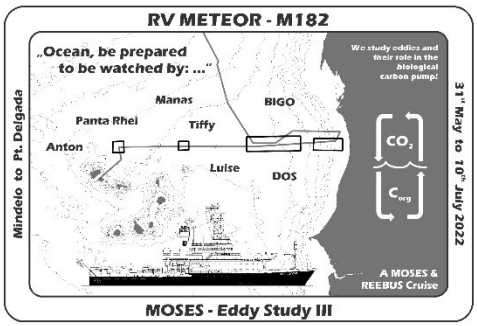
RV METEOR – M182

31.05. - 10.07.2022, Mindelo - Pt. Delgada



2nd Weekly Report

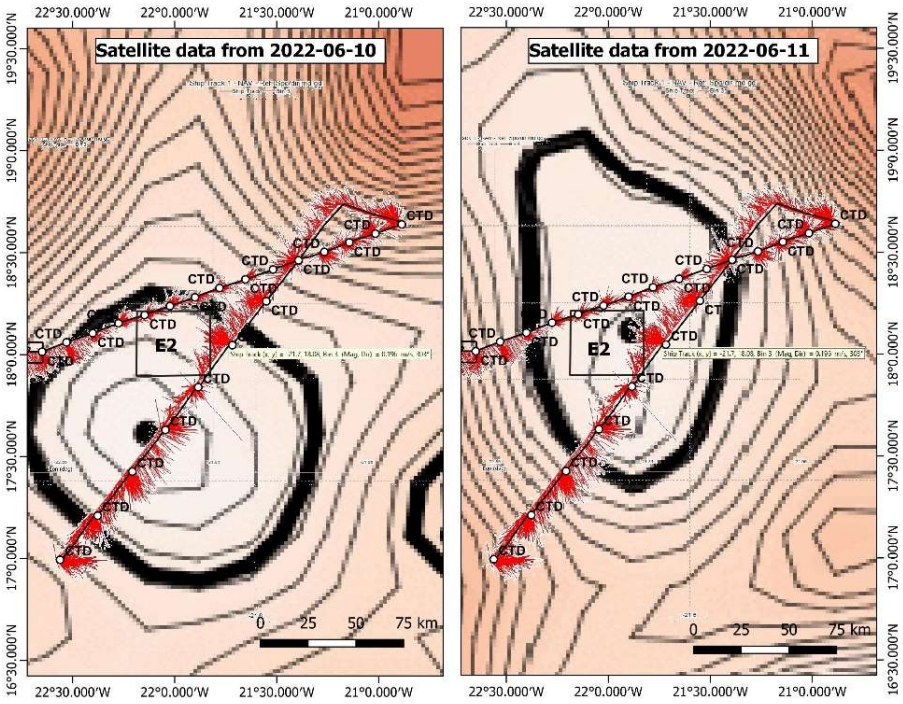
06. - 12.06.2022

The second weekly report is due, and several scientists are working on getting data, maps and information ready. One of them is Mareike Kampmeier, she is my right hand on this cruise. She was strongly involved in organizing the cruise including container logistics, documentation, flights, hotels … In Kiel she was supported by Astrid Ulbrich who, after planning, managed the booking of hotels, flights, taxis, and last minute things. Mareike supports me when planning the daily schedule, joins the daily bridge meetings at 8:30 in the morning and she takes care of mapping the seafloor with the multibeam. Together with Jochen Mohrmann and Karl Heger she takes over the night shifts when we map the seafloor. Karl and Jochen are the "data crunchers" and data managers on the cruise. They are from the DeepSea Monitoring group of GEOMAR and brought a number of big processing computers on board for photogrammetric reconstructions and 4D visualization.

