RV SONNE

Cruise SO285 "TRAFFIC 2"

Emden – Emden,

20th August – 2nd November 2021

3. Weekly report

Reporting period: 30st August - 5th September 2021

During this week we continued our cruise along the central tropical Atlantic, with 4 different stations on our way, beginning at 11°N and ending at 4°S. Here, we gathered data for the validation of satellite retrievals from various sensors orbiting the Earth. Gaining insights from outer space is thereby of great importance, as it allows us to embed our shipboard measurements into the broader feature resulting from the dynamic of coupled ocean and atmospheric processes. The use of satellite images, which we are provided with on a daily basis through our partners of Plymouth Marine Laboratory, in the UK, are therefore essential for the planning of our expedition, as well as for the analysis and interpretation of our measurements.

Despite the numerous physical parameters such as the sea surface temperature and sea level height, we are especially interested in the ocean color, which is typically used to derive chlorophyll concentrations and primary productivity on local as well as global scales. Primary production is thereby a measure of the amount of CO_2 which is photosynthetically assimilated by phytoplankton.

In contrast to our shipboard measurements, satellite data are mostly restricted to the surface layer and depths of no more than 40 m, which resembles depths of the so-called mixed layer (ML) at our stations in the subtropical and tropical Atlantic. Below the ML lies the thermocline, which separates the surface layer from waters of the deep ocean, and mostly remains undetected by satellites.

Our plankton research and CTD casts have thereby revealed two overlaying production regimes which largely operate in the shadow of satellite observations. The so-called new production dominates the deeper regime, whereas the upper regime is mostly characterized by regenerated production. These terms have been introduction to science around 45 year ago and refer to different nutrient sources feeding primary producers. New production relies on nutrients that are being uplifted into the sunlit surface ocean (euphotic zone) with nutrient enriched deep waters. Regenerated production, in turn, is based on nutrient recycling within the euphotic zone that comprises the ML and thermocline at our stations (figure 1). Since newly introduced nutrients were consumed at the basis of the euphotic zone through new production and recycling strongly reduces the accumulation of nutrients in ambient waters, nutrient concentrations close to zero characterize the euphotic zone at our sampling sites.

The majority of plankton occurred between the basis of the ML and the oxygen peak at a water-depth of about 40 m. Below this depth, plankton biomass decreased and revealed a minimum at the basis of the thermocline. Dinoflagellates dominated the phytoplankton community in the upper part of the euphotic zone, while cyanobacteria (*Prochlorococcus*) were enriched in the deeper part of the thermocline.

