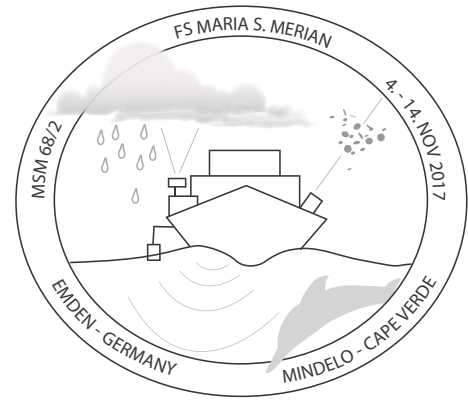


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Short Cruise Report RV MARIA S. MERIAN – MSM 68/2

Emden, Germany – Mindelo, Cape Verde
3.11.2017 – 14.11.2017

Chief Scientist: Stephanie Fiedler
Captain: Björn Maaß



Fig. 1: Cruise track and stations of research expedition MSM 68/2 (Map: Google Earth)

Objectives

The expedition MSM 68/2 with RV MARIA S. MERIAN is primarily used for measuring atmospheric properties with focus on clouds and aerosol. This initiative is part of the DFG funded project “Collecting atmospheric reference data over oceans” (CARO) led by the Max Planck Institute for Meteorology (MPI-M). The aim of our expedition is a continuous measurement of atmosphere and ocean properties along the cruise track from Emden, Germany, via the North Sea and the English Channel to Mindelo, Cape Verde (Fig. 1). The ground-based observation network is typically sparse over marine regions such that our measurements make a valuable contribution to filling gaps in the observational system.

We have operated different instruments for measuring properties of the atmosphere and ocean. Atmospheric remote sensing instruments (Fig. 2) were used for deriving (1) the cloud fraction and base height from two imager systems and a ceilometer, (2) the precipitation rate and droplet size distribution from an OceanRAIN optical disdrometer, (3) the aerosol optical depth at different wavelengths and total water vapor content from a hand-held sun photometer MICROTOPS, and (4) the atmospheric gases and aerosol from a MAX-DOAS. The continuous measurements of ocean properties are carried out with (1) a submersible pump, a thermosalinograph and a novel automated system for determining the temperature, salinity and total alkalinity of continuously pumped near-surface seawater, as well as (2) an echo sounding system (swath sonar multibeam) for mapping the sea-floor topography. Moreover, observations of cetaceans are recorded with photo IDs and GPS location.

Additionally to the continuous measurements, we had two stations during the expedition (Fig. 1). One was at the Cape Verde Ocean Observatory (CVOO) with a full-depth CTD-rossette hydrocast for measuring profiles of temperature, salinity, and pressure, as well as the content of O₂, nutrients, and CO₂. Collecting ocean data at the CVOO is a contribution to extending the record for this site that is regularly revisited by research vessels. The other CTD was carried out at our ARGO station offshore of Portugal. Here we measured a 2000m-deep reference profile for water temperature and salinity after we had deployed the new ARGO float. This data will be used for validating the measurements of the ARGO float.

Our comprehensive dataset will be assessed in more detail for scientific purposes in the next months and years. Some of the instruments activated during our cruise will keep being in operation during that time for collecting additional data. These include the newly deployed ARGO float that autonomously measures and transmits vertical profiles of the water temperature and salinity in the upper 2000m of the North Atlantic. Moreover, our remote sensing instruments for clouds have been successfully installed and tested during MSM 68/2. The imager ‘Pinocchio’ and the ceilometer will autonomously record data on RV MARIA S. MERIAN until 2019. These data allow us to compile a first ground-based cloud type statistic over the Atlantic, where scientific endeavors based on observations often rely on satellite-borne information. Our new cloud statistic will provide an avenue for validating both satellite retrieved cloud information and high-resolution modeling results from the German weather and climate model ICON, which is at the forefront of ongoing research at MPI-M and the German Weather Service.