Work from the past week

The from the night of 5th to 6th June we were running an XOFOS which arrived back on deck shortly after midnight. We used the night to acquire more bathymetric data before starting a BIGO deployment (station M182_30-1) at the E1-hill site. A TV-MUC followed on top of the hill from where we also started a XOFOS track downhill in NNE direction. Although we hoped the see more fauna on the sometimes steeper slopes, the seafloor looked rather similar to the abyssal plain of the surrounding. At the end of the XOFOS deployment, a multinet was the last gear of the day, before we started another multibeam survey until 9:04 in the morning when we were back at the E1 site. As the GC was the last station at E1 we started to recover two LBL transponder that were placed for the AUV navigation and spent several hours testing the USBL navigation for the small AUVs ANOTON and LUISE. After dinner the XOFOS went into the water to explore the seafloor followed by multibeam mapping and the transit towards Mindelo for getting the needed AUV spare parts and O-ring. After the successful hand over, we turned back north to take a night multinet at CVOO followed by a long multibeam survey towards the east and the start of the Eddy-Hunt CTD transect. Satellite images showed sea surface height anomaly indicative of an eddy roughly at the E2 area. The supposed eddy had dimensions roughly 115 km by 180 km and as such was rather big. We planned a transect in NE direction with 15 CTDs every 8 nmi to cover the entire extent using also the ship based ADCP. An ADCP is a hydroacoustic instrument that sends out four acoustic beams at the same time and upon receive of echoes from the water column calculates the direction and speed of the water mass using the frequency shift in the received signal caused by the Doppler effect (thus the name Acoustic Doppler Current Profiler = ADCP).

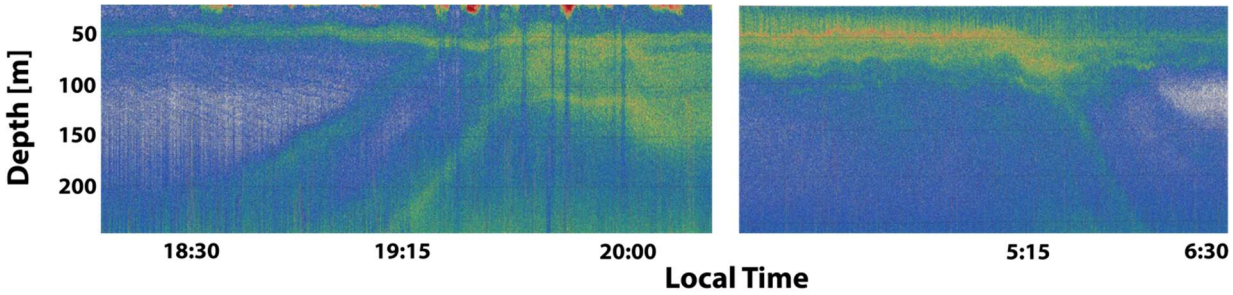
The ADCP is thus able to show the current directions down to 800m water depth for 32m thick layers. In an eddy the current directions should either be clock or counter-clockwise with faster velocities to the outside. We did a second CTD section in SW direction crossing the potentially shifted eddy centre. All the CTD sampling and steaming in between took us until 12th June at 7:00 in the morning. To confirm the eddy current direction, we went on a northward ADCP-transect towards the E2 area and could conform the anti-clockwise rotation of the eddy and its most likely core position. We arrived at E2 at 17:00 on 12th and took a GC. We are now back at the eddy core and just deployed a CTD to sample the area before we lower the XOFOS for investigating the small animals in the upper 900m of the water column.



The background map shows isolines of sea surface height from satellite data. Eddy structures are identifiable by depressions or rises in sea surface height. Our candidate is a cyclonic eddy causing a depression. Measured current directions were plotted above it, illustrating that the vortex rotates counterclockwise. The whole vortex itself is also moving and changing shape during our measurements.

First results from the scientists

Water column biology: During the last week we obtained first data from the single beam echosounder, which showed the biomass distribution in the water column as well as diel vertical migration of zooplankton and nekton. Pelagic crustaceans, gelatinous zooplankton, fishes, and cephalopods started moving to the sea surface in the early evening. The first echograms (a graphic representation of the received backscatter) showed that the migration happened in two distinct pulses. Size of migrating organisms, presence of predators, and interspecific differences in migration behavior may play a role in the exact timing of the ascent and descent.



Diel vertical migration shown with a single beam echosounder.

