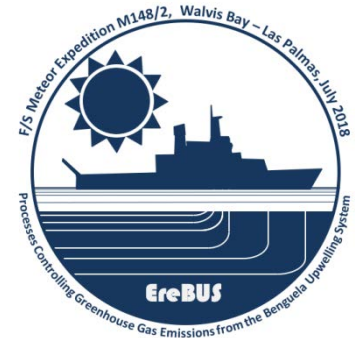


1. Wochenbericht (29. Juni - 1. Juli 2018)

M148/2 „EreBUS“ 01.07.2018 (Walvis Bay, Namibia) -
20.07.218 (Las Palmas, Spain)

On Friday the first group of 13 scientific members of the M148/2 EreBUS transit expedition along the Namibian shelf, continental margin and into the tropical South Atlantic Ocean arrived in Walvis Bay to begin unloading containers and setting up laboratories on the R/V Meteor.



The Meteor Expedition M148/2 “EreBUS” aims to investigate the microbial processes producing and consuming the trace green-house gases (TGG) methane and nitrous oxide in the Benguela Upwelling System (BUS) and physical and geochemical controls regulating these processes.

We will use the transit from Walvis Bay to Las Palmas to sample the water column and surface sediments on the Namibian shelf and across the continental margin at 18°S into deep water, and continue sampling the upper 500 m of the water column on a transect through the Angola Gyre. We will identify microbial communities contributing to TGG turnover at key water and surface sediment depths, and explore the metabolic capacities of these microorganisms with state-of-art cultivation and genomic techniques. The contribution of symbiotic microorganisms living with small eukaryotes will be investigated. Hydrographic and optical properties will be gathered in support of the experiments. We will measure primary productivity and nitrogen fixation as well as determine the trace metal availability and fluxes that may regulate key enzymatic processes. The source and fate of dissolved organic matter compounds will be investigated in order to understand their impact on microbial respiration.

On Saturday evening, together with the Captain and Crew of the R/V Meteor, and organized by the German Embassy in Windhoek, we welcomed guests from national and local governments, media and non-governmental agencies in Namibia to a reception onboard the ship. The scientific background and goals of the expedition were shortly presented, and a tour of the ship was organized. Enthusiasm and interest in the ship and the science were clearly palpable in the lively discussions over the subsequent buffet dinner.

On Sunday morning the remaining scientists joined with the colleagues already in Namibia to board the ship. Unfortunately, due to illness, one of our Namibian colleagues had to cancel his participation. But otherwise, all are well and busy setting up laboratories and preparing for leaving port tomorrow morning. Our first station is only a couple of hours outside of Walvis Bay, so we will be working late to get started.

We are waiting for one box of scientific equipment, but then hope to sail by late morning. The weather forecast is a bit daunting, with high winds forecast for tomorrow combined with swell out of the Antarctic. Nevertheless, we are cautiously optimistic with our plans and look forward to get out to sea.

Greetings from Walvis Bay, Namibia from Tim Ferdelman, Chief Scientist, on behalf of the scientists and crew

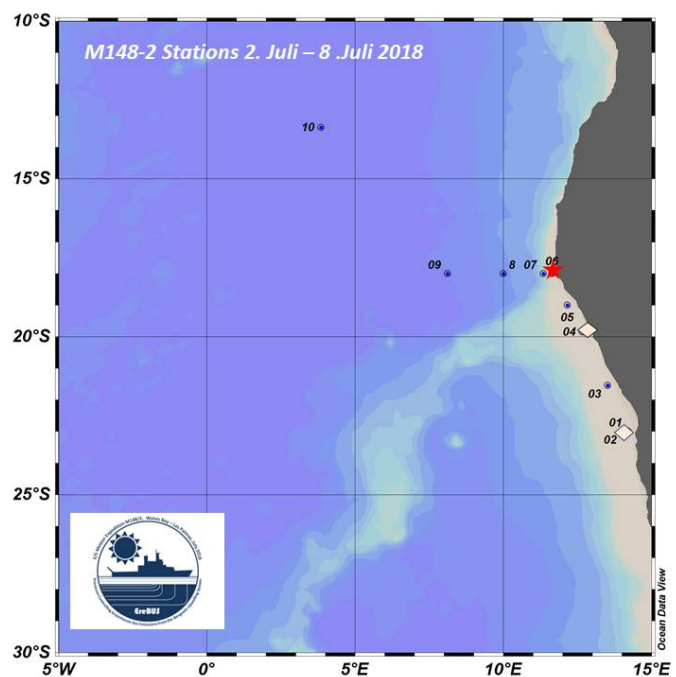
M148/2 „EreBUS“ 01.07.2018 (Walvis Bay, Namibia) -
20.07.2018 (Las Palmas, Spain)



