FS METEOR

Expedition M203 “BOWTIE”

10. August 2024 - 24. September 2024 | Mindelo - Bridgetown

4 . Weekly Report (26.08.2024 - 01.09.2024)

We spent the fourth week of our cruise in the ITCZ in the Eastern Atlantic. For several days we experienced very light and variable winds characteristic of the doldrums, with embedded convection and even thunderstorms. On the 27th of August we performed coordinated measurements with the German research aircraft HALO and the King Air aircraft operated by Norwegian colleagues. Both planes flew several direct overpasses of FS METEOR (figure 1). One of the objectives of the coordinated measurements are the comparison of remote sensing retrievals from the upward looking instruments on FS METEOR and the downward looking instruments of HALO with the in-situ measurements of cloud properties from the King Air. The fast moving planes which fly every few days also complement the continuous ship-based measurements giving us a more complete picture of the ITCZ.

On the 28th of August FS METEOR picked up drones, a replacement part for the radar and two drone pilots outside the harbour of Praia to make the BOWTIE experiment finally complete, after global logistics had let us down before our departure from Mindelo nearly two weeks earlier. Captain Korte

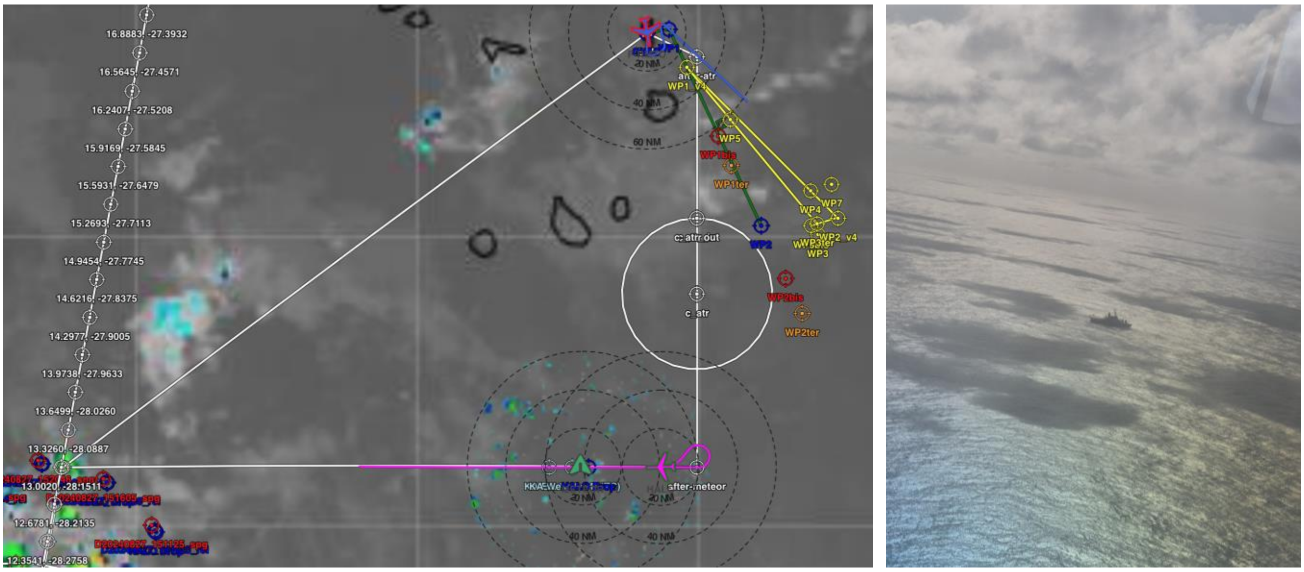

Figure 1: The left figure shows FS METEOR (green arrow), HALO (pink plane), the French ATR plane just after take-off from Sal in the North and the EarthCare satellite orbit on the left. The background shows the SEA-POL radar measurements around FS METEOR. The right photo shows FS METEOR as seen from the King Air aircraft (taken by Tim Carlsen).

