FS Meteor
Expedition **M206**

01.12.2024 (Fortaleza) –
30.12.2024 (Belém)

M206, 4. Weekly Report 16.12.-22.12.2024

The week began with a station (33) to sample the water column outside the Brazilian EEZ at the northern edge of our working area in order to sample the part of the Amazon River plume that branches off to the east (Fig. 1). We then returned to the transect of the Amazon outflow to follow the river plume towards French Guiana.

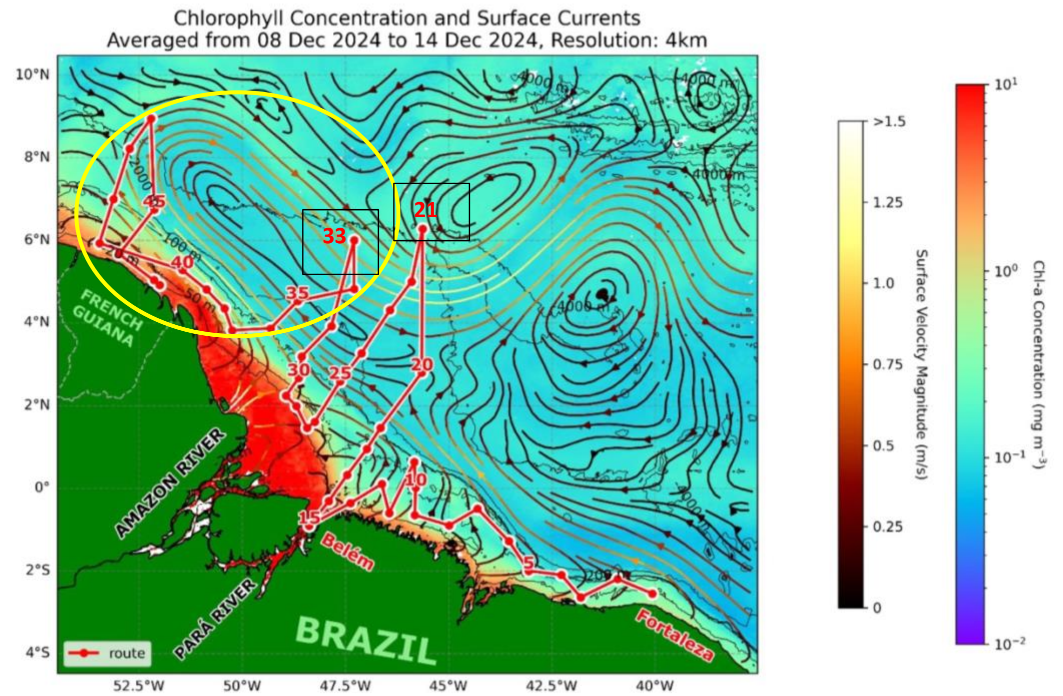

Fig. 1: Map of the working area based on satellite data for chlorophyll; the stations in the yellow circle were carried out last week.

On the route, we carried out further water and sediment stations over the Amazon fan in water depths between approx. 3000 m and 60 m. However, due to the low water outflow from the Amazon, we hardly saw any reduction in salinity even at the stations closer to the estuary. As the shelf area here is extremely shallow and the Brazilian Navy does not allow us to deviate from the route specified in the application or to move stations without submitting a new application, we were unable to move our route to the north-west closer to the coast in order to detect possible freshwater influences after all. This was only possible after we had crossed the border into the Exclusive Economic Zone of French Guiana. And indeed, we were able to clearly identify the effects of the numerous estuaries and mangroves along the entire coast of French Guiana in the lower salinity of the surface water here. The greenish colour of the water is visible evidence of the high plankton activity, nourished by the fluxes of matter from the coastal regions, and we took advantage of this situation to sample water and sediment extensively. The situation in this region with the lowered salinities in the coastal area is in stark contrast to the situation of the entire mangrove belt along the Brazilian coast between Fortaleza and the Pará outflow, where we have always observed an increase in salinity. We are very excited to see what effect these differences have on the distributions of dissolved organic carbon, trace metals and their isotopes based on the analyses of the samples.

