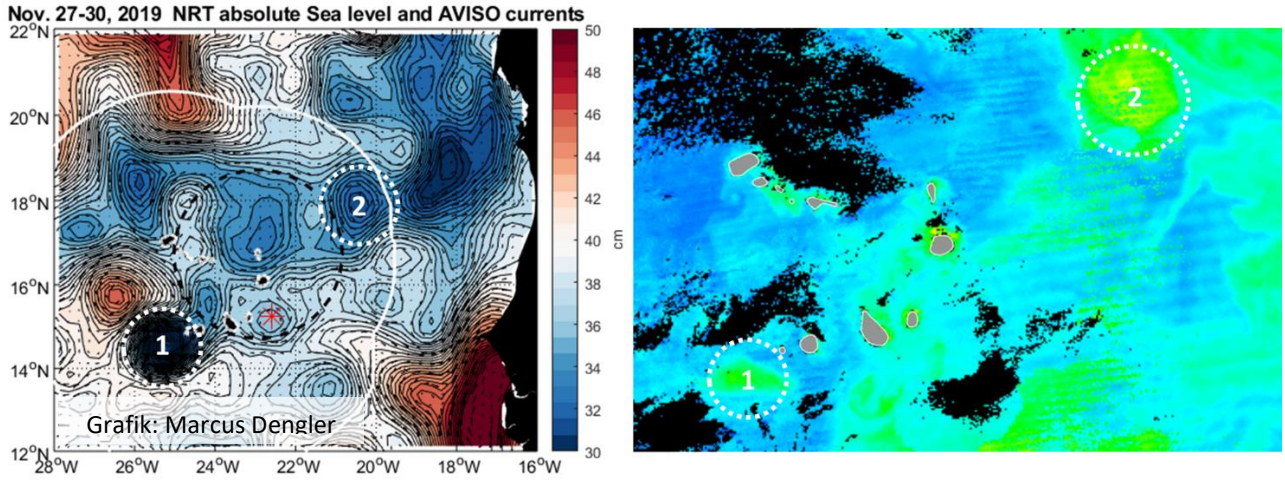
Weekly Report 2: 25.11.-1.12.2019: An entire ship in eddy fever…

In the 2nd weekly report I would first like to explain our approach in the eddy studies of the M160 cruise. It all starts, of course, by identifying individual eddies and select them for a detailed study. As a first step, we use a variety of satellite remote sensing products. By means of their typical properties (temperature, sea level anomaly, chlorophyll concentration) we can usually identify and classify the eddies. The second step is to launch autonomous surface and underwater vehicles to make measurements in these eddies. In addition to gliders, the oceanographic counterpart to a glider plane, wave gliders and, for the first time, sailing drones are also used - all equipped with a whole range of sensors for physical, chemical and biological parameters. All this has been going on for weeks or even months and is still helping us continuously during the expedition.



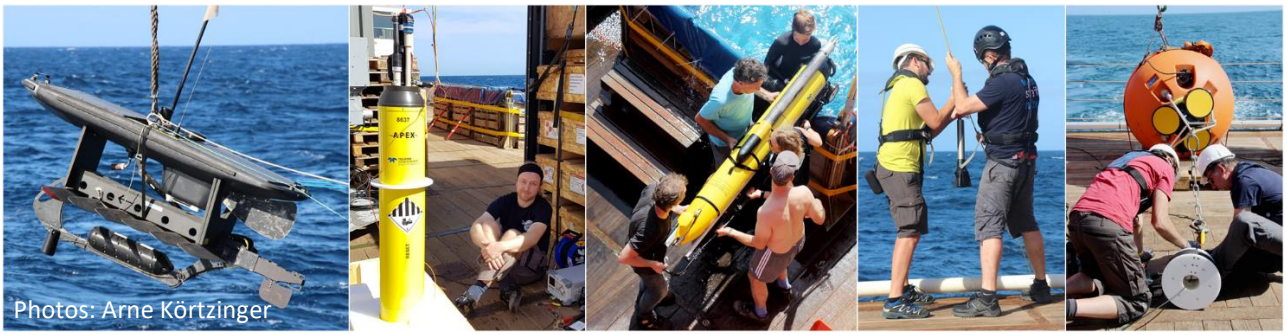
Recent satellite maps of the sea level anomaly (left) and chlorophyll content (right) in the working area. The white line shows the limit of our research permission for Cape Verdean territorial waters, the black dotted line indicates the approximate range of the research glider plane Stemme operating from Cape Verdean island of Sal. The dashed circles indicate the two eddies chosen for our detailed eddy studies.