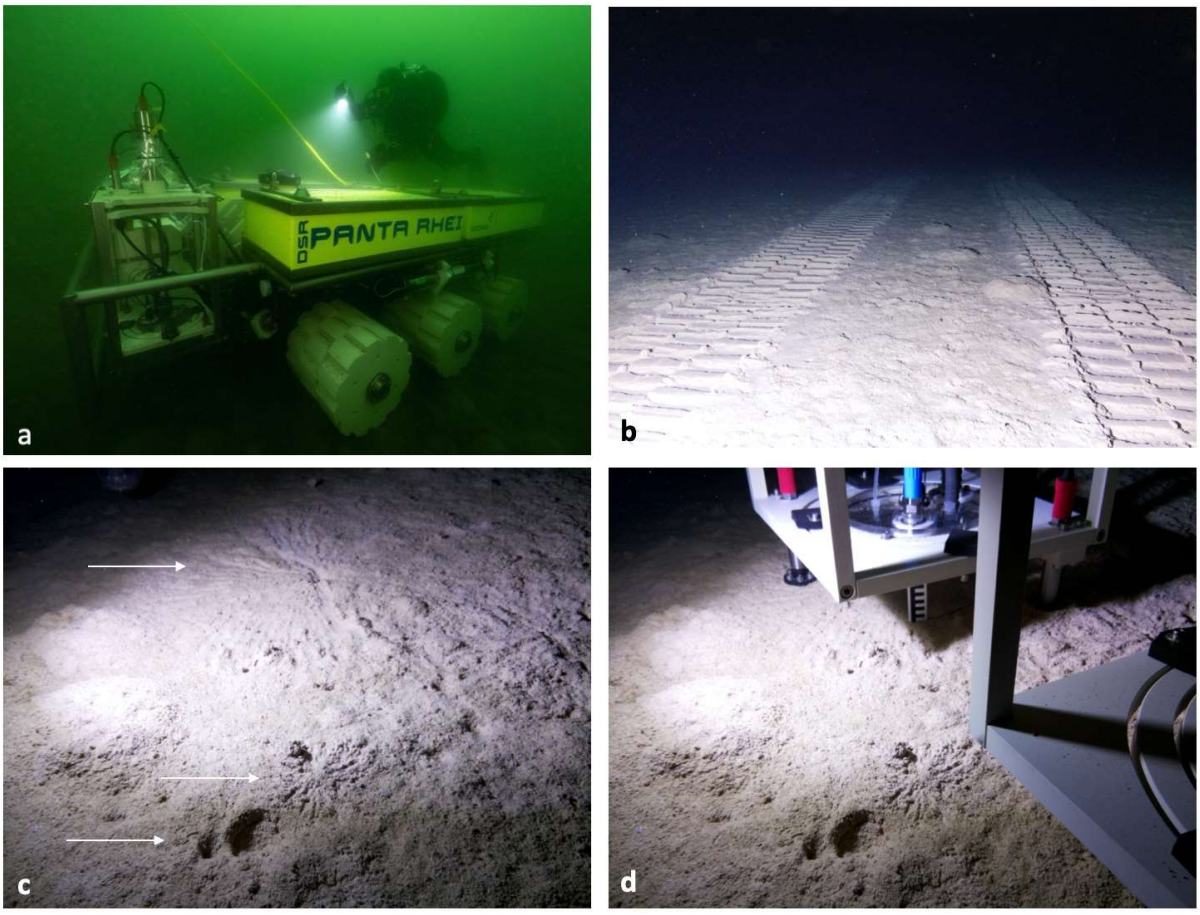
We also continued our sampling with the multinet, which helps us to quantify the vertical community structure and to compare it to our optical tools and echosounder. Our plan for the upcoming weeks is to include multinet tows inside the core of an eddy-like feature and to compare the vertical structure and diversity to our samples outside the eddy-like feature.

Impressions from the pelagic transects.

The first test dives with a new forward looking stereocamera mounted on the OFOS system were challenging but successful. We tested different settings and fixed the positioning of the camera and LED lights. Thus, we were able to conduct the first horizontal imaging transects at depths from 25m to 900m in the day and at night. We saw plenty of very exciting gelatinous organisms that we would have missed with the net – "Colonial" jellyfish called Siphonophores and other jellyfish, arrow worms (Chaetognatha), and comb jellies (Ctenophora) of which some are known but yet undescribed (see figure below). This cydippid ctenophore has tentacles that exceed greatly the length of their body size and are extended to ambush any bypassing prey. This exact feeding position is only possible to reconstruct via *in situ* observations. Closer to the sea surface we saw more fish, shrimps and large amounts of krill. We are looking forward to the next week to have more horizontal imaging transects in and outside of the eddy-like feature to complement our other samples.