As I write, the R/V Meteor finds itself sailing into the open blue waters of South Atlantic Ocean on a northwest heading. We have a pleasant wind and gentle 1 to 2 meter swells from behind and are making excellent time along our third and last station transect. This stands in contrast to the weather conditions marking our departure from Walvis Bay last Monday for the first station of the EreBUS expedition. We left port shortly after 11 AM and were immediately confronted with high winds and 5 meter wave heights. It proved to be a challenging start for the first main sampling station, but after several hours we were able to meet most of our sampling goals. Only the sediment multi-corer deployment was dropped due to inclement wind and wave conditions. Thereafter, we commenced an extremely busy sampling campaign running northwards along the Namibian shelf, finally reaching our northernmost shelf station on Wednesday, July the 4th. Here, in addition to our standard sampling program, our colleagues from the Institute of Baltic Sea Research Warnemünde (IOW), recovered, serviced and re-deployed a seafloor-moored ADCP unit, used in making continuous current measurements through the water column.



Recovery of the ADCP mooring at Station M148-206



Stations from the first week of sampling activities . White diamonds are where the pump-CTD was deployed. The star indicates the station the mooring was recovered, in addition to a pump-CTD cast.

Along the continental shelf transect in the Benguela upwelling region, hydrographic and geochemical profiling with the CTD showed a well-mixed upper water column with increased chlorophyll concentrations indicative of the the high productivity of the Namibian shelf. Oxygen concentrations declined below, although truly anoxic conditions were not present, even a few meters above ground, and dissolved hydrogen sulfide, which frequently occurs in micromolar concentrations in these shelf waters, was not detected. Deploying a so-called *pump-CTD* we obtained high depth resolution

profiles of the important greenhouse gases N₂O and methane as well as other chemical constituents. In contrast to the regularly used CTD and sample bottle rosette system, the pump-CTD allows for the continuous sampling of water during deployment leading to a vertical resolution of about 1-2 m. It also allows us to pinpoint depths of low-oxygen water for obtaining samples for incubation experiments performed on-board. The near-simultaneous profiling and sampling has the advantage that the water samples are in the laboratory within minutes as the pump-CTD is lowered through the water column leading to minimal changes in the geochemical conditions.

After the first few days of intensive sampling along the continental shelf and a short westward transect to reach open ocean waters, the laboratories and freezers are packed with samples. The scientific party is analysing and processing samples and the intensive work on deck has now shifted to the laboratories of *R/V Meteor* as we head into oligotrophic waters.

Greetings from $10^{\circ} 52' S 1^{\circ} 34' E$ from Tim Ferdelman, Chief Scientist, on behalf of the scientists and crew

3. Weekly Report (July 9, 2018 – July 15, 2018)

M148/2 „EreBUS“ 01.07.2018 (Walvis Bay, Namibia) -
20.07.2018 (Las Palmas, Spain)



Under the rain-heavy skies of the Intertropical Convergence Zone (ITCZ) the *R/V Meteor* skirts the coast of Western Africa on the transit north to Las Palmas. Cruising through the economic exclusive zones of countries such as Liberia and Sierra Leone since late Thursday morning, the underway data gathering systems and water sampling systems have been shut down, and the last station of this expedition also lies over two days behind us.

