Maria S. Merian MSM77
Weekly report 1, 16.09.2018

Here we go - finally!

After having some problems with the journey (delays in the flight schedule, loss of luggage) which are usual for us meanwhile, our 8-member “advance troop” reached Longyearbyen in the afternoon of September 13th. The following day was primarily used to prepare the large equipment to be deployed during the expedition. The majority of the participants finally arrived (complete and with luggage!) in the night from Friday to Saturday. After a short breather, we started to setup the laboratories and prepare the various measuring, recording and sampling devices.

In the early evening of September 15th we finally set sail. The cruise will take us to the LTER (Long-Term Ecological Research) observatory HAUSGARTEN in Fram Strait. This area is re-visited by us annually already since 20 years. The multidisciplinary work at HAUSGARTEN observatory is carried out to investigate the impact of Climate Change and the continuously retreating sea-ice on the Arctic marine ecosystem.

Today, HAUSGARTEN resembles a network of 21 stations at water depths ranging between 300 and 5.500 m, which were sampled by us in the water column as well as at the seafloor. The stations are sampled every year during the summer months both in the water column and on the seabed. The planned work will be carried out in close cooperation between the HGF-MPG Joint Research Group for Deep Sea Ecology and Technology, the PEBCAO Group ("Phytoplankton Ecology and Biogeochemistry in the Changing Arctic Ocean") of the AWI and the Helmholtz-University Young Investigators Group SEAPUMP ("Seasonal and regional food web interactions with the biological pump") and will make valuable contributions to various national and international research and infrastructure projects (e.g. INTAROS, ICOS, ARCHES, FRAM, and SIOS). Furthermore, the work contributes to the research programme PACES II ("Polar Regions and Coasts in the changing Earth System") of the Alfred Wegener Institute Helmholtz Centre for Polar and Marine Research (AWI), which was started in 2014.

On the morning of September 16th at around 8:00 a.m. we reached the first station and started this year's "gardening work", of which we will report in detail in the following weeks.

With the best regards of all participants,
Thomas Soltwedel

MERIAN MSM77, 2nd Weekly Report, 16.-23. September 2018

"Gardening" off Spitsbergen

For a week we are now operating in the study area of this expedition, the LTER (Long-Term Ecological Research) Observatory HAUSGARTEN. We have been visiting this area in the Fram Strait for 20 years now in order to investigate the influence of global climatic changes on a polar marine ecosystem in a multidisciplinary approach.

The HAUSGARTEN stations are sampled annually during the summer months both in the water column and on the seabed. Water samples are collected with a CTD/Rosette Water Sampler. Sampling at the seabed is carried out with cabled instruments, the so-called multicorer and the box corer, which cut out certain sediment volumes at the deep-sea floor and bring them on board. The fibre-optic cable of Maria S. Merian allows us to follow the sampling at the deep-sea bottom "live" on the TV screen. The camera system on the Multicorer transmits razor-sharp images of a hidden world. A towed photo/video system gives us information about large-scale distribution patterns of larger organisms at the bottom of the HAUSGARTEN area. The comparison with photographs from the past decades gives us information about temporal changes in the density and composition of the so-called epibenthos.

Our Autonomous Underwater Vehicle (AUV) "PAUL" (Fig. 1) has already been sent three times on lonely journeys through the cold Arctic Ocean. PAUL is mainly used to carry out physical, chemical and biological investigations in surface water. During the current cruise, however, we will also use the AUV at ground level to carry out seabed mapping in selected areas. The underwater vehicle is equipped with sensors for a long range of parameters. These include the temperature and conductivity of the water, the concentration of nitrate, chlorophyll *a*, oxygen and carbon dioxide as well as the amount of dissolved organic substances (CDOM). In addition, the intensity of the photosynthetically active radiation (PAR) is continuously measured. A water sampler integrated into the underwater vehicle is able to take up to 22 samples with a total volume of 4.8 litres to determine the plankton composition and to calibrate the nitrate and chlorophyll sensor.

The transport of organic material (dead phyto- and zooplankton) from the sea surface into the deep sea removes the carbon from the upper ocean layers and thus allows the

further absorption of carbon dioxide from the atmosphere. However, it is still not clear which factors favour the formation of sinking particles and ultimately control the degradation of these particles on their way into the deep sea. The HGF Young Investigators Group SEAPUMP, which cooperates closely with the HAUSGARTEN group, is dedicated to this field of research. In addition to optical devices (particle cameras), various sampling devices (a so-called "Marine Snow Catcher" as well as drifting sediment traps) are used to investigate the quantity and quality of the sinking material.