and the German Research fleet coordination centre contributed greatly to make this transfer possible. On Thursday we started with the recovery of the autonomous oceanographic instruments that were deployed 11 days earlier as part of a process study on inertial waves at 11.5°N, 23°W (Figure 1). Inertial waves in the ocean are excited by clockwise rotating winds. The period of the rotation must correspond approximately to the local inertial period, which at 11.5°N is exactly 2.5 days. The necessary atmospheric conditions in our working area are caused by tropical waves forming over Africa, which migrate westwards and can grow into tropical cyclones over the Atlantic. These waves are also associated with very heavy rainfall in the Intertropical Convergence Zone, which we have already experienced onboard on several occasions.

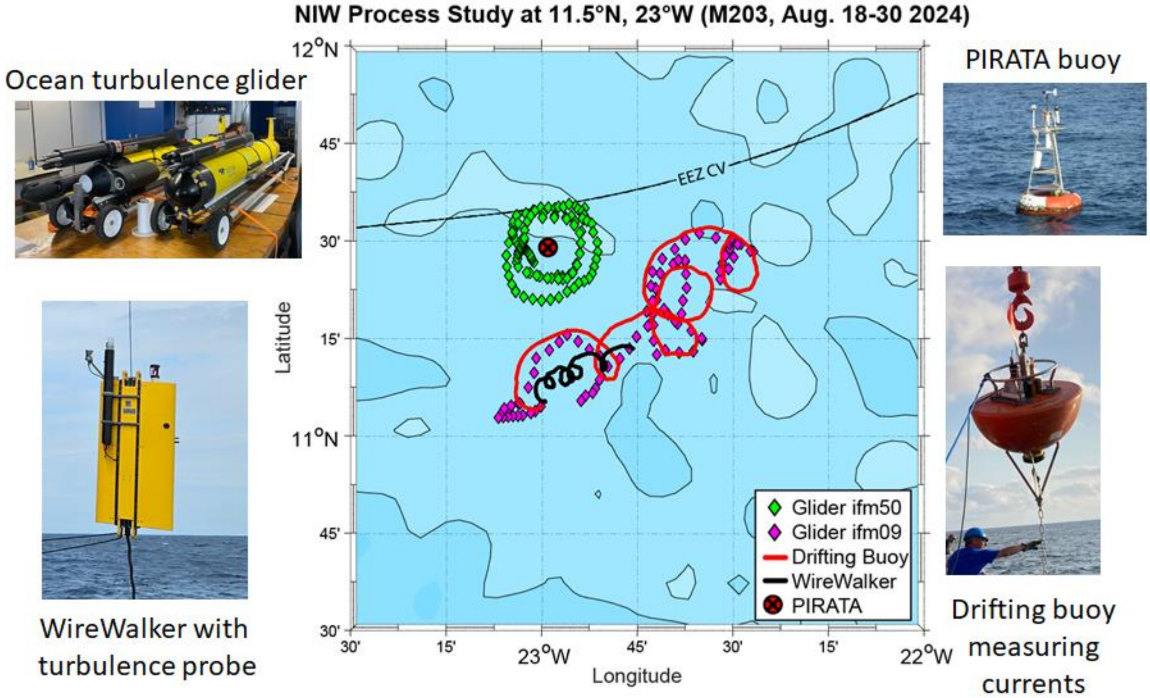

Figure 2: Overview and positions of the autonomous measuring devices deployed as part of the process study on inertial waves.

Although the winds within tropical waves rotate counterclockwise, clockwise rotating winds prevail on their northern flank due to their westerly propagation of the waves. Under these conditions, momentum is very effectively transferred from the atmosphere to the ocean and the ocean reacts with strong, also clockwise rotating circular currents in the surface layer, i.e. in the upper 20 to 40 meters (Figure 2). At the same time, internal inertial waves reaching down to the sea floor are excited, which subsequently propagate towards the equator. Together with the tides, the inertial internal waves represent the energy supplier for the ocean's pronounced internal wave field. The strong circular movements in the surface layer, on the other hand, lead to increased turbulent mixing in the underlying stratified water masses, whereby heat is transferred from the surface to the deeper ocean layers. This mixing process is of crucial importance for the heat balance of the surface layer. At the same time, nutrients are transported from the deep layers of the ocean to the surface, increasing primary production.