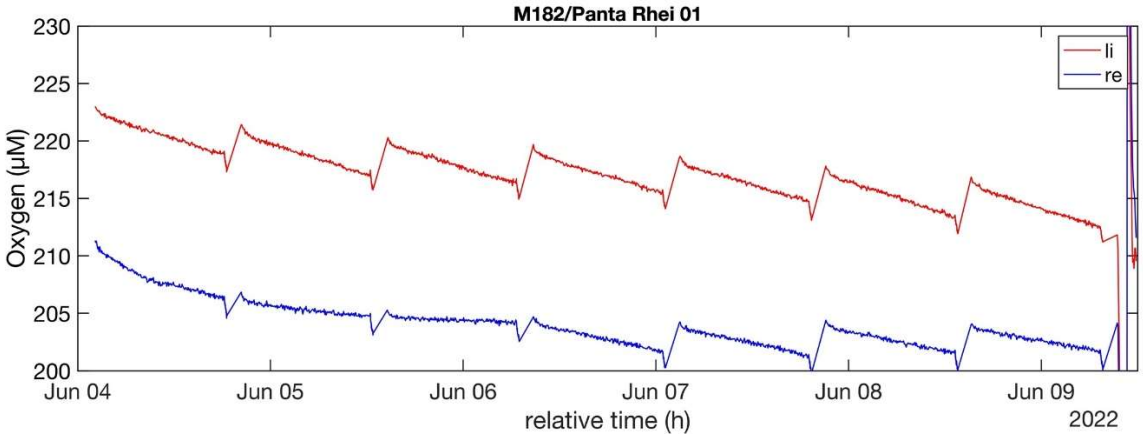
Benthic chemical fluxes: During the past days, we successfully conducted in situ measurements of the benthic total oxygen uptake (TOU) at the station E1 in a water depth of about 3700 m. The aim is to determine the respiration of all infaunal organisms (bacteria, protozoa, meiofauna, macrofauna) in the sediment and to determine the organic carbon turnover of the deep-sea benthic ecosystem along a depth section. Secondly, these measurements are performed to elucidate the effect of the elevated export production during the passage of productive mesoscale eddies on the carbon turnover in deep-sea sediments off Cape Verde. Another major aspect is to measure the variability of the benthic carbon turnover in relation to the seafloor topography, which in interaction with currents strongly affects the deposition of particulate organic carbon.

To perform sea floor respiration measurements, in addition to the well-established GEOMAR lander systems BIGO-I and BIGO-II (Biogeochemical Observatory), the newly developed Deep-Sea Rover (DSR) Panta Rhei has been deployed for the first time. This wheel-driven vehicle, which was developed within the projects MOSES and ARCHES funded by the BMBF and the Helmholtz Society, slowly moves forward on the seafloor and repeatedly conducts TOU measurements in specific benthic flux chambers, Figure 1. In addition to the flux chambers, which represent the centerpiece of the Rover, it harbors sensors for the measurement of physical properties of the bottom water as well as the current regime.



(a) First tests of the DSR Panta Rhei in the Baltic Sea. Two flux chambers for the determination of TOU are located at the front of the Rover. (b) The Rover was deployed at the station E1 off Cape Verde in a water depth of 3600 m. Subsequently to the placement of the DSR Panta Rhei at the seafloor it left its landing site. The photo shows the view to the rear revealing its wheel tracks. (c) Pristine deep-sea sediments prior to the flux measurement. Traces of animals (arrows) can be easily identified at the sediment surface. (d) Same sediment surface as depicted in (c) but with inserted flux chamber to determine the TOU.

