RV METEOR - M181 - "TRATLEQ2"

17.04. - 28.05.2022, Cape Town - Mindelo

5th Weekly Report (09. - 15.05.2022)

During the fifth week of METEOR cruise M181 we continued our measurements along the equator. On May 12th we arrived at the exclusive economic zone of Brazil southeast of the Brazilian Saint Peter and Saint Paul Archipelago, a group of 15 small islets and rocks just north of the equator. While the archipelago was designated an environmental protected area already in 1986, it became evident for us only shortly before the cruise that the Brazilian Ministry of Environment requires a separate application for measurements in that area. With the help of our Brazilian partner at the Federal University of Pernambuco, the German embassy in Brazil and the German Research Fleet Coordination Centre, we were able to submit such an application and finally received authorization, first from the Brazilian Ministry of Environment and finally on May 11th, just one day before the measurements were planned to start, from the Brazilian Navy. We would like to thank everyone involved for their help allowing the continuation of our scientific work along the equator.

One of the major goals of the TRIATLAS project is to better understand the current status of the tropical Atlantic marine ecosystem. During METEOR cruise M181, we are specifically focusing on the physical drivers of biological productivity in the equatorial upwelling system by studying phytoplankton, zooplankton, and fish populations as well as primary production by phytoplankton. We combine various tools and techniques covering a wide range of spatial scales, from satellite data (Fig. 1) that provide us phytoplankton concentrations across 1000s of kilometres covering the whole ocean basin, to camera and acoustic systems that provide us images of objects as small as 10 micrometres. Specifically, we use camera and acoustic systems attached to a newly designed CTD rosette frame to take pictures and measure echo of soundwaves reflected by objects such as plankton and fish as the rosette travels from the surface to the bottom of the ocean. We also use captured water from different depths using the Niskin bottles on the CTD rosette for rate measurements and other analyses.

There are two kinds of camera systems on the CTD rosette. The Plankton Imaging with Scanning Optics (PISCO) system is a prototype camera system developed at the GEOMAR Helmholtz Centre Kiel and is being used for the first time in deep ocean environment during this cruise. The system consists of a light source and a camera to record the shadow of objects. This technique allows us to take pictures and count transparent organisms such as jellyfish (Fig. 2) that are fragile and cannot be easily studied for example by using the zooplankton multinet, which is used during our cruise as well. The novel feature of the PISCO system is a highspeed tunable lens that allows it to scan the focal plane through the whole field of view within one single exposure of 16 microseconds duration. PISCO can detect organisms between 300 micrometres and

several centimetres in size. The second camera on the CTD rosette is part of the Underwater Vision Profiler (UVP5) consisting of a down-facing HD camera and two red LED lights. This camera can take pictures and identify objects between 50 and 500 micrometres in size. Thus, this system is useful to count different kinds of zooplankton (Fig. 3) as well as large colonial phytoplankton such as *Trichodesmium*. The UVP5 is also used to measure the size and number of particles through the water column to estimate the export of carbon from the ocean surface to the deep ocean.

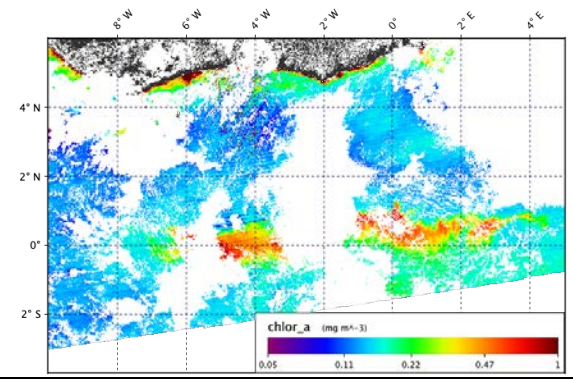

Fig. 1: *Satellite image from May 1st, 2022 of a phytoplankton bloom that has lasted over 3 weeks already.*