On the basis of all available information, we have selected two cyclonic eddies that are located in the Cape Verdean EEZ and clearly identifiable. In both eddies, we have now deployed a large number of observational instruments. You can imagine it a little like a patient in the intensive care unit of a clinic with measuring electrodes all over the body. The "electrodes" that we attach to the eddy are gliders (we already have a fleet of 9 gliders in the water), wave gliders (2 in use) and saildrones (2 in use) as well standard and special biogeochemical Argo floats (3 each in use), which drift with the current and regularly measure vertical profiles of the upper 1000-2000 meters, plus surface drifters, which follow the current with the help of a drogue. As with the patient in the intensive care unit, there is of course a proper doctor's visit in addition to these autonomous measurements. We are currently having such a visit at eddy 2 and perform a long list of direct observations and

samplings from the vessel. For this purpose, we have placed a cross-shaped station pattern across the eddy, which extends beyond the eddy boundaries and thus allows us to contrast its properties to surrounding condition. Along this cross, we do station work at short intervals of about 10 kilometers up to a maximum depth of 2000 meters and carry out a large number of underway measurements during steaming.

Underway measurements provide us with continuous data on:

- Currents in the upper 700 meters with different profiling ultrasonic Doppler current meters (ADCP – Acoustic Doppler Current Profiler)
- Near-surface currents with radar system (X-band)
- Vertical profiles of temperature and salinity with towed freefall system (underway CTD, Moving Vessel Profiler)
- Temperature, salinity, oxygen and chlorophyll in the upper 100 meters with towed instrument array
- Temperature, salinity, oxygen, chlorophyll, CO_2 partial pressure, total gas tension, and turbidity with thermosalinograph and a suite of flow-through sensors and systems
- Ocean color with hyperspectral sensors.



A wave glider goes into the water (left), a biogeochemical Argo float is programmed for use (2nd from left), an ocean glider is placed in the seawater pool (center) for ballasting, a CTD sensor is attached to the towed instrument array (2nd from right), a mooring is prepared for deployment.

Measurements on station include the following program:

- Profiling measurements and water sampling with CTD rosette sampler for a variety of biogeochemical (oxygen, nutrients, inorganic and organic carbon parameters, particulate and dissolved organic constituents etc.) and biological properties (bacterial/protist communities, environmental DNA, primary production, bacterial production, bio-optical parameters etc.)
- Sampling of undisturbed particle aggregates (“marine snow”) for decomposition experiments (Marine Snow Catcher)
- Sampling of sinking particles at different depths with drifting sediment traps containing particle-preserving gels
- Imaging of macroscopic particles in the water column with photographic techniques (UVP – Underwater Vision Profiler, CPICS – Continuous Particle Imaging and Classification System)
- Sampling of zooplankton across various depth intervals (Multi-Schließnetz)

The CTD rosette sampler comes out of the water (left) and on deck where the different working groups start sampling according to a well-defined protocol (2nd from left). The multinet is prepared (2nd from right) and goes into the water for the next haul (right).

In order to coordinate this demanding and complex program and to adapt it to the current observations, we have daily work meetings. None of the participants has so far applied such a variety of observation and sampling instruments to a marine phenomenon in a concerted manner. This makes it very exciting for all of us here, even if the dynamics of the eddies sometimes mess up our program.

The first long measurement flight of the research motor glider Stemme just ended and our colleagues from HZG have identified sharp temperature fronts at the edge of our eddy with an infrared camera. There we want to conduct the first of our two experiments on sub-mesoscale frontal dynamics with support from the air in the course of the coming days – but more about this next week.…

With warm advent greetings from all of us,

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