Free-falling systems, so-called "bottom-landers" (Fig. 2), are used to carry out various measurements and experiments on the seabed. They consist of a steel frame, bottom weights that drag the system down to the seafloor and floats that ensure that the frame rises again to the sea surface after the weights have been dropped. Depending on the scientific question, bottom-landers can be equipped with a variety of measuring and recording devices. For example, we use profiling microsensors to determine the oxygen content in the upper sediment layers with high resolution. Incubation chambers which enclose a certain volume of water and sediment are used to determine the oxygen consumption of the small sediment inhabiting organisms. Last Monday, a bottom-lander deployed at the southernmost HAUSGARTEN station was successfully recovered from the seabed after about 65 hours of standing time.

In addition to these stationary devices, we also operate various mobile platforms (so-called “benthic crawlers”) on the seabed. One of these autonomous vehicles, our "TRAMPER" (Fig. 3), was successfully recovered by the beginning of last week after 12 months of operation at 2500 m water depth. TRAMPER is equipped with a micro profiler, which measured oxygen profiles at the seabed once a week, then drove a short distance, only to carry out the next measurement a week later. Autonomous devices such as TRAMPER allow us to obtain seasonal data from the Arctic deep sea, which is very difficult to access especially during the winter months.

Everyone on board is doing well!

With best regards to the loved ones at home,

Thomas Soltwedel

MSM77, 3rd Weekly Report, 24-30 September 2018

"Gardening" under extreme conditions

Last week's work was seriously influenced by the weather conditions in the area. The extension of a low pressure system in the Svalbard area prohibited the use of more complex equipment, so that for example our autonomous underwater vehicle (AUV) "PAUL" could only be used for short deployments. Wind forces of 7-8 Beaufort and waves up to four meters in height forced us to limit our activities to the use of more robust, cabled equipment, e.g. water samplers, camera systems, sediment corer. Hence, the coastal stations off the Kongsfjord and north of Spitsbergen could successfully be sampled despite the adverse conditions with temperatures below zero degrees and light snow drift. Since last Friday, the weather has increasingly calmed down, so that we hope to be able to resume our research activities in the next days.

On Saturday morning, we recovered a free-falling system which we deployed towards the end of last week in 1500 m water depth on the so-called Vestnesa Ridge west of Spitsbergen. The bottom-lander (Fig. 1) developed within the framework of the EU project "INTAROS" (Integrated Arctic Observing System) was build in order to investigate the effects of the progressive acidification of the oceans on seafloor-inhabiting organisms in an experimental approach. Such investigations have so far mainly been carried out in laboratory experiments and in-situ only in shallow water areas. With the technically sophisticated, autonomous experimental set-up for carbon dioxide enrichment of seawater at the bottom of the deep sea, we are breaking new ground. If we could approve that the entire system is working perfectly, we will deploy the so-called "arcFOCE" (Arctic Free Ocean Carbon Enrichment) system for long-term deployment towards the end of the expedition. Sampling of the experiment and the recovery of the entire device is scheduled for summer 2019.

We are now eagerly awaiting the return of our second "Benthic Crawler". The autonomous benthic crawler "NOMAD" (Fig. 2) is the big brother of TRAMPER, which was already mentioned in the last weekly report. NOMAD is equipped with two small incubation chambers in addition to a microprofiler system measuring dissolved oxygen in surface sediments. The chambers are smoothly placed on the sediment. Subsequently, the decrease of oxygen caused by remineralization processes at the sediment-water interface is continuously measured in the water body enclosed by the chambers. In addition, NOMAD carries a special camera system that scans the surface sediments to detect sunken organic material (dead phytoplankton that has settled to the seafloor). This organic matter is the main food source for all animals living on the seabed and in the sediments.

In fact, by far the largest part of the organic matter produced at the sea surface is already degraded by zooplankton and bacteria on its way into the deep sea - on average only about 2% of this material reaches the bottom of the deep sea. An exception is the so-called "Molloy Deep" in the central Fram Strait, with a water depth of about 5600 m probably the deepest depression of the Arctic Ocean. At the bottom of the Molloy Deep, actually the deepest station of the HAUSGARTEN observatory, we found unusually high concentrations of organic matter. The topography of the Molloy Deep is reminiscent of a huge funnel-shaped trap. Local hydrographic conditions, which might favour the rapid sinking of particulate organic matter in the area, as well as slope slides, which transport surface sediments to greater depths, cause an accumulation of this material at the bottom of the depression, which is about 2 km in diameter. In order to quantify remineralization processes at the bottom of the Molloy Deep, we deployed one of our free-falling systems ("bottom lander") by the end of last week. In the HAUSGARTEN area, this is only the second use of such a system in this great water depth. The recovery of the bottom lander is planned for next Monday.