For the process study, we used two gliders, a drifting buoy equipped with a current profiler and temperature and conductivity sensors, and a WireWalker. The two gliders and the WireWalker were additionally equipped with microstructure probes, which are used to sample the strength of turbulent mixing. As shown in Figure 2, we observed strong inertial oscillations in the surface layer during the study, which even intensified during the passage of a tropical wave between August 24 and 25. We were also able to detect very high turbulence levels below the surface layer with the microstructure probe used on board our vessel. Exact time series of the intensity of the mixing from the data sets of the microstructure probes of the autonomous devices will be available as soon as these have been post-processed.

Together with the datasets from the meteorological measurement devices on board, which includes detailed records of the horizontal distribution of the wind variability within 200 km of our vessel measured by the SEA-POL radar, we will gain new insights into the momentum flux between the atmosphere and the ocean as well as the inertial wave associated momentum flux to the upper and deeper ocean. Moreover, the data set will allow to quantitatively understand the mixing caused by the inertial waves. Two further process studies are planned for the cruise and will be carried out in the central and western tropical North Atlantic.

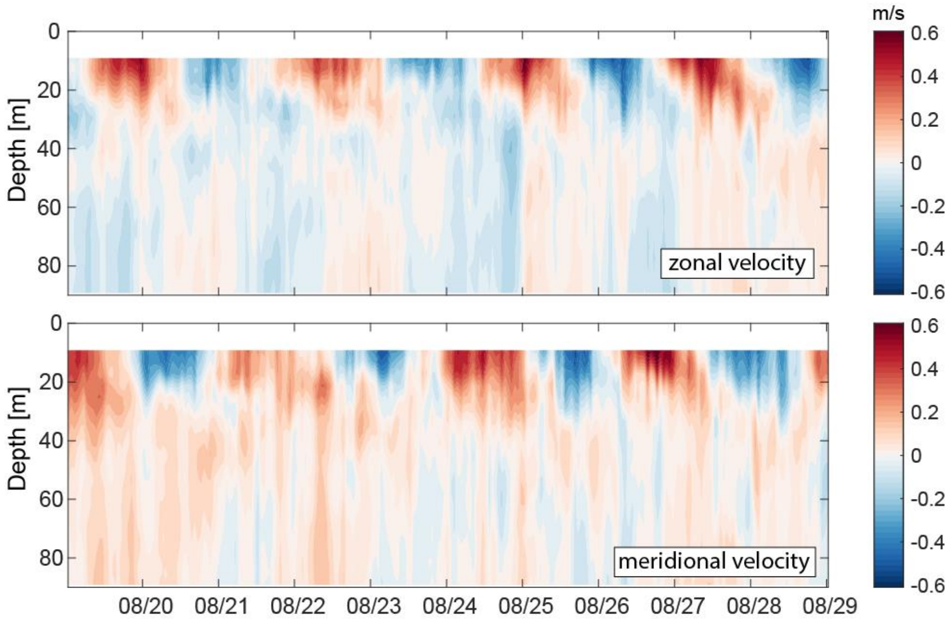

Figure 3: Zonal (top) and meridional currents (bottom) in the upper 90m of the water column measured by the current profiler attached to the drifting buoy. The phase shift between the two current components describes rotating water movements in the upper ocean.

We have now left our working area in the Eastern tropical Atlantic and are currently steaming towards the central Atlantic, where we will re-deploy ocean gliders and drifters and perform transects of the ITCZ along 38°W.

Greetings from all participants of M203 from the tropical Atlantic.

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