bottom, MSS
23.06.2011	722	14.00	-23.00	4312	CTD/RO, MSS	02:48	CTD 1300, MSS
24.06.2011	723	13.50	-23.00	4526	CTD/RO, MSS	02:40	CTD 1300, MSS
24.06.2011	724	13.00	-23.00	4734	CTD/RO, MSS	02:43	CTD 1300, MSS
24.06.2011	725	12.50	-23.00	4911	CTD/RO	01:03	CTD to 1300
24.06.2011	726	12.00	-23.00	5039	CTD/RO, MSS	02:28	CTD 1300, MSS
25.06.2011	727	11.50	-23.00	5108	CTD/RO, MSS	02:26	CTD 1300, MSS
25.06.2011	728	11.00	-23.00	5152	CTD/RO, MSS, CTD/RO, CTD/RO	03:18	CTD 1300, MSS, CTD 10, CTD DCM
25.06.2011	729	10.50	-23.00	5285	CTD/RO, MSS	02:29	CTD 1300, MSS
25.06.2011	730	10.00	-23.00	5080	CTD/RO, MSS	02:20	CTD 1300, MSS
25.06.2011	731	9.50	-23.00	4990	CTD/RO, MSS	02:46	CTD 1300, MSS
26.06.2011	732	9.00	-23.00	4600	CTD/RO, MSS	01:16	CTD 1300, MSS
26.06.2011	733	8.50	-23.00	4570	CTD/RO, MSS	02:02	CTD 1300, MSS
26.06.2011	734	8.16	-22.97	4500	MSS, CTD/RO	01:19	CTD 1300, MSS
26.06.2011	735	8.01	-22.96	4500	24h Driftstation	09:12	3 x CTD 100, 1 x CT 1300, 2 x MSS
27.06.2011						16:30	4 x CTD 100, 4 x MSS
27.06.2011	736	7.48	-23.00	4320	CTD/RO, MSS	02:26	CTD 1300, MSS
27.06.2011	737	7.00	-23.00	3490	CTD/RO, MSS	02:34	CTD 1300, MSS
28.06.2011	738	6.50	-23.00	3790	CTD/RO, MSS	02:33	CTD 1300, MSS
28.06.2011	739	6.00	-23.00	4030	CTD/RO, MSS	02:42	CTD 1300, MSS
28.06.2011	740	5.50	-23.00	4060	CTD/RO, MSS	02:33	CTD 1300, MSS
28.06.2011	741	5.00	-23.02	4023	CTD/RO, MSS	02:25	CTD 1300, MSS
29.06.2011	742	4.50	-23.00	4001	CTD/RO, MSS	02:34	CTD 1300, MSS
29.06.2011	743	4.00	-23.00	4061	CTD/RO, MSS	03:35	CTD 1300, MSS, CTD 10, CTD DCM
30.06.2011	744	1.58	-19.08	4061	GL	00:21	GLIDER