During the next week we will mainly operate in the vicinity of the ice edge in the western and northern parts of the Fram Strait. We also plan to use our AUV in these areas - as long as the weather condition allow….

Despite the occasionally adverse conditions during the last week, we are still in a good mood.

Greetings to our beloved ones at home,

Thomas Soltwedel

Fig. 1: Recovery of the “arcFOCE” (arctic Free Ocean Carbon Enrichment) system after its first test deployment west off Svalbard.

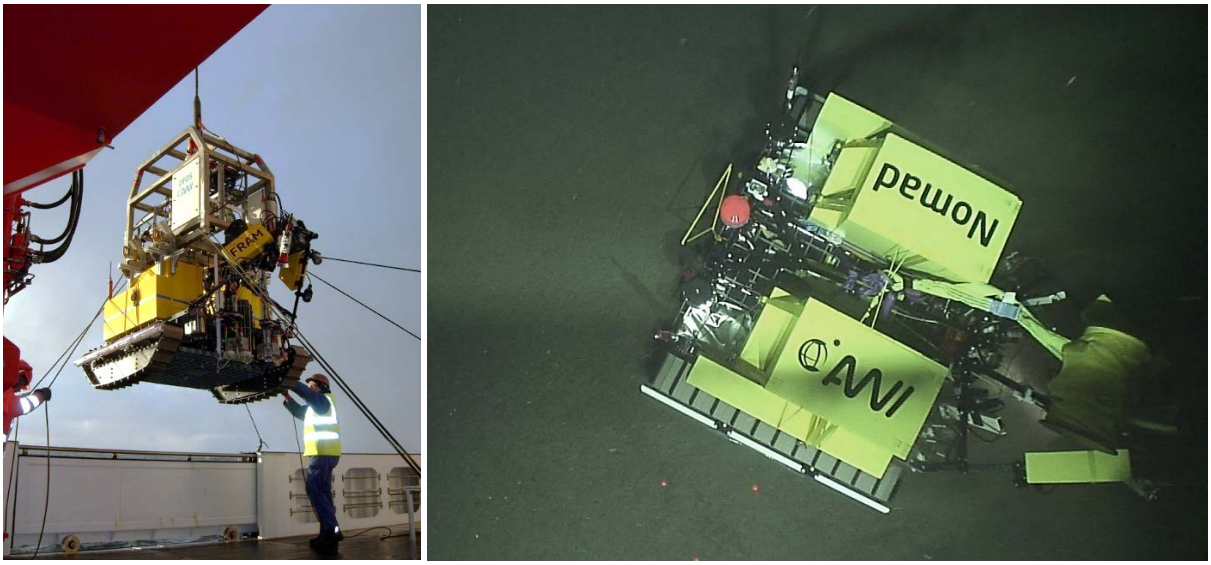


Fig. 2: Launching of the benthic crawler NOMAD (left) and arrival of the system at the seafloor(right).

RV MARIA S. MERIAN MSM77

4th Weekly Report

01.-07. October 2018

End of this year's "gardening" work

Last week we worked mainly in central and northern parts of the Fram Strait. Once again we used the entire range of instruments that we had with us on this expedition. The sampling in the water column and at the deep seafloor, which was already described in the last weekly reports, was carried out routinely and in rapid succession - and was successful throughout.

The colleagues in our AUV team had to make certain compromises. Their investigations focus on physical and closely related biological processes at front systems, such as those found between the warmer Atlantic water in the eastern Fram Strait and the colder water masses in the West of the strait. An Autonomous Underwater Vehicle (AUV) is ideally suited for this type of investigations as it is capable of generating an extremely tight grid of data points. Unfortunately, the planned operations of our AUV in front of the ice edge in the westernmost part of our HAUSGARTEN had to be cancelled at short notice due to the continuing "unfavourable" weather conditions. Wind forces of about 7 Beaufort had set the sea in motion in such a way that the 2-3 m high waves did not permit the safe operation of the vehicle. But exactly for such situations you always have a "plan B":

