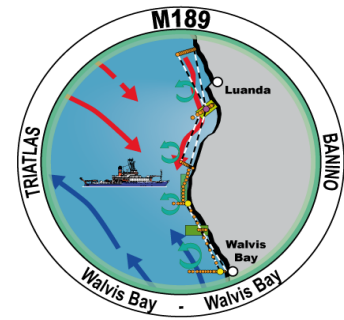


# FS METEOR Cruise M189

04/16 – 05/13/2023

Walvis Bay (Namibia) – Walvis Bay (Namibia)



## 3<sup>rd</sup> Weekly Report (April 24 - 30, 2023)

The third week of our cruise began with a port call in Walvis Bay, Namibia, where we arrived on Monday afternoon. All customs formalities were quickly completed and scientific instruments that arrived late were taken on board. At 7 p.m. we left the port heading north to carry out our measurement program off the coast of Angola.

On Wednesday morning, two hours before entering Angolan territorial waters, the requested exemption from the temporary import and export tax for FS METEOR was granted by the Angolan General Tax Administration (AGT). We would like to express our sincere gratitude to Dra. Filomena Vaz Velho, Director of the Instituto Nacional de Investigação Pesqueira (INIPM) in Luanda, Angola, for her support in applying for the tax exemption. Without her professional help, tax exemption would not have been possible.

The granted tax exemption also allowed the continuation of our measurement program. With wind and waves from astern, FS METEOR changed course to sample the currents and stratification in the Angola-Benguela Frontal Zone (Fig. 1). The

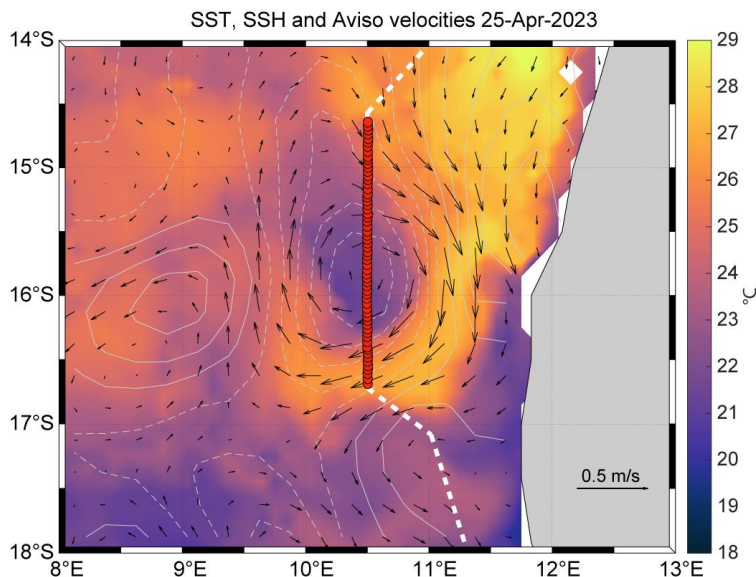


Fig. 1: Satellite-derived distributions of sea surface temperature (colour contours), sea level anomaly (thin white lines, negative anomalies are represented as dashed lines) and sea-level anomaly-derived surface currents (arrows) from April 25, 2023. METEOR's cruise track is indicated by the thick dashed lines and positions of underway CTD casts are marked by red dots.

Angola-Benguela Front separates warm surface waters to the north from cold waters to the south. Its position varies between 15°S and 17°S and temperature differences across the front range from 5°C to 10°C. The presence of the front is due to two opposing easterly boundary currents, the southward-setting warm Angola Current and the northward-setting Benguela Coastal Current. In the frontal zone region, interannual oceanic heat or cold waves, so-called Benguela Niños or Niñas, are pronounced. These extreme events have a strong impact on the local climate and the marine ecosystem.

