M136

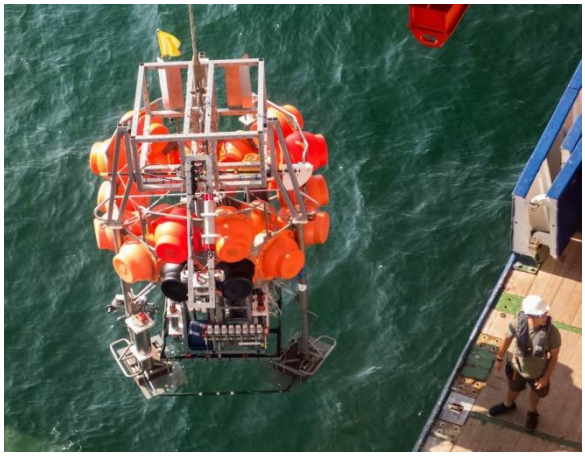
(11.04. – 3.05.2017)

2. Wochenbericht vom 23. April 2017

The work program during the second week of the cruise was completed successfully. The process study investigating fronts and filaments in the southern working area at 14°S ended on Monday. Also, a drifting sediment trap at 14°S deployed during the first week of the cruise was recovered. During the transit to the main working area at 12°S we recovered two gliders. Due to their real-time data transmission capabilities, they helped the identifying fronts and filaments for the process study. Now they are needed for determining high-resolution distributions of hydrography, oxygen, and nutrients and for capturing the variability of turbulent mixing along the 12°S section. The gliders have already been redeployed on the 12°S transect. Altogether, the measurement program along 12°S has progressed nicely. Two of three planned moorings have been deployed; two sediment traps collecting data on the variability of sinking particulate organic matter have been deployed and numerous biogeochemical analyses from water samples and sediment samples taken by a multi corer have also been conducted. Additionally, three 40-hour deployments of the Biogeochemical Observatory (BIGO) Landers have successfully been completed.

Glider deployment on the 12°S section (Photo: G. Krahmann)

The major objective of this research cruise is to quantify benthic and pelagic nutrient and trace metal cycling in oxygen minimum zones (OMZs). In difference to previous measurement programs on solute cycling processes in OMZs, our investigations focus on the coupling between benthic and pelagic nutrient and trace metal fluxes by performing simultaneous flux measurements in both habitats.



Deployment of a BIGO lander (Photo: J.F. Schubert).

The strength of nutrient and trace metal cycling processes in the sediments is quantified using the BIGO landers. During the deployment period, changes of nutrient and trace metal concentrations due to solute fluxes between the sediments and overlying waters are determined in two chambers. The BIGO Lander automatically inserts the chambers into the sediments two hours after deployment.

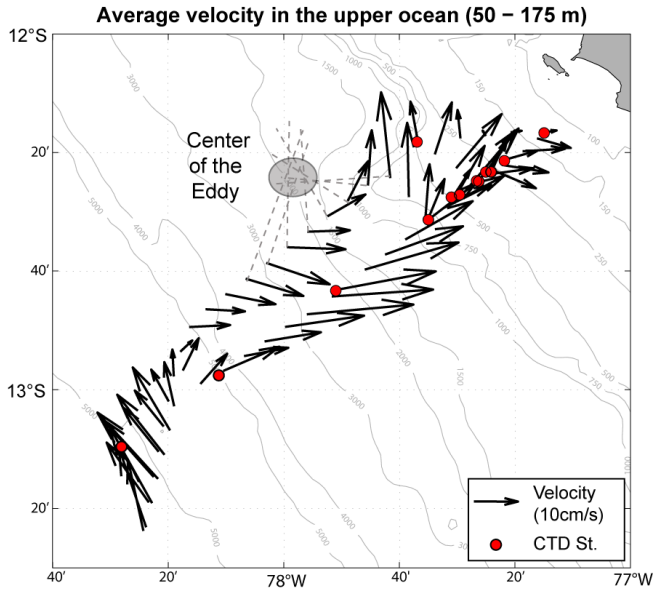
While the BIGO landers are deployed, microbial nutrient and trace metal cycling rates are determined in different depths of the water column above the deployment positions. The water column cycling rates are determined by incubations with ^{15}N, ^{13}C and ^{18}O labelled compounds and by genetic analysis to identify different microbial strains and to quantify their activity. The water column cycling rates are determined by colleagues from the Max-Planck Institute for Marine Microbiology in Bremen.

