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HELMHOLTZ-ZENTRUM FÜR POLAR-
UND MEERESFORSCHUNG

EXPEDITION PROGRAMME PS108

Polarstern

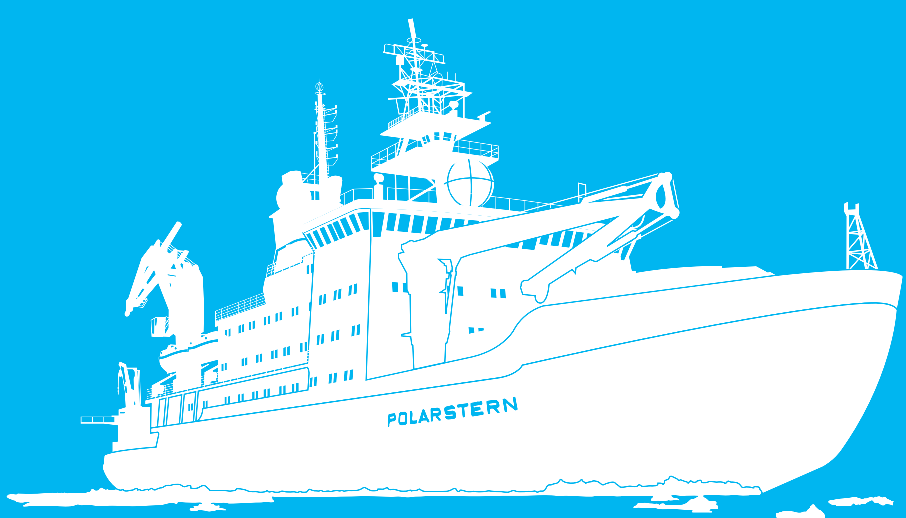
PS108

Tromsø - Tromsø

22 August 2017 - 9 September 2017

Coordinator: Rainer Knust

Chief Scientist: Frank Wenzhöfer



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Contents

1. ÜBERBLICK UND FAHRTVERLAUF

Frank Wenzhöfer (AWI)

Das Forschungsschiff *Polarstern* wird am 22. August von Tromsø aus zur Expedition PS108 auslaufen. Das Arbeitsprogramm dient vornehmlich zwei Themen: (I) Verifikation der Einsatzmöglichkeiten neuer, innovativer Technologien, die im Rahmen der HGF Allianz ROBEX entwickelt wurde, für die Exploration extremer Lebensräume und der kontinuierlichen Untersuchung in der Tiefsee sowie (II) Durchführung von Messungen und Probenahme an den Tiefsee-Experimenten am LTER Observatorium HAUSGARTEN mit Hilfe des ROV KIEL 6000 (Geomar). *Polarstern* wird während der Reise in zwei Arbeitsgebieten operieren, der östlichen Fram Strasse am Tiefseeobservatorium HAUSGARTEN und in der Gashydrat Stabilitätszone vor Spitzbergen (Fig. 1.1). Die Expedition endet am 9. September in Tromsø.

Die Fähigkeit, wichtige Fragen zur Veränderung unserer Ozeane zu untersuchen, ist grundlegend limitiert durch den Mangel an Schlüsseltechnologien, die uns erlauben *in-situ* Experimente durchzuführen, gezielt Proben zu entnehmen sowie langzeitstabile Sensormessungen im Ozean durchzuführen. Das Ziel der *Polarstern* Expedition ist es, neue und innovative Unterwasser-Technologien, die im Rahmen der HGF Allianz ROBEX entwickelt und gebaut wurden, in der Tiefsee einzusetzen, um biogeochemische Prozesse im Ozean besser verstehen zu können. Hierzu zählen drei unterschiedliche benthische Crawler Systeme, jeder entwickelt für spezielle wissenschaftliche Fragestellungen, ein Glider, unbemannte Flugsysteme (Unmanned Aerial Vehicle, UAV) die den Einsatz des AUVs unterstützen, sowie Sensorik für Langzeitmessung von Sauerstoffprofilen, Lab-on-Chip (LOC) Technologie und ein Unterwasser-Massenspektrometer. Dies demonstriert und verifiziert zum einen die Interoperabilität von robotischer Technologien für den Einsatz in extremen Lebensräumen und zur kontinuierlichen Meeresbeobachtung. Des weiteren tragen die Messungen direkt zu Ökosystemuntersuchen in der Arktis bei. Hierbei werden arktische Ökosysteme untersucht, die stark vom Klimawandel beeinflusst sind, wie z.B. Gashydrate in arktischen Schelfsedimenten und benthische Tiefseegemeinschaften. Im Gebiet der Gashydrat Stabilität Zone (GHSZ) sollen Gashydratvorkommen im Meeresboden sowie Gaskonzentrationen in der Wassersäule auf unterschiedlichen räumlichen und zeitlichen Skalen quantifiziert werden. Arbeiten am HAUSGARTEN - Tiefseeobservatorium dienen der Untersuchungen des Kohlenstoff- und Nährstoffflusses, sowie der Verknüpfung, Zusammensetzung und Struktur von benthischen und pelagischen Lebensgemeinschaften auf unterschiedlichen zeitlichen und räumlichen Skalen. Die Expedition dient darüber hinaus dazu, um weitere Installationen im Rahmen der HGF Infrastrukturmaßnahme FRAM (Frontiers in Arctic marine Monitoring) vorzunehmen. Die gesamten Arbeiten werden dabei durch das ROV KIEL 6000 (Geomar) unterstützt.