After a drift ice field had separated from the sea ice off the Greenland coast in the middle of the week and a long, loosely connected sea ice "tongue" had formed towards the east on the open sea, we spontaneously changed our plans and used the ship to conduct an approx. 45 km long transect crossing this ice field. A so-called "CTD/Rosette Water Sampler" was used about every 1.5 km to examine the water layers under the ice field. The device carries a series of sensors to measure various physical and biochemical parameters as well as a ring-shaped arrangement of water samplers which can be individually closed on an electrical signal. In this way, data on oxygen concentration and salinity, nitrate concentration and temperature distribution can be collected. Water samples taken at different depths provide information on additional biochemical parameters (e.g. dissolved organic carbon and nitrogen) and will be analysed at a later stage for the dominant plankton species. Within 24 hours, data from 33 vertical profiles and more than 160 water samples could be obtained. Such sampling can of course hardly replace the use of an AUV, however, it ultimately led to a very interesting and extensive data set, albeit with a significantly coarser spatial resolution.

Towards the end of the week we succeeded in a spectacular recovery operation of one of the autonomous bottom vehicles (Benthic Crawler), which we had deployed last week in 1500 m water depth on the Vestnesa Ridge off Spitsbergen. Our Benthic Crawler NOMAD had

persistently "denied" the dropping of its basic weight, so that the device could not independently return to the sea surface by its buoyancy. Therefore we had no other choice than to "fish" for the vehicle. For this we used our towed camera system OFOS (Ocean Floor Observations System) underneath we attached strong ropes with large hooks (see figure). Since we knew the location of the NOMAD at the seafloor, we rather quickly found the device with the camera system. However, reaching the vehicle with one of the hooks was much more difficult, required a lot of patience and even more skill. Thanks to the incredible manoeuvrability of the "Maria S. Merian", which enabled us to hold the ship exactly in position and move it precisely at meter-scales (!), the ship's command and the winch operator finally managed to "pick up" the device and bring it safely back to the sea surface (see figure). Our NOMAD did not suffer any damage during this action and there was a great relief to have the relatively expensive vehicle back on board.

Yesterday our Autonomous Underwater Vehicle "PAUL" was used one last time in front of the great panorama of Spitsbergen to test the new sonar system of the AUV in front of the Kongsfjord. Afterwards we set sail for Edinburgh, where the expedition will end in the afternoon of October 12th. On our way to Edinburgh, we will encounter an extensive low-pressure system with all its negative side effects - anyway, nothing will affect the generally positive atmosphere on board.

With best regards from on board,

Thomas Soltwedel

Recovery of the Benthic Crawler NOMAD: The photo/video system OFOS with hooks attached to the frame (top left), searching for the gear (top right), finally hooked up (bottom left), back again at the sea surface (bottom right); all images copyright: Deep-Sea Research Group, AWI.

RV MARIA S. MERIAN MSM77

5th Weekly Report 08 - 13

October 2018

On the way home!

On Saturday, October 6th, we set sail for the long way home - first destination: Edinburgh. Here we will arrive in the late afternoon of October 12th, use the evening for a short sightseeing tour of the city, and then fly back to Germany the following day.

The last days of this expedition were characterized by the general cleaning up. All equipment and laboratory instruments used during this cruise were dismantled and stowed in boxes and containers. Samples were preserved for later examinations, data collected during this expedition was saved - and in parts already evaluated. Finally, all laboratories and other working areas were intensively cleaned so that the following groups could find clean working conditions on their journey, just as we did at the beginning of our leg.

On the way out of the study area of this expedition we made a short stopover near the volcanic island Jan Mayen northeast of Iceland. Colleagues from the European infrastructure project "Euro-Argo" had asked us to recover a malfunctioning drifting system (float) sought to repeatedly submerge into greater water depths (see Figure). "Euro-Argo" is part of the international "Argo" program of the World Meteorological Organization (WMO), the Global Ocean Observing System (GOOS), and the Intergovernmental Oceanographic Commission (IOC) initiated in 1999. "Argo" is a global network of more than 3500 autonomous instruments which are drifting on and in the world ocean to register physical properties in the water column and to transmit the data via satellite connections to a huge group of users.

Since the float reported its position via satellite at short intervals, we were able to spot it rather quickly. The recovery of the narrow and only about 1.5 m high cylindrical device with 7-8 Beaufort and waves up to 4 m in height turned out to be less problematic than initially assumed. Of course, a zodiac could not be used for the recovery under these conditions. Thanks to the excellent manoeuvrability of the ship (see also the previous weekly report) and the skill of the ship's command it was finally possible to steer the ship so close to the float that it could be "caught" by the deck crew with a long rod and a sling attached to it (see Figure). There was great relief both, on board and at the "Euro-Argo" headquarter, when the instrument was finally recovered. Following the cruise, the instrument will be sent to the Operations Centre in Brest (France) for repair and later use.