01.07.2011	745	-4.00	-15.00	3807	CTD/RO, SF, MSS	02:13	CTD 700, MSS, FLOAT
02.07.2011	746	-3.00	-15.00	3805	CTD/RO, MSS	02:08	CTD 700, MSS
02.07.2011	747	-2.00	-15.00	4000	CTD/RO, MSS	02:53	CTD 700, MSS, CTD 10, CTD DCM
02.07.2011	748	-1.00	-15.00	4170	24h Driftstation	02:32	4 x CTD 100, 1 x CTD 700, 4 x MSS
03.07.2011						15:04	Terminated after 16 h
03.07.2011	749	-0.81	-14.79	4061	GL	01:00	GLIDER
03.07.2011	750	0.00	-15.00	3620	CTD/RO, MSS	02:03	CTD 700, MSS
03.07.2011	751	1.00	-15.01	3620	CTD/RO, MSS	02:04	CTD 700, MSS
04.07.2011	752	2.00	-15.00	5253	CTD/RO, SF, MSS	01:55	CTD 700, FLOAT, MSS
05.07.2011	753	-0.71	-13.07	4087	CTD/RO	04:30	CO2-Sensortest
06.07.2011	754	-5.00	-10.00	3005	GO-FLO, CTD/RO, SF, MSS	03:14	GOFLO, CTD 700, GOFLO, FLOAT, MSS
07.07.2011	755	-4.00	-10.00	3628	GO-FLO, CTD/RO, MSS	02:40	GOFLO, CTD 700, GOFLO, MSS
07.07.2011	756	-3.00	-10.00	3981	CTD/RO	03:07	CTD 700, MSS, CTD 10, CTD DCM
07.07.2011	757	-2.98	-10.07	3955	GL	00:26	GLIDER
07.07.2011	758	-2.00	-10.00	4194	24h Driftstation	06:25	4 x CTD 100, 2 x CT 300, 1 x CTD 700
08.07.2011						19:26	6 x MSS
09.07.2011	759	-1.00	-10.00	3989	CTD/RO, MSS	02:10	CTD 700, MSS
09.07.2011	760	0.00	-9.87	5039	CTD/RO, MSS	02:00	CTD 700, MSS
09.07.2011	761	0.21	-9.68	4501	GL	00:48	GLIDER
09.07.2011	762	1.24	-9.88	5002	GL	00:25	GLIDER
09.07.2011	763	1.26	-9.81	5002	GL	00:29	GLIDER
09.07.2011	764	1.26	-9.81	5253	CTD/RO, SF, MSS	02:43	CTD 700, FLOAT, MSS
11.07.2011	765	-5.00	-5.00	4442	SF, MSS, GO-FLO, CTD/RO, GO-FLO	02:54	SF, MSS, GO-FLO, CTD/RO 700, GO-FLO
11.07.2011	766	-4.00	-5.00	4629	GO-FLO, CTD/RO, MSS	02:29	GO-FLO, CTD/RO 700, MSS
12.07.2011	767	-3.00	-5.00	4634	GO-FLO, CTD/RO, MSS	01:59	GO-FLO, CTD/RO 700, MSS
12.07.2011	768	-2.00	-5.00	5065	GO-FLO, CTD/RO, MSS	03:09	GO-FLO, CTD/RO 700, MSS
12.07.2011	769	-1.00	-5.00	5002	24h Driftstation	05:16	6 x CTD 100, 1 x CTD 700
13.07.2011						20:17	6 x MSS
14.07.2011	770	0.00	-5.00	5023	CTD/RO, MSS	02:07	CTD 700, MSS
14.07.2011	771	1.00	-5.00	5059	CTD/RO, MSS	02:04	CTD 700, MSS



16.07.2011	772	-5.00	0.00	3284	CTD/RO, MSS	02:06	CTD 700, MSS
16.07.2011	773	-4.00	0.00	4574	CTD/RO, MSS	02:57	CTD 700, MSS
16.07.2011	774	-3.00	0.00	4505	CTD/RO, MSS	02:06	CTD 700, MSS
16.07.2011	775	-2.00	0.00	4648	24h Driftstation	01:18	3 x CTD 100, 3x CTD 350, 1 x CTD 700
17.07.2011						23:54	6 x MSS
18.07.2011	776	-1.00	0.00	4802	CTD/RO, MSS	02:16	CTD 700, MSS
18.07.2011	777	-0.39	-0.12	4888	CTD/RO, MSS	00:53	GL
18.07.2011	778	0.00	0.00	4866	CTD/RO, MSS	04:47	CTD 4920, MSS
18.07.2011	779	1.00	0.00	4885	CTD/RO, MSS	05:19	2 x CTD 500, CTD 700, MSS

CTD/RO	CTD-rosette
MSS	Microstructure profiler
GO-FLO	close-open-close water samplers
GL	Glider recovery
TD	Lagrangian surface drifter
SF	Deployment of profiling float