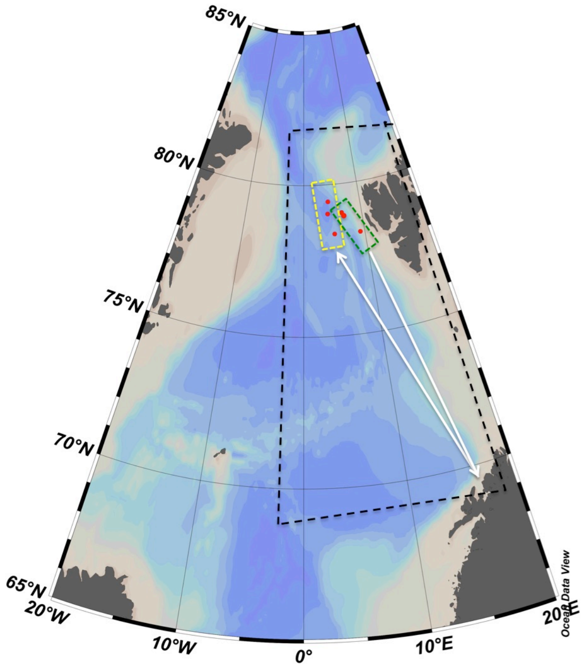

Abb. 1.1: Untersuchungsgebiete und geplante Fahrtroute der Polarstern Expedition PS108. Die Arbeiten finden am HAUSGARTEN Tiefseeobservatorium in der östlichen Fram Strasse (gelbe Box) sowie der Gashydrat Stabilität Zone vor Spitzbergen (grüne Box) statt.

Fig. 1.1: Working areas and planned transit route. The station work will be conducted at the HAUSGARTEN deep-sea observatorium in the eastern Fram Strait (yellow box) and at the gas hydrate stability zone (GHSZ) off Spitzbergen (green box).

SUMMARY AND ITINERARY

Polarstern will depart for research cruise PS108 from Tromsø on August 22. The work carried out during the expedition will be dedicated to two major tasks: (I) test the capability of new and innovative technologies, developed during the HGF Alliance ROBEX, for exploration of extreme environments and deep-sea observations and (II) perform measurements and sampling at the HAUSGARTEN experimental sites using the ROV KIEL 6000. *Polarstern* will mainly operate in two working areas, in the eastern Fram Strait at the deep-sea observatory HAUSGARTEN and the gas hydrate stability zone (GHSZ) off Spitzbergen (Fig. 1.1). The cruise will end in Tromsø on September 9.

Our ability to address questions concerning ocean change is fundamentally limited by the lack of key technologies enabling *in-situ* experimentation, conducting targeted sampling, and performing persistent sensor measurements. During the expedition newly developed technologies, including 3 different types of benthic crawler, each designed for its specific scientific purpose, a glider, unmanned aerial vehicles (UAVs) to support AUV operations at the ice edge, and sensor systems like long-term oxygen profiler, Lab-on-Chip (LOC) technology and underwater mass-spectrometer will be used to study biogeochemical processes in the ocean. This will on the one hand demonstrate the interoperability and verification of mission critical robotic technology required to operate in extreme environments and to perform continuous ocean observations. In addition this will contribute to investigations in Arctic ecosystems strongly influenced by climate change, such as marine arctic sediments hosting gas hydrates and arctic deep-sea benthic communities. At the gas hydrate stability zone (GHSZ) off Spitzbergen we will quantify gas hydrate deposits as well as water column gas concentrations at different spatial and temporal scales. At the HAUSGARTEN deep-sea observatory in the eastern Fram Strait, studies on the pelagic-benthic coupling will be performed, to investigate how benthic life is governed by the food supply from surface waters. The expedition will also be used to accomplish installations for the HGF infrastructure FRAM (Frontiers in Arctic marine Monitoring). The work during the expedition will be supported by the ROV KIEL 6000 (Geomar, Kiel, Germany).