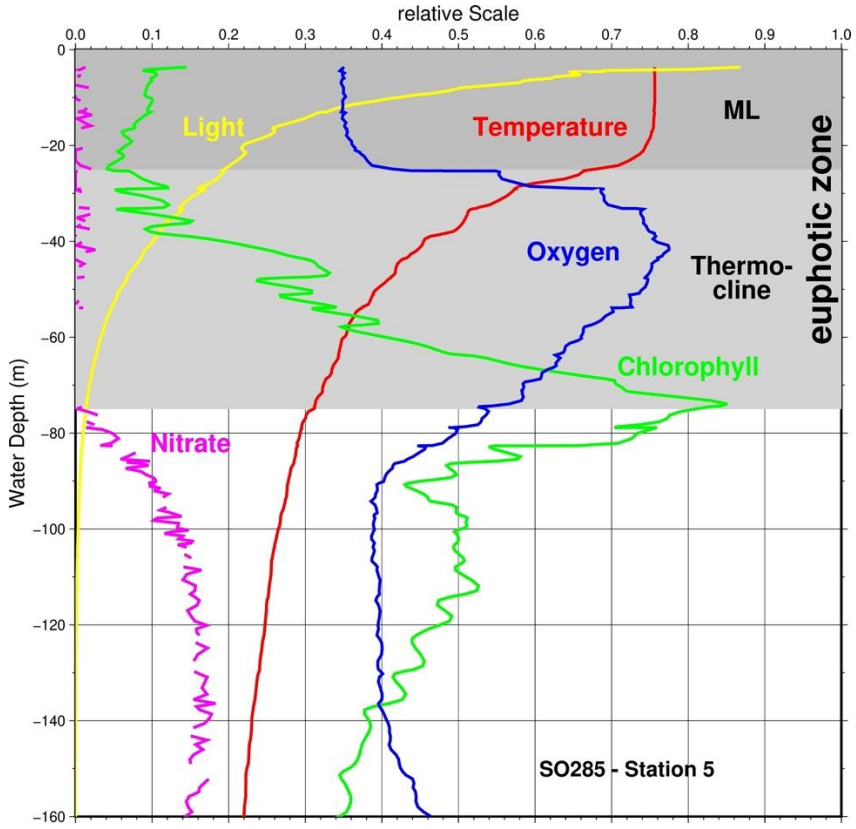

Figure 1: Vertical structure of the upper water column based on physical properties (ML and thermocline) as well as biogeochemical characteristics (euphotic zone, chlorophyll- und production-(oxygen-) maximum).

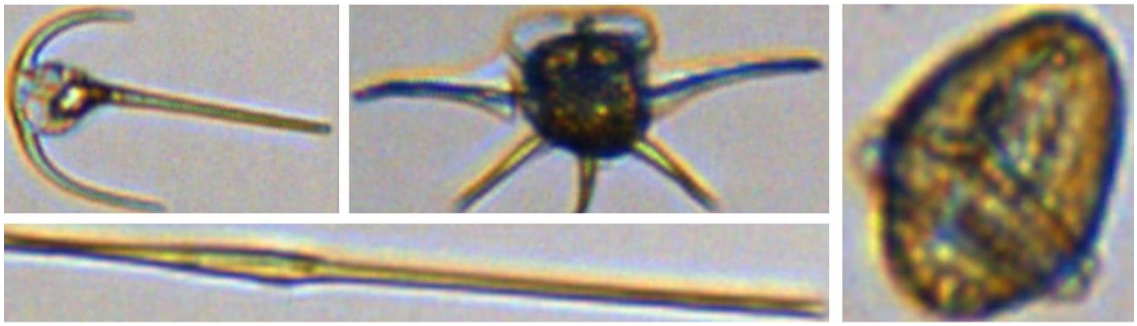

Figure 2. Dinoflagellates obtained from the Apstein net at station 5 and photographed with a Flow Cam on board RV SONNE. The size of these dinoflagellates is about 20 µm but the images here are presented not on correct scales. Photos: Sophia Hirschmann and Bettina Martin.

To gain adequate sun energy to perform photosynthesis in darkness at the basis of the euphotic zone, cyanobacteria were rich in chlorophyll, as were the concentrations of the surrounding waters. Due to a higher light intensity, phytoplankton required less chlorophyll in the upper layer where it drove the regenerated production. Hence it was chlorophyll-poor, but still more productive as compared to plankton dwelling in the chlorophyll maximum at the basis of the thermocline. This was evident from the increase of dissolved oxygen in the upper part of the thermocline, which is released in the course of photosynthesis. Enhanced mixing, in turn, masked this production signal in the ML by favoring the gas exchange and the emission of oxygen into the atmosphere.

The enrichment of plankton biomass, associated with an increase of oxygen concentrations in nutrient poor waters in the upper part of the thermocline, implies that the regenerated production largely sustains the pelagic ecosystem. This is a picture consistent with the global

understanding of the ratio of new to regenerated production. It also shows, in the spirit of TRAFFIC, that productivity is largely driven by the recycling efficiency of marine ecosystems. Furthermore, it indicates that especially in regions of strong solar radiation, such as in the tropics and subtropics, high chlorophyll does not always imply high production and that the production maximum below the ML is largely outside the view of satellites. Field observations, as shown for station 5, will be compared with satellite data after the cruise to check their quality and to contribute to an improvement of the remotely sensed primary production rates.

RV SONNE, at 9°S / 14°W, 05.09.2021

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