Deployment of moored profiler, a CTD and velocity profiler that crawls vertically along a mooring wire (Photo: M. Dengler).

Microbial nutrient and trace metal cycling rates in the benthos and the water column are linked to physical transport processes of these solutes. A major aim of this cruise is quantifying physical solute fluxes in the water column sustaining solute cycling processes. By balancing physical transport processes in combination with the benthic flux measurements, the loss of nutrients and trace metals in the oxygen minimum zones will be determined. This requires determining turbulent fluxes, lateral-diffusive fluxes as well as advective fluxes in the water column. For determining lateral diffusive and advective fluxes we deploy moorings equipped with current meters and perform ship-based measurements of nutrient and oxygen concentrations, hydrography and upper-ocean velocity. Turbulent fluxes will be calculated from ship-based and glider-based measurements of stratification and microstructure shear and temperature data collected by microstructure probes. Temporal variability and trends in nutrient and oxygen concentrations are recorded by the autonomous glider platforms measuring oxygen and nutrient concentrations on the transect for the next 60 days.

Left: Deployment of a drifting sediment trap. Sinking organic particles are trapped and preserved by cylinders mounted to a wire at several different depths and attached to a surface buoy. (Photo: J.F. Schubert). Right: Frederic, Carolina and Jon preparing the sediment trap (Photo: M. Dengler).

Nutrient cycling processes in oxygen minimum zones are driven by organic matter export from the sunlit upper ocean into the deeper ocean. However, our current understanding of the variability of sinking organic matter is very limited and only a few export rates within oxygen minimum zones exist. During our cruise, export rates of particulate organic matter and organic matter degradation rates in the water column are quantified by using drifting sediment traps and by measuring Thorium concentrations using in-situ pumps. The investigations focus on the impact of oxygen concentrations on degradation rates and on patterns of organic geochemical tracer changes during degradation processes. Until last Sunday, we successfully completed two of the four sediment trap deployments. During both deployments, the retrieved cylinders were nicely filled with organic material suggesting a successful processing of the data. A third sediment trap was already deployed at 5000m depth on the 12°S section.



Average currents between 50m and 175m depth (arrows). The data suggest a pronounced anticyclonic eddy north of our transect having a center at about 12°20'S, 78°W. (Graphic: J. Lüdke)

Upon our arrival at 12°S we noticed that upper ocean velocity was behaving unexpectedly. The shipboard velocity measurements by METEOR's ocean surveyors did not indicate the expected southeastward flow along the topography associated with the Peruvian Undercurrent. Instead, a strong flow directed towards the coast was revealed with a current core at about 100m depth. In the following days, we obtained a more detailed picture of the upper ocean currents particularly during transit for deploying and recovering the sediment traps. Now we assume that the onshore flow is the southern flank of an anticyclonic eddy that likely developed just a few days before we reached the 12°S section. Eddies generated at the eastern boundary transport nutrient-rich waters toward the continental slope and thus play a crucial role for the maintenance of high biological productivity at the coast of Peru. Currently, we are making plans to adjust the observational program to survey physical and biogeochemical parameters of the eddy.

Yesterday marked the zenith of our cruise and we celebrated this event with a barbeque dinner on deck. The atmosphere on board and the food is excellent and we are enjoying the outstanding collaboration with Captain Schubert and his crew.

Best regards from the tropical South Pacific,

Marcus Dengler and the participants of M136