FS METEOR Cruise M189

04/16 – 05/13/2023

Walvis Bay (Namibia) – Walvis Bay (Namibia)

4th Weekly Report (May 1-7, 2023)

This week, our work continued to focus on the tropical upwelling region off Angola. Unlike the Benguela upwelling region to the south, the upwelling off Angola exhibits a strong seasonal cycle and is particularly pronounced during the months of July to September. For this period, satellite data and in-situ measurements show the highest primary production and low surface temperatures along the coast. In contrast, winds along the coast and their rotation, which are the driving forces for cold and nutrient-rich water rising along the coast in many ocean upwelling regions, are weakest from July to September. Using data sets from previous cruises, we recently demonstrated that the seasonal variations in upwelling are caused by an interplay of coastally trapped waves and turbulent mixing processes. A major focus of the measurement program for this cruise, which is taking place during minimum coastal upwelling, is to investigate mixing processes and its relation to stratification near the coast to fill remaining gaps in our understanding. This process understanding is necessary to achieve improved predictions for the evolution of upwelling areas and their productive ecosystems in an ocean that is changing due to climate warming.

On Monday, we conducted current and hydrographic measurements along a section perpendicular to the coastline at 6°S. These data sets taken just south of the Congo estuary give us, among other things, indications of the freshwater transports into the upwelling area to the south, the variability of which also plays a role in the formation of interannual Benguela Niños events.

Fig. 1: Recovery of the acoustic Doppler current profiler and buoyancy after a 13 month deployment period from 11°S. The upward-looking instrument was attached to the mooring line at 500m depth. The velocity records are shown in Fig. 2.

Sampling of the 11°S section that was started last week continued on Wednesday and was completed on Thursday. On Thursday afternoon, we recovered the long-term mooring deployed at a water depth of 1200m to record the variability of the boundary current circulation in the tropical Angolan upwelling region (Fig. 1), which has been maintained for almost 10 years by GEOMAR in collaboration with the Instituto Nacional de Investigação Pesqueira in Luanda. We are pleased to report that all instruments have functioned flawlessly (Fig. 2).

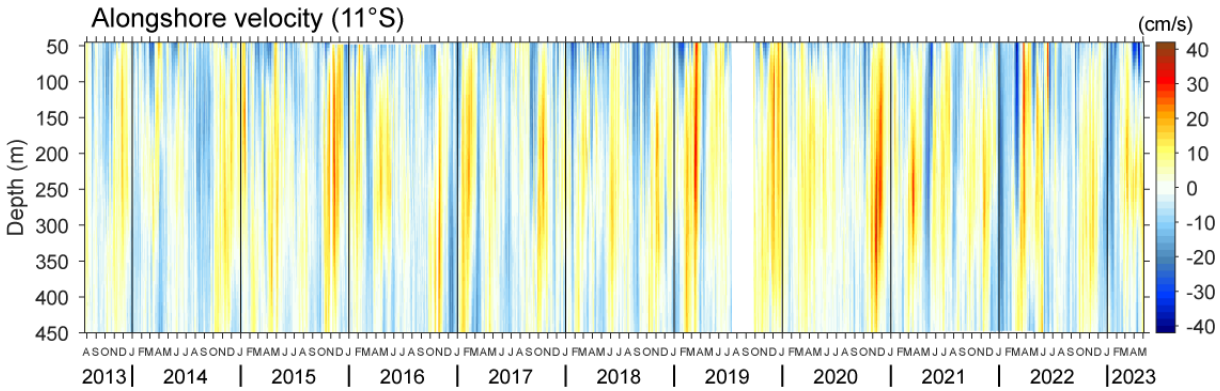

Fig. 2: Timeseries of the alongshore velocity in the upper 500m of the water column as measured by the long-term mooring from the continental slope at 11°S (April 2022 until May 5, 2023). Velocity records from previous mooring periods are added as well. Negative values indicate poleward currents. The high variability of the circulation occurring on intraseasonal time scales is caused by coastally trapped waves propagating poleward along the continental slope, which are predominantly excited in the equatorial Atlantic by changing winds.

Fig. 3. Artisanal fishing boats off Porto Amboim.