During our transit from the oxygen-minimum zone off Namibia into the open waters (Figure 1 left) sampling began for the much more oligotrophic waters of the Eastern South and Equatorial Atlantic. These waters not only have low concentrations of nutrients such as nitrate, but are also low in trace elements. Standard sampling equipment often poses a source of contamination for trace elements, and special Teflon-coated Go-Flo bottles were used on the shelf as well the open waters to obtain very clean water samples for the analysis of dissolved and particulate trace elements, particularly iron (Fe) (Figure 1 right). Fe can limit primary productivity in several oceanic regions, and the chemical phase and fluxes of Fe are not very well known in this so far under-sampled region. The samples obtained on this cruise will later be analyzed in the home laboratories of the Institute for Chemistry and Biology of the Marine Environment (ICBM) at the University of Oldenburg, where not only the chemical phase of the trace elements will be determined but also analysis will be carried out to distinguish sedimentary versus atmospheric sources of trace elements.

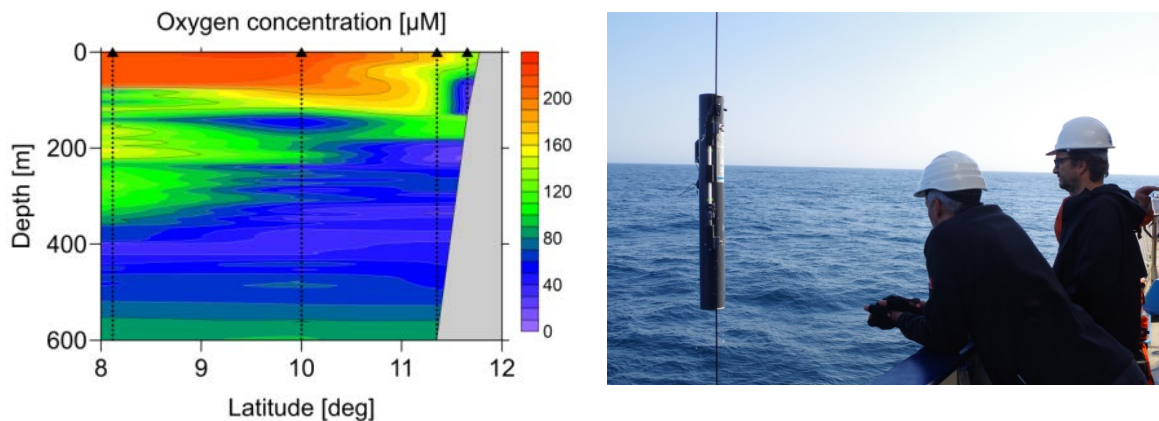


Figure 1: Oxygen concentrations across the Kunene upwelling cell (18°S) (preliminary CTD data; left panel, V. Mohrholz) and Go-Flo deployment on station (right panel).

Primary production is not the only process that can be limited by Fe in the oligotrophic oceans. The fixation of dinitrogen (N_2) gas, yet the largest external source of nitrogen (N) to the ocean, can also be limited by the availability of Fe. Scientists from the Max Planck Institute for Marine Microbiology in Bremen (MPI Bremen) carried out on-board experiments to determine both the rate of primary production and N_2 fixation using stable isotopes. Water samples are kept at close-to-in-situ conditions for a period of 24 h (Figure 2) and subsamples will later be analyzed at the MPI Bremen. While N_2 fixation is usually highest in the oligotrophic waters, not much is known about this process in the Eastern South and Equatorial Atlantic. This is partially due to the assumption that the coastal and equatorial upwelling would inhibit this process rather than on direct sampling and experiments.

The data from this cruise will add to our knowledge on the occurrence of N₂ fixation and its driving forces in this region.