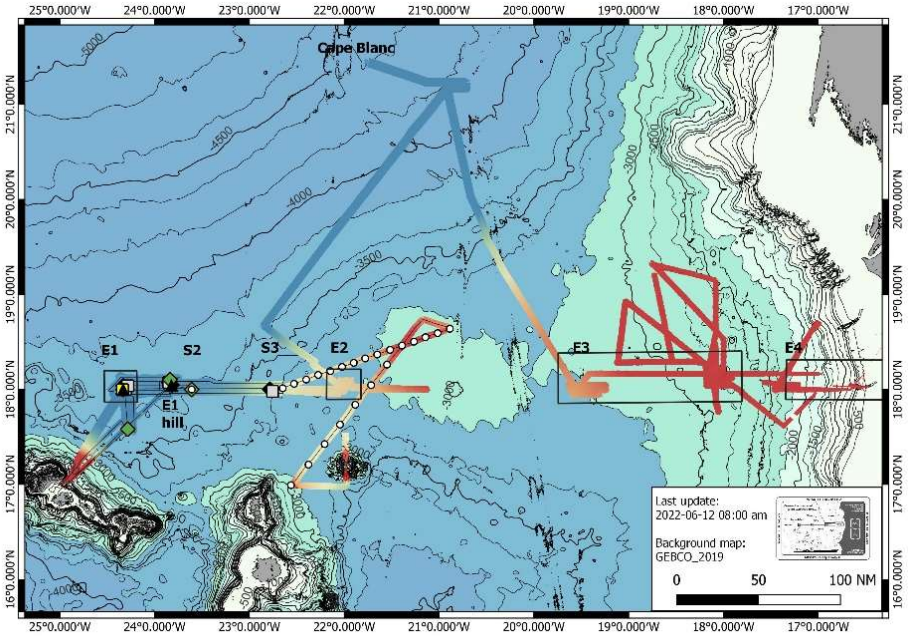
The Rover successfully concluded its measurement program and seven times inserted the flux chambers into the sediment (Figure. 1), sampling different structures of the seafloor. Since after each measurement the Rover moves forward by 70 cm, for each flux measurement it encountered absolutely undisturbed pristine sediments enabling precise flux determinations. Figure 2 shows the oxygen time course during the entire deployment of Panta Rhei. Based on the repeatedly decreasing oxygen concentration the seven TOU measurements inside the left and right flux chamber are easily to recognize. Between the measurements the flux chambers are taken out of the sediment and flushed with ambient seawater.



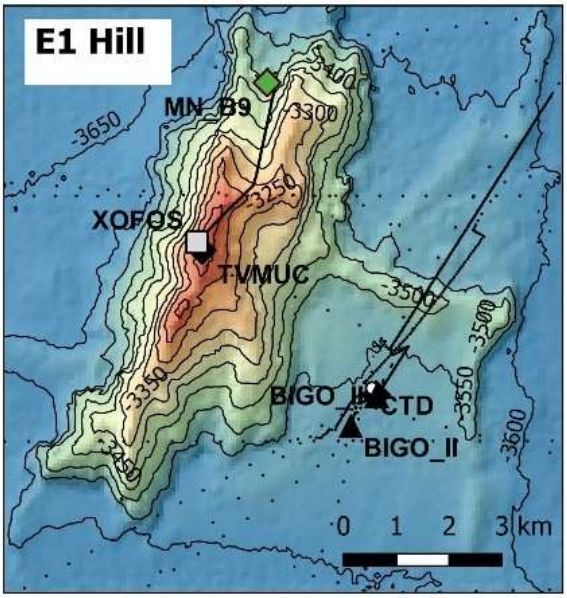
Time course of the oxygen concentration in der left (li) und right (re) flux chamber of the DSR Panta Rhei.

We very much hope that during the further course of the cruise other successful DSR Panta Rhei deployments can be carried out. Towards the end of the cruise it is planned to deploy the Rover for half a year to determine changes of the seafloor sediment community respiration in response to the passage of a productive eddy at the sea surface.

Multibeam mapping and station maps: During the last week we generated some nice maps of the areas we sampled, particularly the area between E1 and E2; see examples below. Thanks to just recent replacement of the multibeam transducers, we are able to acquire bathymetric data of very good quality. In almost 4 km water depth the seafloor is flat with only some isolated topographic features.



