PS114 - Weekly Report No. 1 | 10 - 15 July 2018

Into the Arctic

[16. July 2018]

A walk through the ship shows: Everything is ready to go! Just a few days ago there were partly unpacked transport boxes everywhere (from whole containers to small cardboard boxes).

On Tuesday morning we, that means 47 scientists, boarded Polarstern in Bremerhaven. After a long dock time in the shipyard there are always many last-minute jobs to do. Nonetheless we cast off punctually at 10 am. We had a couple of additional persons on board in the locks and then on the river Weser who set up some of the new instruments installed in the shipyard. After they went from board we set out on our long transit northward to our study area. By now we are almost in the Fram Strait, between Svalbard and Greenland, at the transition between the Nordic Seas and the Arctic Ocean.

Pic. 1: An acoustic release, which is mounted at the bottom of a mooring line, is being tested. The release allows us to unfasten the mooring from the sea floor after 1 to 2 years in the water and to retrieve it at the sea surface. (Photo: J. Vernaleken)

Pic. 2: An instrument, which will be mounted on a mooring line and which takes water samples every 8 days, is being filled with necessary liquids and the mechanical components are adjusted. (Photo: J. Vernaleken)

During the first three days we had brilliant weather, calm seas and it still got dark at night. Yesterday the fog crept up and the temperatures dropped below 10°C. The general comment was, that now it feels just like every other year in our study area. And at night it no longer gets dark.

The long transit allows us to prepare without having to rush. This extra time was especially helpful because we have a total of seven 20-foot containers with gear that needed to be sorted. The space on board had to be allotted to the different groups, since the gear had to

go somewhere. And, of course, everyone wanted to have a comfortable and convenient work space. In the end a solution for that was found.

This cruise will cover a lot of mooring work. Moorings are cables that are deployed vertically in the water column for 1 to 2 years and on which different instruments can be mounted. These instruments can continuously measure the water properties, such as temperature, velocity or nitrate concentration and light over several years. Additionally, they contain instruments which take water samples and samples of particles in the water column which can then be analysed in the lab. Since 2016, the FRAM Infrastructure Initiative has resulted in the addition of many different and sometimes novel instruments deployed in our moorings. This means that almost a third of our scientific party is kept busy with the preparations for more than 10 different instrument types (Pictures 1 and 2).

Pic. 3: Large Volume air samples are taken on the sighting platform on top of the bridge. They will be used to determine the concentration of organic trace compounds. (Photo: A. Behrendt)

Pic. 4: We managed to fit three gas chromatographs on this table. They will measure climate active gases from water samples. (Photo: W.-J. von Appen)

Still, countless types of data cannot (yet) be measured by our moorings. Because of that, many of our cruise participants collect samples which will be analysed on board. Some of these air and water samples are already being taken during our transit. These are used for example to determine the distribution of long lived organic compounds as well as the species distribution of small phytoplankton. Nitrate isotopes are used to follow the path of energy through the food web. A lot of instruments have been set up for these measurements (Picture 3).

We will also take video images and samples of the water column and the sea floor in our study area. Numerous filtration devices are set up to pump particles from the water which are then used for further analysis in the lab. Additionally, we will measure numerous gases on board the ship (Picture 4).

Our team consists of a lot of old hands, but also quite a few newcomers. Because of this we had a lot of explanations and briefings next to the general preparations and anticipation for the work to come. After all, we want to explore new things which call for complex instruments and work flows! By now we are well prepared and look forward to our first mooring retrieval on Monday.

With the best regards,

Chief Scientist Wilken-Jon von Appen on behalf of the scientific crew on board Polarstern

PS114 - Weekly Report No. 2 | 16 - 22 July 2018

Chemistry on Board

[23. July 2018]

Now we have been working in the working area for 7 days which were intense but successful. A lot of moorings were recovered and deployed. We also took many water and sediment samples and videos which are part of the work of the FRAM infrastructure. This has kept many of us busy, but also happy with the success. We will tell you more details on this next week. But today, let's hear from two of our groups which are doing chemistry on this ship.