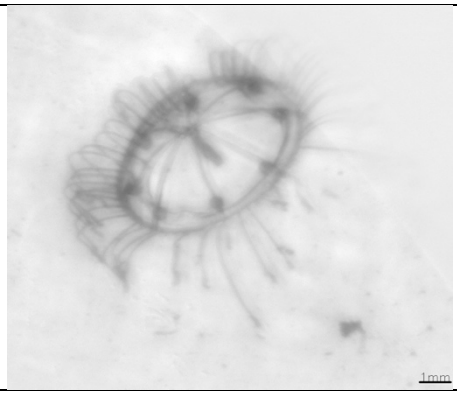

Fig 2: *A jelly fish image captured with the PISCO camera at 33 m depth.*

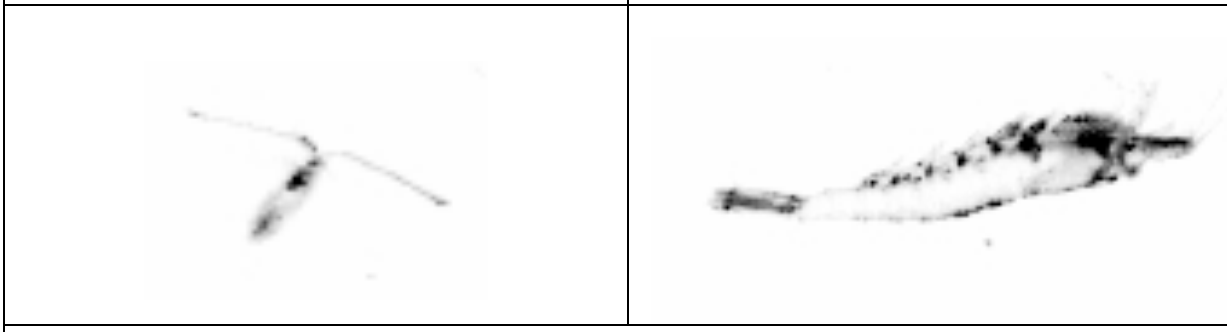

Fig. 3: *Images captured by the UVP5 - (left) copepod and (right) krill.*

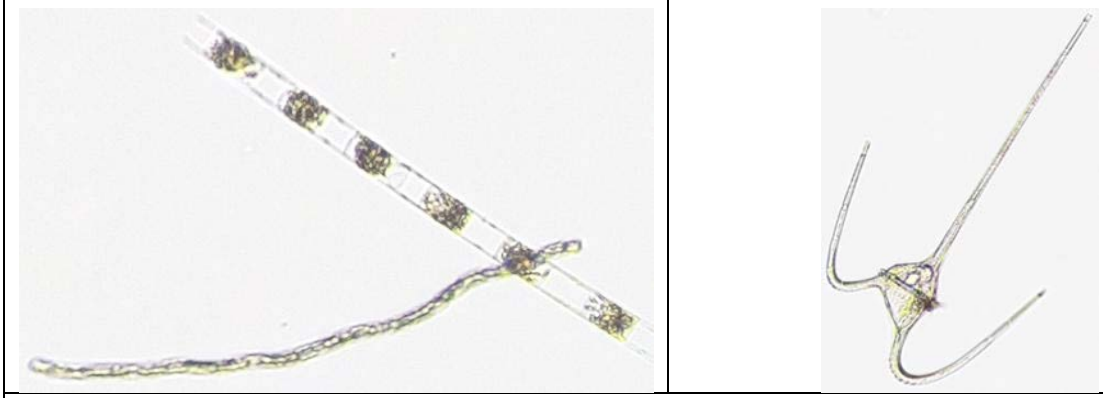

Fig. 4: *Images of phytoplankton captured by the Planktoscope. (left) A chain of the diatom Hemiaulus with symbiotic cyanobacteria and a single trichome of Trichodesmium that were abundant at the bloom around 2° East. (right) Image of the dinoflagellate Ceratium.*