Overview of the research area with bathymetric data of M182 and M156 (Eddy-I). The area extends between Cape Verde and Mauritania along the 18th parallel. Pre-planned stations are E1 - E4 with intermediate CTD stations (S1 - S10).



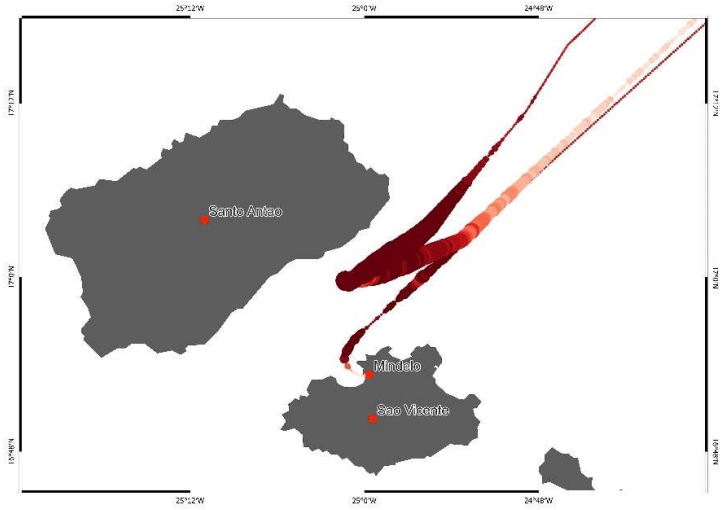
Between E1 and S2 we discovered a 350 m high underwater ridge (E1 hill).

After acquisition we directly process the bathymetry and clean it from acoustic artifacts and generate maps on the fly. This data is important for planning the next stations for our benthic equipment. To find out whether those underwater features provide different types of habitats for deep sea fauna, we did video surveys with our XOFOS (X-tended OFOS) over flat plains, the ridge and ridge slope. The benthic fauna might not be spectacular on a first glance. But the longer we watch the seafloor, the more bioturbation and types of lebensspuren can be discovered. Even though we cannot see those animals, we record their traces which they leave on the sediment. In the literature these feeding structures and burrows are described, but their inhabitants are mainly still unknown. Nevertheless, we do see differences in between different areas and will compare it to the local geochemical properties within the sediment to be able to understand material fluxes and carbon uptake and storage abilities. After the XOFOS dive, the work continues with processing the video footage and creating photo mosaics, which allow us to annotate the bioturbation and deep sea fauna and will be the data base for further analyses.

When things do work out

Shortly after the cruise started we realized that an O-ring of Tiffy's INS was damaged and we needed replacement. A student helper traveled down to Mindelo and with the help of Cordula Zenk (the administrative director of the OSCM institute in Mindelo from Geomar side), the Cape Verde coast guarded agreed to deliver the O-rings and spare parts to the ship. We met at 17:30 of the 8th June between the islands Sao Vicente and Santo Antao and successfully hand over the packages and a small "thank you" for the officers on the small vessel. While approaching the small vessel the wind strongly picked up and caused wind gusts of up to 10 Beaufort from northerly directions. This, so told the DWD weather person on board, was due to a very local weather phenomenon on the leeward side of islands that created a small depression, causing the wind to pick up. Good for us, this was a very local phenomenon and the next station at the CVOO site could be undertaken as planned.

Handover at sea of spare parts by the coast guard.



Increased wind speed during the time of the spare part handover. Large red circles indicate faster wind speeds.

Currently the 74th station is running and the AUV Tiffy finally completes its first dive thanks to the O-ring delivery. The weather has improved a bit compared to last week and there are only rare cases of seasickness among the scientific crew. The 2 days during which the eddy was surveyed via CTD and ADCP served as a small recovery break for all (except the CTD team, who worked through with dedication), which was used for instrument preparation and relaxation in the ship's own hot tub. Thus, everyone is well prepared for the upcoming program that will survey, sample and observe the eddy in the next few days using all methods at our disposal.

With best regards from all involved,

Jens Greinert

GEOMAR Helmholtz Centre for Ocean Research Kiel