Zhiyong and Hanna from the Institute of Coastal Research at HZG, have taken some seawater and air samples during our transit north. They will investigate the occurrence and transport of organic contaminants with emerging concern including persistent organic pollutants (POPs) in the marine and Arctic environment. Organic contaminants are toxic chemicals that adversely affect human health and the environment around the world. Once these organic contaminants enter into the Arctic environment, they are subject to biogeochemical cycling, e.g. sedimentation to the ocean floor, bioaccumulation in the body of fish, bird and marine mammals, and exchange between air and seawater, snow and ice.

Pic. 1: Water Sampling (Photo: Zhiyong Xie)

Several classes of emerging organic contaminants including halogenic flame-retardants, fluorinated chemicals, pesticides and plasticizers will be investigated in this cruise. Aside from ocean currents, the atmosphere is considered to be the primary and most rapid pathway for organic contaminants transport to the marine and arctic environment. Two high-volume air samplers are set up on the monkey deck of Polarstern and continually running under headwind to collect oceanic air. Sometimes, the air samplers have to be turned off when the air is coming from the back of the ship to avoid sampling exhaust air from the chimney. Atmospheric particles are collected on a quartz fibre filter and the gaseous phase is retained using a polymer resin column. Along the track from Bremerhaven to AWI Hausgarten, the wind direction frequently varied between north, northeast, south and southwest. Therefore, we have changed the sampling columns according to the wind directions to ensure the air masses from different origins are sampled. The signals of new organic contaminants are expected in the air which crossed northern and western part of Europe, while classic POPs released from Arctic cryosphere might be recorded by the samples with air masses from high Arctic. Simultaneously, a high-volume water sampler is connected to the ship in-take system in the wet lab. Surface seawater from 12 m depth is sampled continuously while Polarstern steams towards the Arctic. Moreover,

samples of each one-litre seawater are collected for the analysis of water-soluble substances (Picture 1).

Pic. 2: Trace Gases (Photo: Moritz Baumann)

In addition, sampling for organic contaminants and nitrogen isotopes is also part of the CTD water budget. Seawater from 5 to 8 depths is sampled from the bottom up to the surface, which may give a primary vertical profile and provide evidence for discharge of organic contaminants from melting snow and ice. The vertical profiles can give information for the mixing of organic contaminants in different water masses. When the ship will head west to recover and deploy oceanographic moorings close to East Greenland's coastline, we will hopefully have brilliant weather. We are looking forward to fly with the helicopter to the ice to get snow samples for analysis of our organic contaminants.

A multidisciplinary team composed of Ian, Glen, and Jackie from the Plymouth Marine Laboratory (UK) and Damian, Hanna, and Moritz from the GEOMAR Helmholtz Center for Ocean Research Kiel joined the PS114 cruise in order to investigate the many unknowns regarding the distribution and sea-air fluxes of trace gases in the Arctic Ocean, as well as their trends under future climate change scenarios. The field work is being carried out within the framework of the PETRA (Pathways and Emissions of climate-relevant TRace gases in a changing Artic) project and it involves a comprehensive assessment of the potent greenhouse gases (GHG) nitrous oxide (N_2O) and methane (CH_4), as well as the indirect GHG carbon monoxide (CO) and dimethylsulphide (DMS). In order to fulfill this task, the PETRA-team combines high-resolution along-track measurements with incubation experiments at selected locations. The dissolved gas concentrations in surface waters (~11 m depth) are determined by means of a state-of-the-art laser-based gas analyzer system (Picture 2).

Pic. 3: Incubation Chambers (Photo: Moritz Baumann)

Comparison of this data set with the contemporaneous atmospheric mixing ratios of each gas will allow a precise estimation of the sign of the fluxes (i.e. into or out of the ocean). On the other hand, experimental manipulations are done so as to simulate future climate change conditions in the Arctic and their relationship to the cycling of trace gases. Current predictions for climate change estimate ocean warming and increased acidification, as well as increased availability of light due to reduced ice coverage. To test the individual and combined effects of these stressors in the microbial communities responsible for the production and consumption of N_2O, CH_4, CO and DMS, the PETRA-team set up a series of incubation chambers which emulate current natural conditions and the predicted conditions for future climate change. A thorough comparison of these different conditions will provide essential insights on the potential trends on production and emissions of these trace gases in the future Arctic. To this end, the team has been collecting large amounts of water from the CTD/Rosette at selected locations and monitoring the changes in the physical and biogeochemical environments of these natural

communities while contained in several enclosures (Picture 3). Despite a few technical issues at the beginning of the cruise, most measuring systems are performing well and lots of data points are being gathered, while a similarly large amount of frozen samples will be sent back to the labs of both institutes for further analysis.