On Friday evening, we found that one of our gliders had not surfaced at the predicted position, but about 8 nautical miles to the southeast. On its own, it could not possibly have moved that far away. Therefore, we discontinued our station work and headed for the last known position of the glider. At first, however, our search was unsuccessful; we could neither find an AIS signal, nor small fishing boats by means of ship radar in the area. Renewed position reports of the glider shortly after midnight indicated that it was already in the roadstead off the town of Porto Amboim, about 10 nautical miles south of our 11°S section. After continuing the station work until Saturday morning, we went first with FS Meteor and later with the rubber boat to the position of the glider. Thanks to the very accurate GPS information, we were able to quickly locate the fishing boat, about 8 m long, among the many boats lying there (Fig. 3). The fishermen, at first surprised by our visit, were very cooperative and both sides were very happy about an exchange deal in which we got back our intact instrument for ship's paint, oilskins, sunglasses and some supplies from the store of the first steward. It must have been a great coincidence that the fishermen had caught the glider with their net - the seine nets on board the boat seemed to us to be shorter than 300m.

In the afternoon, as a precautionary measure, we picked up the remaining glider and deployed the long-term mooring back to its previous position. Over the night until the next morning, further turbulence measurements were carried out on the 11°S section into shallow waters.

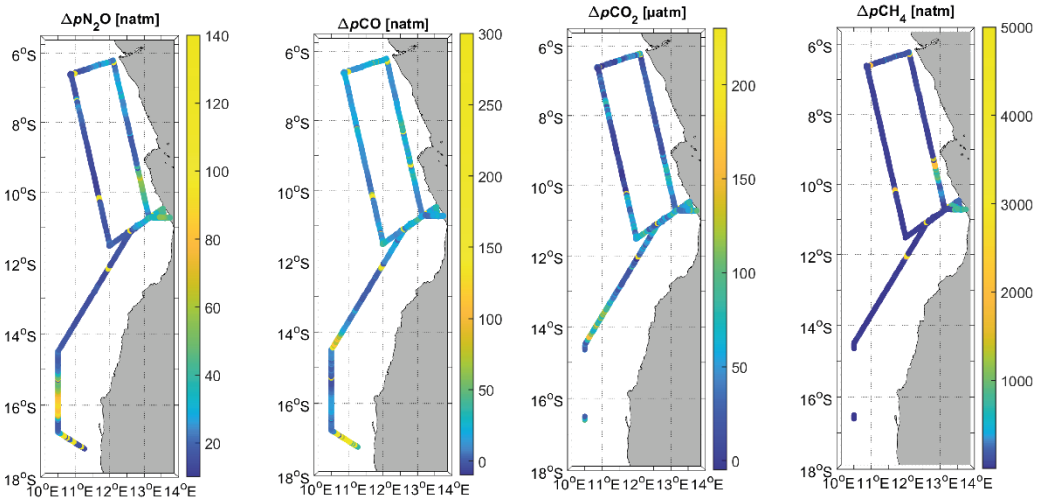

Fig. 4: Distribution of the difference in partial pressures of nitrous oxide (N_2O, left), carbon monoxide (CO, middle left), carbon dioxide (CO_2, middle right), and methane (CH_4, right). Values greater than zero indicate regions where the ocean emits trace gases.

Since the second sailing in Walvis Bay, we have been continuously measuring the concentration of dissolved trace gases in the surface waters and the atmosphere above the ocean along our sailing route. Our measurements include concentrations of nitrous oxide (N_2O), carbon dioxide (CO_2), carbon monoxide (CO), and methane (CH_4). For concentration determination, we use an autonomous high-resolution spectroscopic analyzer. From the difference of the partial pressures of the gas concentrations in the ocean and the atmosphere, the amount and direction of the flux of greenhouse gases can be estimated. Today, the measurement methods have been refined so that even small differences in concentration can be determined.

A first evaluation of our data sets (Fig. 4) shows an equilibrium between the ocean and the atmosphere in larger regions. In contrast, in the nearshore regions between 9°S - 11°S and also in the cyclonic eddy at 16°S, the ocean emits nitrous oxide, methane and carbon dioxide. The low oxygen concentrations found on the shelf during the cruise form the basis for microbial production of nitrous oxide, which is then emitted to the atmosphere.

Abb. 5: A large part of the M189 team.

In 5 days, we will have reached Walvis Bay harbor. A successful but also very work-intensive research cruise has nearly come to completion. We are grateful to Capitan Hammacher and his crew for the excellent collaboration and the pleasant working atmosphere during the cruise. The crew of FS METEOR greatly contributed to the success of the cruise. Likewise, I am grateful to the dedication and commitment of the scientists, the technical staff and the students who equally contributed to the success.

Best regards from the southeastern tropical Atlantic Ocean

on behalf of the cruise participants of M189,

Marcus Dengler

(GEOMAR Helmholtz Centre for Ocean Research Kiel)