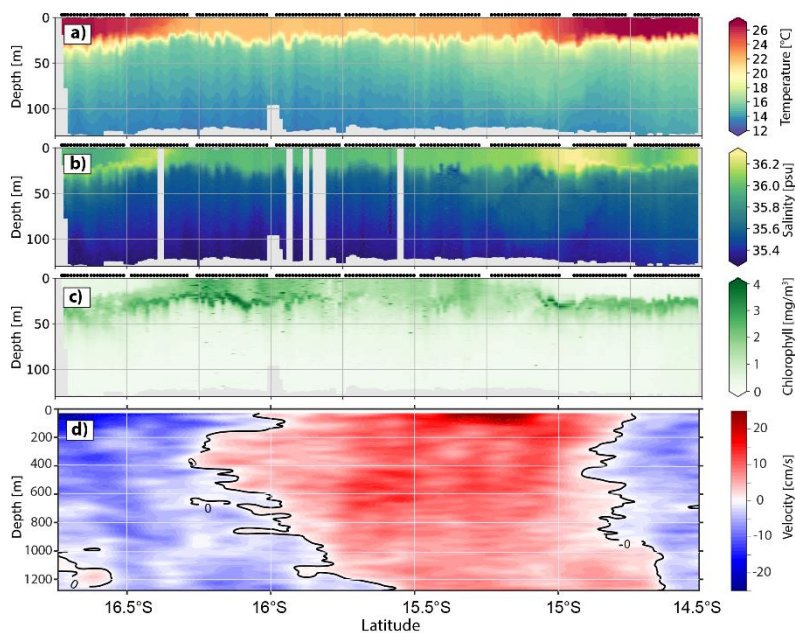


Fig. 2: Meridional Distribution of (a) temperature, (b) salinity, (c) chlorophyll and (d) zonal velocity (30-1200m) along the section through the cyclonic eddy as indicated in Fig. 1.

Upon arrival in the study area, we found the Angola-Benguela Front shifted far to the south, and was located at about 17.5°S. In contrast, surface temperature maps from satellites (Fig. 1) and our in-situ measurements (Fig. 2) show a circular patch of cold water at 16°S surrounded by warm water, which also exhibit temperatures above 26°C on its southern flank. The cold water represents the core of a mesoscale cyclonic eddy. Satellite retrievals suggest that the cyclone formed in mid-March and subsequently propagated westwards.

Very high chlorophyll concentrations, exceeding those measured in the northern Benguela upwelling region, occur especially at the temperature fronts in the vortex. This indicates elevated submesoscale processes occurring at the fronts of the eddy. Velocities measured with the shipboard ADCP (Fig. 2d) further suggest that eddy-associated currents reach to great depths. Recent satellite data-based studies of eddies in the South Atlantic indicate the formation of an average of two mesoscale eddies per year in this region - so we were very fortunate to sample such an event. The analysis of the obtained in-situ data set will allow conclusions about eddy formation and will thus lead to a better understanding of the physical processes in the Angola-Benguela Front.

After completing the sampling of the eddy on Thursday afternoon, we set course for the coastal region off Angola at 11°S. The high water and air temperatures and the decreasing wind north of 15°S led to an abrupt change of clothing of all cruise participants and a busy working deck. In the evening we celebrated the mid-cruise festival with an excellent barbecue on deck.



Fig. 3: Mid-cruise barbecue of M189.

With weak southeasterly winds and temperatures around 30°C, we reached our main study area in Angolan waters at 11°S on Friday afternoon and started with CTD and microstructure measurements along section perpendicular to the coast. For almost 10 years, GEOMAR, in collaboration with the Instituto Nacional de Investigaç o Pesqueira in Luanda, has maintained a mooring on this transect to sample the variability of the boundary current circulation in the tropical Angolan upwelling area. The flow and hydrographic datasets from this mooring have

fundamentally changed the understanding of the circulation and its variability and have already been incorporated into many publications.



Fig. 4: Deployment of the glider having an Underwater Vision Profiler attached.

On Saturday, we deployed two landers equipped with current profilers on the shelf, a mooring on the continental slope, and released three gliders with different auxiliary sensors to sample the physical and biogeochemical processes associated with upwelling in tropical Angolan upwelling region. For the first time, we also included a glider with an optical Underwater Vision Profiler as an auxiliary sensor (Fig. 4). In recent years as well as on this current cruise, similar instruments have been deployed during station work on the CTD rosette. The instrument, which consists of

an HD camera and LED lights, measures the number of particles in different size classes and stores images of larger particles for later identification. The measurements of the Underwater Vision Profiler aim to better understand the uptake of carbon dioxide in the ocean and the global carbon cycle.

This Sunday morning we set course to 6°S to take a section south of the Congo River mouth. Besides the good weather conditions, the excellent cooperation with Captain Rainer Hammacher and the crew of METEOR is certainly a reason for the very good mood on board.

Best regards from the southeastern tropical Atlantic Ocean  
on behalf of the cruise participants of M189,

Marcus Dengler  
(GEOMAR Helmlotz Centre for Ocean Research Kiel)