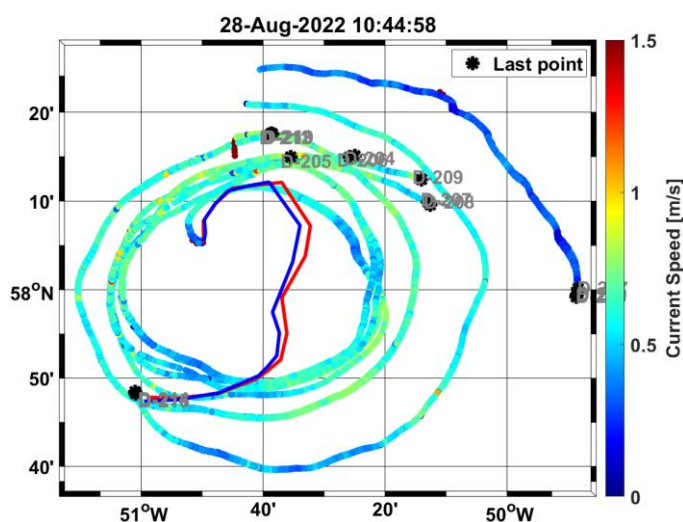


3rd Weekly Report (22. – 28.08.2022)

After finishing the work on the "53°N Observatory" in the southern part of the Labrador Sea we headed northwest - to the time series station K1. The time series station K1 is, like the 53°N observatory, installed since 1997 in the Labrador Sea and goes back to a special research area (SFB) in Kiel that has been funded by the German Research Foundation DFG. The K1 station measures water properties in the deep convection region. The term "deep convection" stands for the sinking of surface water to great depths (up to 2 km) and is mainly caused by the cooling of the sea surface in winter. During deep convection events, substances and gases from the surface of the oceans are also carried into the deep sea. These include the greenhouse gas carbon dioxide (CO₂), whose accumulation in the atmosphere through the burning of fossil fuels is one of the most important greenhouse gases and plays a major role in global warming. The ocean is a "sink" for CO₂. This means that since the beginning of industrialization the oceans have absorbed about 20-30% of the CO₂ emissions from the atmosphere. Without CO₂ uptake by the ocean, global warming would be even more dramatic than it already is. The great depths to which the CO₂ reaches through deep convection in the North Atlantic act as a long-term buffer, the CO₂ is out of the atmosphere for the time being and can no longer contribute to increasing the greenhouse effect. Thus, it is obvious that it is of great importance to comprehensively understand the mechanisms of oceanic CO₂ uptake. Only in this way can reliable predictions be made about the future role of the ocean in an issue that is central to the fate of humanity. The data from the time series station K1 help us to investigate the interplay of processes that influence the penetration depth and the characteristics of the water. The recovery of the time station went without problems - not least because the entire team on board - on the ship side and on the science side - cooperates excellently and is highly motivated.

Since the re-deployment of the K1 mooring is planned for later in the cruise, we continued heading north. At a location that we determined from satellite data, the two already prepared gliders were deployed in an oceanic eddy. Eddies are crucial for the exchange of water masses between the strong boundary currents of the Labrador Sea and the open Labrador Sea. The size, dynamics, and vertical structure of the eddies need to be measured. Also, the temporal changes of these same quantities are of interest.



Map of trajectories of the Helmholtz Zentrum Hereon Drifter positions, color coded for velocity, and of the two underwater electric glider IFM03 & IFM13.
Graphics: J. Horstmann

The gliders provide us with the vertical structure over a depth of 1km and at the same time we can see the measurements quasi in real time, because we receive data via satellite phone about every 6 hours. To analyze dynamics of the surface waters we use a special radar and so called "drifters", both brought on board by Dr Jochen Horstmann from Helmholtz Zentrum Hereon. Heading further north from the center of the eddy we released a group of 3 drifters every 10 km. In this way we can now determine the dynamic boundary conditions in different "zones" of the eddy relative to the center. Now, after almost 4 days of deployment, most of the drifters have already made a complete turn on the “eddy carousel” - equivalent to a speed of more than half a meter per second and thus very fast for ocean currents. The shape of the field of drifter trajectories help to make instantaneous and time-averaged current effects visible and calculable. Also, these fascinating looking circles invited to a betting game: the participants were asked to choose a favorite out of the 15 drifters who would be the first to reach the region north of 58°N. The result could be followed on the basis of the position reports every 5 minutes - theoretically! For certain headings of the ship there is no telephone and internet on board and so the race could not be followed live for the most part. Nevertheless, at the end it was extremely exciting and the first and second place were only a few minutes apart. Scientifically it is amazing that the drifters stay so close together, even the drifters that were exposed further to the edge are now coming closer to the center. We will revisit the vortex in a few days to recover the gliders and take the opportunity to do some more surveying.



*Who is spotting the Argo drifter first on the bridge of RV METEOR
Photo: J. Karstensen*

Another newsworthy action of the week was the recovery of a defective Argo deep drifter. This drifter, which is also equipped with a CO₂ sensor, was in operation for the Federal Maritime and Hydrographic Agency (BSH) in Hamburg and the GEOMAR Helmholtz Centre for Ocean

Research Kiel, as a contribution to the European Research Infrastructure Euro-Argo. Unfortunately, the CO₂ sensor failed for reasons unknown so far and the BSH asked for help with recovery, which we were happy to provide without consequence to our research program. Despite very poor visibility, with the help of everyone, including our colleagues from the BSH, the drifter was ultimately found immediately and recovered by crane.



Finally, at the end of this week, a mooring off the coast of Greenland was also replaced. This mooring is part of an Observatory of more than 10 moorings led by the Woods Hole Oceanographic Institution. With the 53°N observatory at the southern exit of the Labrador Sea and additional moorings on the east coast of Greenland, on the Reykjanes Ridge, and off the Scottish coast, this creates the "OSNAP array" - a multinational observational approach to determining the overturning circulation in the North Atlantic. The scope and size of this array makes it impossible for one nation to maintain such a measurement system alone, and only in collaboration can such programs be shouldered and thus establish an indispensable milestone in the study of the overturning circulation.

We continue to be excellently fed by the cooks Patrick and Peter and are very grateful for the support of all crewmembers. The many interesting blog entries of this cruise can best be accessed via the Beluga web portal of GEOMAR <https://beluga.geomar.de/m184>.

Greetings on behalf of all participants of the RV METEOR cruise M184,
Johannes Karstensen
(GEOMAR Helmholtz Centre for Ocean Research Kiel)