The samples for the radiogenic isotopes are largely taken from the CTD rosette stations and processed in the wet laboratory (Fig. 3). The CTD profiles provide us with information about the properties of the water column, including the possible influence of freshwater mixing, and help us to decide at which water depth the samples should be taken. We can clearly distinguish the large water masses, especially in the deeper stations. The Antarctic Intermediate Water (AAIW) can be recognised by its minimum salinity. The North Atlantic Deep Water has a higher salinity than the AAIW, a lower temperature (~ 3-5 °C) and a higher oxygen content. We could not identify the Antarctic Bottom Water, which shows a decrease in oxygen content. In addition, a deep chlorophyll maximum can be detected at about 80 m depth, which is accompanied by an oxygen minimum just below (Fig. 2). The deep chlorophyll maximum is located at the lower end of the euphotic zone, at the upper end of the nutricline. We find more chlorophyll and a lower oxygen content in the areas influenced by the Amazon plume compared to the open ocean (Fig. 2). At this time, however, a cyclonic eddy prevailed in the Amazon plume. Its rotation normally leads to upwelling, which can also contribute to a higher chlorophyll concentration.

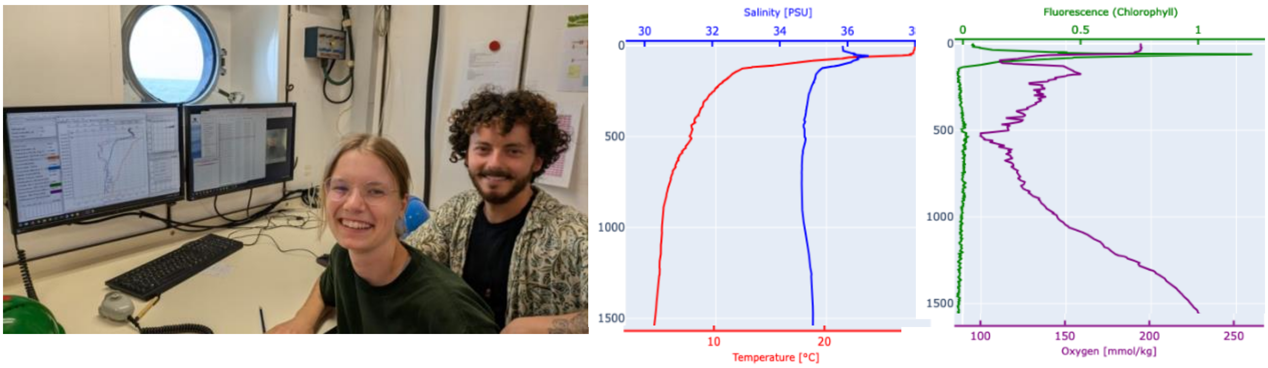

Fig. 2: Neele Sander and Rami Kalfouni supervise the CTD stations and analyse the CTD profiles. The CTD profile on the right shows an example for the upper 1500 m of station 21, which has higher chlorophyll values and a slightly more pronounced oxygen minimum zone in the part of the Amazon plume flowing eastwards from 8-10° N compared to the stations outside the plume. (Graphic: Nico Fröhberg)

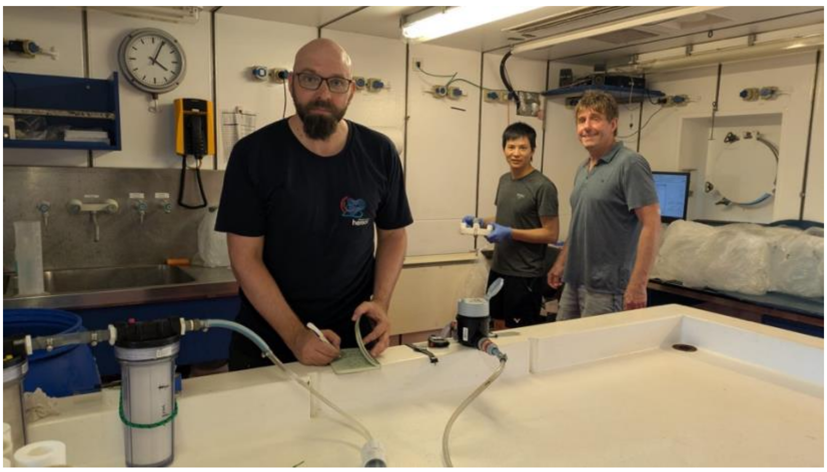

Fig. 3: In the wet laboratory, David Kaiser (left) enriches the radium isotopes from pump and CTD rosette samples on manganese-containing column material; Antao Xu and Martin Frank (centre and right) process the large-volume samples for neodymium isotopes and the concentration measurements of rare earth elements.