2. BIOLOGICAL LONG-TERM EXPERIMENTS AT THE DEEP SEAFLOOR

T. Soltwedel, M. Bergmann, C. Hasemann, C. Kanzog, F. Wenzhöfer (AWI), K. Meyer (WHOI), A. Nordhausen (MPI)

Objectives and scientific programme

During *Polarstern* expedition PS108, the Remotely Operated Vehicle (ROV) “KIEL 6000” (Geomar) will be used to sample previously established biological *in-situ* long-term experiments in 2,500m water depth at the central HAUSGARTEN site HG-IV (Fig. 1.1).

Impacts of reduced food availability on the small benthic biota

The reduction of organic matter availability at the deep seafloor due to large-scale environmental changes in the Arctic is one of the scenarios for the future Arctic Ocean. The starvation experiment has been designed to study the reaction of the small benthic biota (size range: bacteria to meiofauna) to decreasing food/energy availability. Four cages (2 x 2 m in dimension, 50 cm in height; Fig. 2.1) covered with solid lids preventing the sedimentation of particulate organic matter (representing the main food/energy source for benthic organisms) were deployed in summer 2008 and have been repeatedly sampled over the following years to assess the reaction of the small biota to decreasing food accessibility.

Impacts of marine litter in the Fram Strait

Marine litter has long been on the political and public agenda as it has been recognized as a rising pollution problem affecting all oceans and coastal areas of the world (Bergmann et al., 2015a). Analysis of seafloor photographs taken at the central station of the HAUSGARTEN observatory indicates that litter rose more than 20-fold between 2004 and 2014 and reached densities similar to those reported from a canyon near the Portuguese capital Lisbon (Tekman et al., 2016). Although countless reports exist on the effects of litter on seabirds, marine mammals and turtles, little is known about the effects on biota inhabiting the seafloor. During the *Polarstern* expedition PS93.2 in 2015, we therefore deployed different ROV-based experiments to assess the impact of plastic litter on benthic organisms and biogeochemical parameters: three ‘heavy’ rigid plates and three canvasses (80 x 80 cm) made of lighter-weight rubbish bin material were placed on the sediments. In addition, we covered large benthic sponges with plastic bags (Fig. 2.2).