Now we are looking forward to seeing what the second half of our cruise brings, especially whether we also will be able to go west to Greenland or whether there is too much ice. We'll let you know about that next week.

With best greetings,

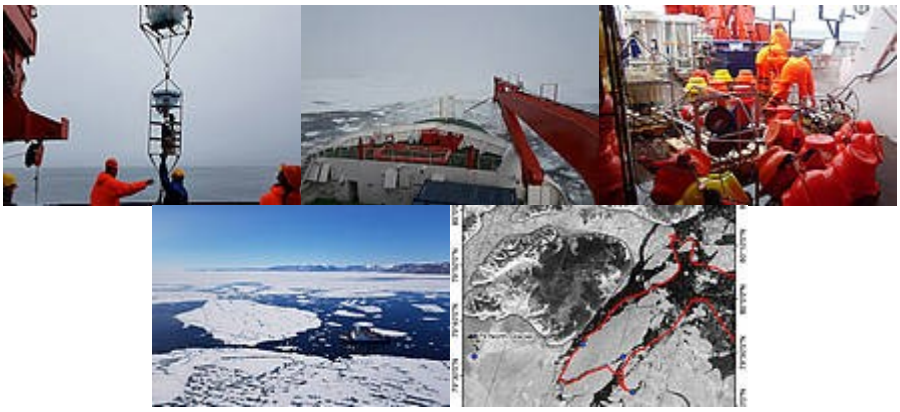
Zhiyong Xie and Damian Arevalo-Martinez, and Wilken-Jon von Appen on behalf of the scientists on PS114

PS114 - Weekly Report No. 3 | 23 - 29 July 2018

Mooring Work on Foggy Days

[30. July 2018]

After two long weeks of intense work we can be more than happy with what we have achieved! All our instruments worked really well, we took and analysed lots of water and sediment samples, recorded hundreds of pictures from the water column and of the sea floor so as to document life in the deep sea and we recovered almost a hundred instruments which were continuously recording water mass and current properties for the past two years.



The only factor which did not always play along was the weather. Whilst people at home reported brilliant sunshine, we saw nothing but fog, fog and fog for days on end (Picture 2). This made recovering moorings especially difficult. Thankfully we have a sophisticated positioning system called POSIDONIA.

Pic. 1: Mooring Work (Photo: AWI / Wilken-Jon von Appen)

Pic. 2: Looking for Moorings (Photo: AWI / Maren Richter)

With this system we can “wake up” the mooring from our ship to get its exact position. We than edge up to that position and give a signal to the mooring to release its anchor weight and rise to the surface. After a while the mooring appears a couple hundred meters away, directly in front of the ship and we can recover it. This meant that even with the fog we could always find the orange floatation packs quite well (Pictures 1 and 3).

Even so, our recoveries did not always run smoothly. At our northernmost mooring position, at 80°50'N, we were met with lots of large ice floes. At first, we tried to break a hole in to the ice cover by sailing in circles above the mooring position. But the ice drift was too strong, and the hole was closed again in a thrice. That meant: wait. The ice radar showed that a hole in the ice should drift right over our mooring site in the next one or two hours. Of course, we used the time to do other station work. But then, a couple of hours later, the hole had passed by us and still our mooring was covered by a huge expanse of ice. Bad luck. Since we had further station work planned at this site we changed our schedule leaving the mooring to last. But nothing helped, still there was too much ice. Finally, the ice radar showed a larger hole in the ice which was predicted to drift across our mooring site in a couple hours. And the prediction came true! We quickly sent the signal to release the mooring and then all eyes were searching the water in front of us. One minute passed…two minutes…there it is! The day of waiting was worth it!