At each station to date, around 200 litres have been collected and filtered to extract radium. The radium quartet consists of the short-lived isotopes ^{223}Ra and ^{224}Ra, as well as the long-lived isotopes ^{226}Ra and ^{228}Ra. We use the different half-lives of the radioisotopes to determine the age and rate of movement of the water flowing from the Amazon and Pará into the coastal waters and ultimately the tropical Atlantic. In previous studies, including during expedition M147 in 2018, we found that radium is well suited to mapping the distribution of the Amazonian influence and learning that it extends into the open ocean within a few weeks. On this cruise M206 we also want to investigate whether radium is a suitable tool to characterise the potential influence of bottom water on the rather shallow shelf. The measurements of the extracted samples are already partly carried out on board using a RaDeCC (Radium Delayed Coincidence Counter; Fig. 2), in which the natural radioactive decay of the different isotopes is determined by means of their half-life. These measurements are very time-consuming, and samples have to be measured several times to correct initial values (Fig. 4). This is why we can only produce preliminary data on the research vessel, despite good equipment and extremely successful sampling so far. Many more laboratory hours await David Kaiser at the Helmholtz Centre Hereon in the coming weeks.

Fig. 4: RaDeCC measuring device with control computer and helium supply (left). Preliminary results of the ^{224}Ra measurements in the working area show different signatures for the different coastal regions and the open seawater (right; photo and graphics: David Kaiser).

In contrast to the samples from the normal CTD rosette, all samples for the measurement of trace metal contents must be taken under clean room conditions; Fig. 5 shows that this involves considerable effort, but is essential to ensure high data quality. As the M206 cruise is a GEOTRACES process study, the corresponding criteria and guidelines of the GEOTRACES programme must also be met.

Tomorrow (23 December) we will make our way back to the Amazon estuary to sample the river water signature there as best we can. Due to the rules of the Brazilian authorities, we have to take exactly the same route as on the way there. Unfortunately, we have also not (yet) received authorisation for our application to sail the Amazon via the North Channel to Macapá, so we will probably not be able to include this hoped-for highlight in our work schedule for the remaining week before arriving in Belém.

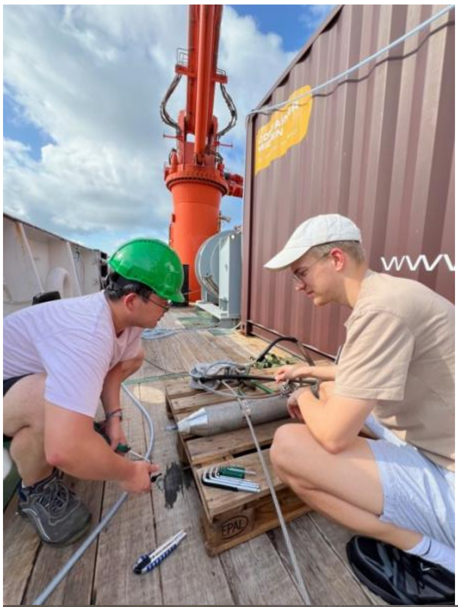

Fig. 5: left, Kechen Zhu and Albert Firus prepare the Tow-Fish for the next surface water sampling mission.
The samples are pumped directly into the universal laboratory via a long hose; as the GEOMAR clean room container that we used on the M147 cruise is not available to us on this cruise due to its use on FS Sonne at this time, the universal laboratory was converted into a clean room tent with the help of films and an air filter system as well as metal-free materials (bottom left), in which Gwendolyn Treguer (bottom right), together with Kechen Zhu, Albert Firus and Laurenz van Bonn, filters and processes all samples intended for trace metals from the tow fish and the bottles of the trace metal-free rosette and the bottom water sampler. From there, the samples are brought to the other laboratories of the various working groups.

With best wishes to everyone for a wonderful and relaxed Christmas, Andrea Koschinsky and Martin Frank (M206 co-guide) and the entire M206 team send their warmest regards.