Narrative

We embarked RV MARIA S. MERIAN on 2 November 2017 in Emden and set up our atmosphere lab on the pile deck. From here we were overlooking the ocean such that it is a great location for atmospheric measurements along our cruise from Emden to Mindelo (Fig. 1). We had a few initial problems with some of the instruments and worked until late for identifying the causes for the errors and fixing the loose contacts of two wires. Since the vessel had just undergone major maintenance at the dockyards, the vessel left the port already in the morning of 3 November 2017, a day earlier than originally planned, for performing necessary tests. The works included testing the brand new navigation system of the vessel. To this end, we were circling around the same position for twelve hours. The cloud data during that period is great for having a record at an almost fixed position offshore. It is a perfect test of our instruments (Fig. 2) for the later operation during the EUREC⁴A campaign in the Caribbean when research vessels will also stay at almost fixed positions. The data of the more precise but less flexible cloud imager 'Dumbo' and the ceilometer are herein useful for validating the new cloud imager 'Pinocchio' that has undergone fresh calibration before installing it on board. 'Pinocchio' keeps recording clouds on RV MARIA S. MERIAN and similar instruments will be aboard other vessels for collecting more data for a marine cloud statistic. At the almost fixed location during MSM 68/2, we are also able to compare our data against measurements from a 'Pinocchio' imager aboard of RV SONNE that passed us with low speed in the early morning of 4 November 2017.

After the technicians had left us, we set course for the English Channel. Our daily science colloquium started on the 5 November 2017 and was a great opportunity for learning about the scientific research of our inter-disciplinary team. On the same day, we were able to perform first sun photometer measurements with the hand-held MICROTOPS instrument of NASA in the clear patches of the air behind the trailing cold front that we had passed in the course of the night. Like expected, the air was clean with low aerosol optical depth. Despite the increasing swell of up to 4m, the instruments reliably recorded the clouds scenes during the front passage. We saw the first cetaceans, the common dolphin, already on the following day, which was unexpected at such a northern position. In the meantime, the novel systems for measuring the seawater alkalinity started to operate and successfully measured during the entire expedition. The swell further increased during the following days with waves of up to 6m. We were busy with the data management, initial analyses and the daily routine of checking the cloud instruments.

In the early morning of 9 November 2017, we reached our first station offshore of Portugal. After testing and deploying the new ARGO float, we performed a 2000m-deep CTD sounding as reference for validating the first temperature and salinity profiles of the float. With the help of the experienced crew, we successfully completed this part of our mission and continued our cruise towards warmer waters after just two hours.

The weather development on the 10 November 2017 already indicated a dust outbreak towards the North Atlantic in the following days such that we got excited about measuring the aerosol optical depth. The models forecasted an eastward extending Azores High and strengthening northeasterly winds over Northwest Africa that mobilize and transport desert dust in our vessel's path. Such a weather pattern is typically referred to as Harmattan surge that is, from a climatological perspective, most common and important for desert-dust emission in winter and spring, such that this event was just at the beginning of the season for this dust storm type. The geostationary satellite of Eumetsat captured widespread dust storms on 11 November 2017. Most of the desert dust reached us on 13

November 2017 with clear dust deposition on deck of the vessel. The associated aerosol optical depths were captured with MICROTOPS and were daily submitted for data quality checks and publication to the marine aerosol network of NASA.

On 13 November 2017, we completed our second and last station. At the Cape Verde Ocean Observatory, we did a full-depth CTD with a hydrocast. Shortly after the CTD was back on deck, the water samples were prepared for the analysis in the lab on land. In the afternoon, we already reached the harbor of Mindelo after traveling through the dust plume. Despite the low visibility, we recorded sightings of spinner dolphins. They gave us a warm welcome to the tropics with their show of high jumps and twists.

Our rather short expedition already ends in the afternoon with news about the closed airport of Sao Vicente due to the dust storm. We got golden data for better understanding this dust storm type. In hindsight, the fairly large collection of atmosphere and ocean data from our entire expedition is great for our scientific research. Back at MPI-M, we are particularly interested in compiling the first ground-based marine cloud statistic from our already large collection of cloud images from MSM 68/2 and previous cruises. The cloud record will continuously grow during the next year thanks to the support of the crew of RV MARIA S. MERIAN, the next chief scientists and not at last the research funding. We are thankful for this fantastic opportunity and the excellent research environment aboard the vessel.