Onboard METEOR we use a Planktoscope – an open-hardware, open-software low-cost imaging microscope to take pictures and count objects in the 10-200 micrometre range. We are using this device to identify phytoplankton and small zooplankton by filtering about 100-200 L of water from the ship's flow through system. We were able to use this system to identify the dominant organisms in a major bloom that extended almost 1000 km along the Equator from about 4° East to 6° West (Fig. 1) to be of nitrogen fixing Diatom Diazotroph Associations and *Trichodesmium* (Fig. 4).
The Acoustic Zooplankton and Fish Profiler (AZFP) is a device that sends out sound waves at four different frequencies (38, 125, 200 and 455 kHz) and measures the echo to study zooplankton and micronekton (e.g., fishes, crustaceans and cephalopods) populations within 30m of the CTD. A substantial part of the zooplankton and micronekton community stays at depth during the day to avoid being eaten and move near the surface at night to feed, making a longer migration than the famous wildebeests of Africa when measured in terms of their body length and distance travelled. This can be seen in Fig. 5 where the deep scattering layer is at around 300-400 m during the day but between the surface and 100 m at night.

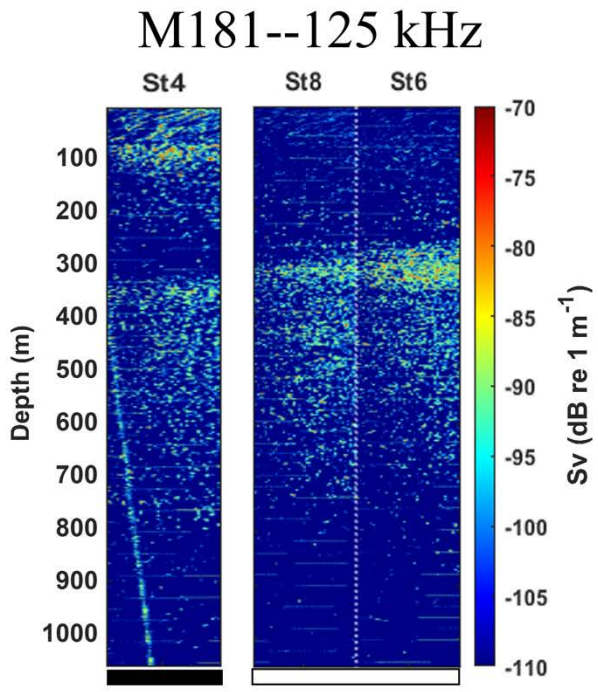

Fig. 5: *Backscatter intensity measured by the AZFP showing copepod populations as bright dots. A copepod population can be seen between the surface and 100m at night (St4, left) while they are deeper, between 300 and 400m during the day (St8 and St6, right). The bright diagonal line seen on the left image is potentially the acoustic signal from the altimeter on the CTD.*

In addition to these measurements, we also take water samples from different depths using the CTD rosette to measure primary production and nitrogen fixation rates and to study the phytoplankton community by measuring diagnostic pigments that are

specific to different phytoplankton groups. These samples will be taken back to laboratories on land for later analysis.
Meanwhile, the station work along the equator is running routinely between the different day and night shifts. Stations that include regular CTD casts, zooplankton multinet stations, thorium pump stations, radiometer measurements and microstructure stations are separated by one 1° longitude corresponding to 5-6 hours of ship time. Time between the station is used for the necessary work in the labs of METEOR or for the calibration and analysis of the data acquired so far. But surely there is time for social activities such as table football, wine tasting or following the final games of the soccer season. Here, we want particularly mention the excellent food on board of METEOR that is served in top quality respecting quite a variety of special demands such as from our vegan and vegetarian cruise participants. Special thanks to the ship's cook team.

Greetings from the tropics and the cruise participants of M181,

Peter Brandt
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