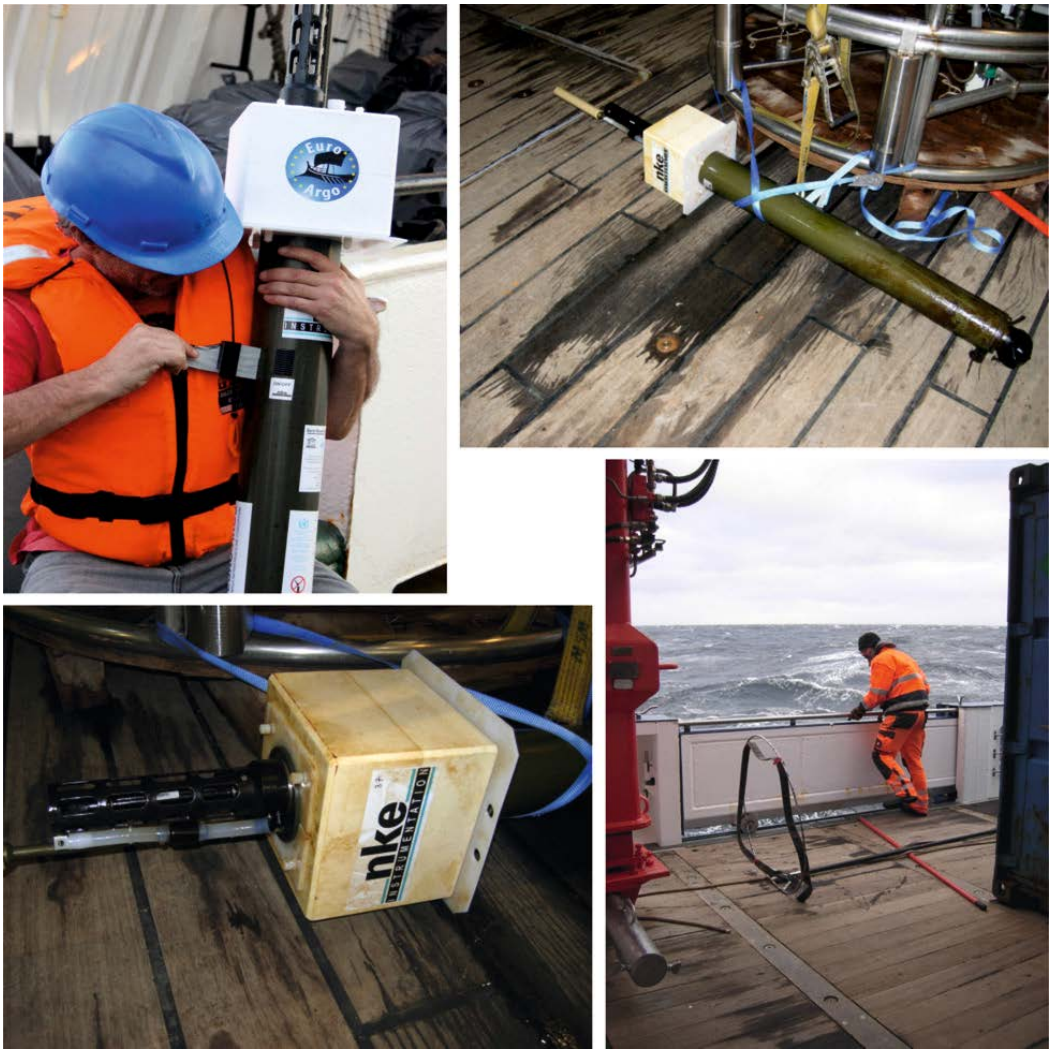
For 20 years now we are visiting our HAUSGARTEN in the Fram Strait, where we document natural variabilities and the effects of Global Change on a polar marine ecosystem. During this

year's expedition, autonomous underwater vehicles were repeatedly deployed in the water column and on the seabed. In addition, free-fall systems, water and sediment samplers, drifting sediment traps and various camera systems were used. None of this would have been possible without the great seamanship of the deck crew, the professional support of the ship's technical staff, the excellent skills of the nautical officers and - not to forget - the always friendly and attentive care of the stewardess and the cooks.

We would like to thank Captain Ralf Schmidt and his crew for their hospitality, the trusting cooperation and the great atmosphere on board - and we are looking forward to our next expedition with Maria S. Merian!

In the name of all participants,

Thomas Soltwedel



Recovery of an Argo-float off Jan Mayen (copyright: Deep-Sea Research Group, AWI).