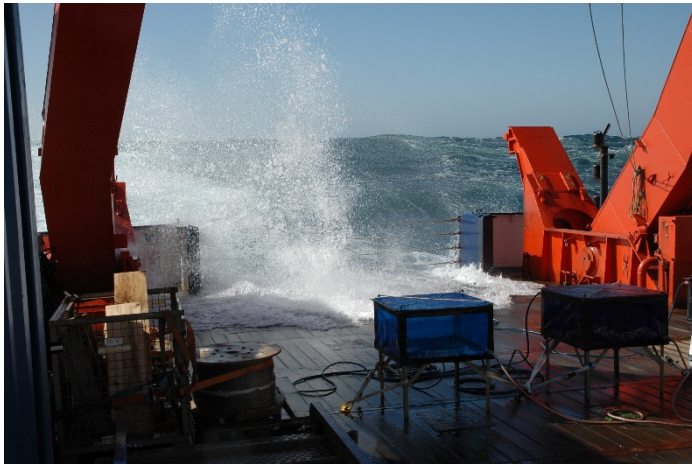


Figure 2 (left): On-deck incubators on the aft deck to simulate in-situ light conditions.

Primary production is at the base of the food web in the ocean, and phytoplankton is grazed upon by larger organisms. To determine the composition of the zooplankton community and to study protists such as Foraminifera, a scientist from the Center

for Marine Environmental Sciences (MARUM) at the University of Bremen deployed

Figure 3 (up): Deployment of multi-net.



a so-called multinet. The multinet collects plankton samples throughout the water column at several intervals so that the depth distribution of the organisms can be studied. While the water column closer to the coastal upwelling off Namibia contained larger amounts of zooplankton, the oligotrophic waters were less densely

populated, reflecting the oligotrophic conditions and the lower productivity in these waters. The samples from the multinet will be taken back home and will later be analyzed at the MARUM.

Back here on the ship, we are looking forward with anticipation to a nice Grill Evening on deck and the World Cup match.

Greetings from 12° 46'N 17° 43'E from Tim Ferdelman, Chief Scientist, on behalf of the scientists and crew

Weekly Report No. 4 (July 16, 2018 – July 22, 2018)

M148/2 „EreBUS“ 01.07.2018 (Walvis Bay, Namibia) -
20.07.2018 (Las Palmas, Spain)



We have reached the end of our transit expedition from the coastal, productive, upwelling waters of Namibia, through the South and Equatorial Atlantic, and final transit to the Canary Islands. During the final transit, scientific work slowed down quite a bit for the majority of the scientific party, with only a few measurements still being done on samples collected earlier on the cruise, and efforts went into packing and stowing equipment and samples. The packing of containers turned out to be tricky due to rougher seas from trade winds in the subtropical Northeast Atlantic, slowing down the ship and deck work. But all is safely stowed and ready for shipment back to Germany: equipment and supplies in two containers, and precious frozen and cooled samples ready for pick-up in Las Palmas. The shipboard work is complete, and now comes the analysis of data and samples in our home laboratories in Bremen, Oldenburg, Wilhelmshaven, Warnemünde, Munich and Hentjes Bay.



The M148-2 Science Party

This is the last weekly report from the *R/V Meteor* Expedition M148/2 “EreBUS”, and at this point I would personally like to thank the scientific crew for their tireless contributions to the project, despite the challenges of pursuing a rigorous scientific plan with little time for setting up and in the face of less than optimal wind and wave conditions at the outset. I especially would like to thank Captain Detlef Korte and his entire crew for their professionalism, enduring patience and cheerfulness. *Meteor* ran like clockwork and we gratefully acknowledge the gift of extra station time. I would like to thank my colleague, Wiebke Mohr, who not only helped with the daunting task of getting my English into German, but also with many additional shipboard organizational duties. Ulrike Tietjen’s organizational magic back home on shore also deserves a word of thanks. All in all, it was a privilege and a pleasure to sail and do science again on the *R/V Meteor*.

Greetings from Las Palmas from Tim Ferdelman, Chief Scientist, on behalf of the scientists and crew