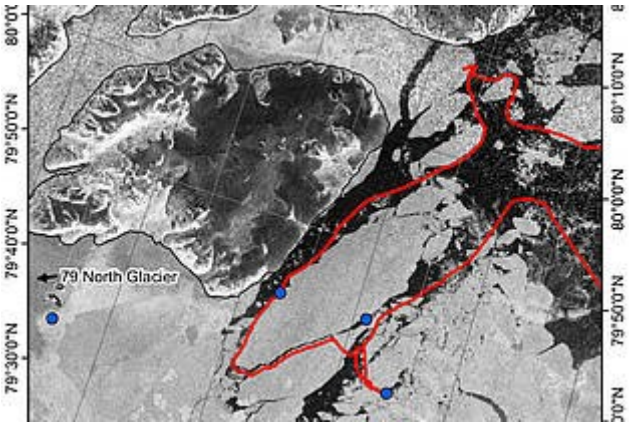
Pic. 3: Working on Deck (Photo: AWI / David Kuhlmey)

Pic. 4: RV Polarstern in front of 79 North Glacier (Photo: AWI / Wilken-Jon von Appen)

In eastern Fram Strait warm Atlantic water is at or relatively close to the surface. There we recovered and deployed moorings which will help us to understand ecosystem processes. They measure nutrient concentrations, light intensity, chlorophyll concentration (which is related to the amount of algae in the water column), amongst other things. The instruments also took and will take water samples in the upper ocean year-round (Picture 1). This is a great advancement, since water sampling would otherwise only take place during summer when research vessels are in the area. But interesting things still happen during the remainder of the year. To be able to know what the currents and water masses in the entire water column are like during all seasons, moorings are deployed in the shape of a triangle at two sites. At these sites three moorings are spaced exactly as far apart as the water is deep. We took some risks with these, because some of the instruments sit only 25 m below the surface. But so far, the risk has payed off.

We recovered five moorings from central Fram Strait. All of them were deployed along the prime meridian between 78°10'N and 80°50'N. With the help of these time series of temperature, salinity and velocity we will try to understand the recirculation of warm Atlantic Water better. The warm and salty Atlantic Water is transported northward through the North Atlantic, along the Norwegian coast into the eastern Fram Strait. There, part of the water flows eastward into the Arctic Ocean and the remainder turns westward (it recirculates) in Fram Strait before returning southward along the eastern coast of Greenland. This circulation can however not be pictured as a well-defined current but is rather made up of numerous small and large eddies. A first look at the data, that our moorings collected during the last two

years, shows many events with strong velocities. Whether theses are the proposed eddies remains to be seen during the more detailed data analysis later on.



Pic. 5: Cruise Track of RV Polarstern (Graphic: AWI / Maren Richter, basierend auf Daten der ESA / based on ESA data)

After our work in the eastern, central and western Fram Strait we yesterday went to the east coast of Greenland. There, we had also deployed four moorings which we now wanted to recover. The 80 km long floating ice tongue of the 79 North Glacier flows into the ocean there, making this a particularly interesting region. The warm Atlantic water from Fram Strait can also be found beneath the floating ice tongue. Thus, a rise in the ocean temperatures can play a key part in melting the ice tongue.

But the ice situation in front northeast Greenland was complicated. In particular, we had to grapple with fast-ice. Fast-ice is sea ice which cannot be moved by currents or wind because it is frozen either to the coast or the seafloor or grounded ice bergs. In front of the glacier the fast ice covers a large area for most of the year. With the help of satellite pictures (Picture 5) we have been keeping an eye on the ice during the last three weeks and although we saw that some movement was starting to take place, the part where our moorings were located was still covered by fast ice. Because we saw some cracks in the ice, we decided to give it a try. Yesterday morning we were only a couple hundred meters from the coast and still fog, fog, fog. Slowly we moved forward through a thin lead between the coast and a large ice floe towards our mooring. At the same time the sun finally burnt off the fog. All of a sudden, we had a clear view (Picture 4) and after weeks of fog and nightshifts the mood on board lifted together with the fog! Everyone enjoyed the view of the beautiful Greenland coast with glaciers and as an added bonus we also saw a polar bear, a walrus and a whale! The sun also made it possible to navigate through different ice cracks to three of our four moorings, which we recovered successfully.

Now we are on our way to the shelfbreak where we want to recover another four moorings. The sun shines, the mood is great and soon we will be on our way back home.

Best greetings and see you soon,

Janin Schaffer, Maren Richter, and Wilken-Jon von Appen on behalf of the scientists of PS114