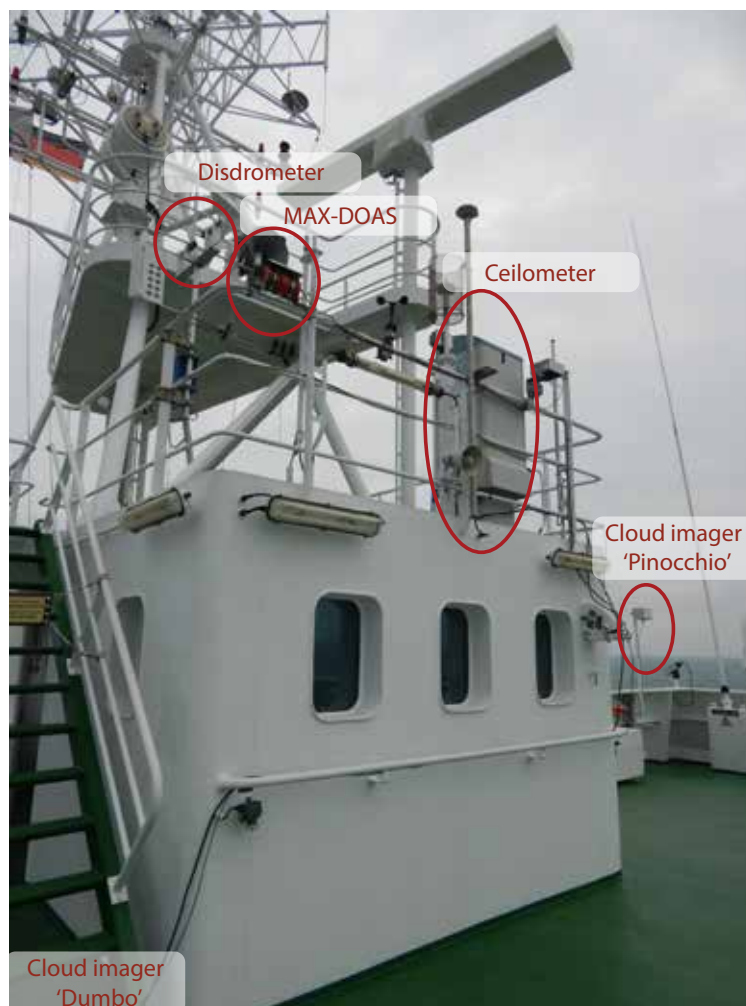


Fig. 2: Installation of the instruments for atmospheric measurements on the pile deck. The cloud imager 'Pinocchio', the ceilometer, and the disdrometer are in operation until 2019.

Acknowledgements

We would like to acknowledge the funding of the German Science foundation and the Max Planck Society that allowed us carrying out this research expedition. Moreover, we would like to thank the captain and crew of RV MARIA S. MERIAN for their help with logistics and measurements aboard, as well as the „Leitstelle Deutscher Forschungsschiffe“ and Briese Research for their support in organizing and coordinating the expedition. We further acknowledge the usage of the sun photometer provided by Alexander Smirnov, NASA, and thank Bettina Diallo and Dörte de Graaf, MPI-M, for designing the webpage and uploading the daily entries for the blog of our expedition (www.mpimet.mpg.de/en/science/the-atmosphere-in-the-earth-system/blogs/ships/merian/).

Teilnehmerliste

1. Stephanie Fiedler	Chief Scientist	MPI-M
2. Samira Terzenbach	Sun photometer	MPI-M
3. John Mrziglod	Cloud imagers	MPI-M
4. Sebastian Donner	MAX-DOAS	MPI-C
5. Katharina Seelmann	Sea water alkalinity	GEOMAR
6. Silvana Neves	Cetacean observation	PLOCAN

MPI-M – Max Planck Institute for Meteorology, Hamburg, Germany

MPI-C – Max Planck Institute for Chemistry, Mainz, Germany

GEOMAR – Helmholtz Zentrum für Ozeanforschung, Kiel, Germany

PLOCAN – Plataforma Oceánica de Canarias, Gran Canaria, Spain

Stationsliste

Station No.	Date / Time [UTC]	Device	Action	Position Latitude	Position Longitude	Depth [m]
MSM68/2_1-1	09.11.17 05:46	ARGO Float	deployed	37° 30,738' N	018° 42,546' W	4872,8
MSM68/2_2-1	09.11.17 06:14	CTD	start	37° 28,961' N	018° 43,833' W	5210
	09.11.17 06:55		maximum depth	37° 28,993' N	018° 43,797' W	4566,7
	09.11.17 07:31		end	37° 28,991' N	018° 43,800' W	4616,3
MSM68/2_3-1	13.11.17 09:13	CTD	start	17° 34,971' N	024° 18,010' W	3604,1
	13.11.17 10:18		maximum depth	17° 34,971' N	024° 18,010' W	3604,4
	13.11.17 11:29		end	17° 34,970' N	024° 18,010' W	3602,1