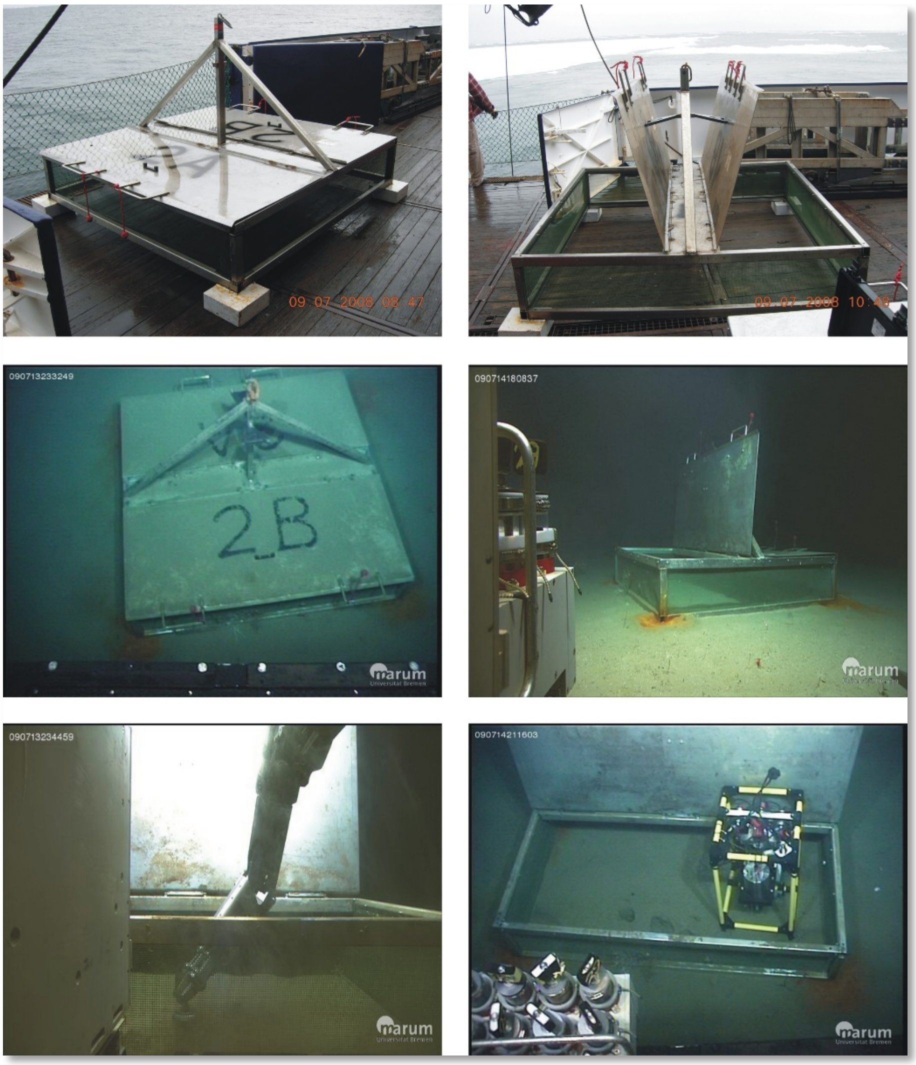

Fig. 2.1: Cages for the starvation experiment on board Polarstern (top) and at the deep seafloor (middle); sediment sampling and microprofiler measurements during Polarstern expedition ARK-XXIV/2 in summer 2009 (bottom)

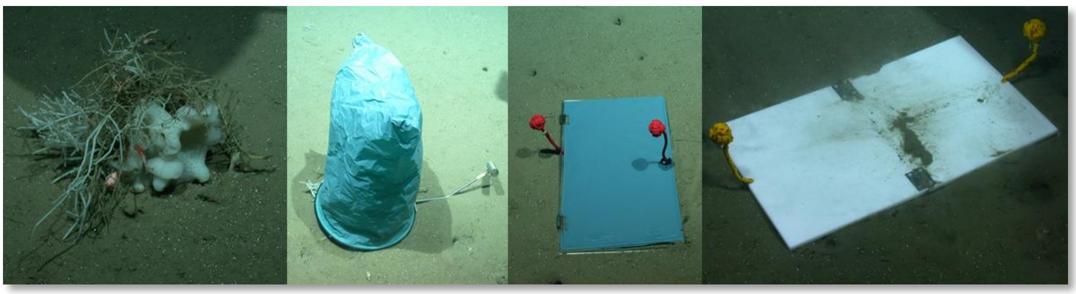

Fig. 2.2: Litter experiments deployed at the deep seafloor by the ROV "Quest 4000" during Polarstern expedition PS93.2 in 2015 (© MARUM)

Impacts of new dropstones at the deep seafloor

There is abundant evidence that habitat structures have important effects on spatial distribution patterns of meiofauna populations in deep-sea environments (Hasemann et al., 2013). A common feature in polar deep-sea regions is the occurrence of dropstones at the deep seafloor, which enhance topographic heterogeneity and alter related hydrodynamic patterns. Changed flow regimes around dropstones can have a direct effect on colonisation and settlement of meiofauna individuals and indirect effects on meiofauna communities by the amount of potential food trapped around dropstones and changing sediment characteristics.

To study community patterns in nematodes (i.e., the dominant metazoan meiofauna group in deep-sea sediments) in relation to altered flow regimes and patchy food availability, artificial dropstones with different shapes (rectangular, cylindrical, and hemispheric; approx. 40 cm in diameter, 10 cm in height; Fig. 2.3) were deployed by means of a video-guided launcher system at 2,500 m water depth during the *Polarstern* expedition PS99.2 in summer 2016 (Fig. 2.4). The stones were deployed roughly in a line along the main current direction (which is to the North-West at about 5 cm s^{-1}) with distances of approx. 10 m to each other.

Fig. 2.3: Artificial dropstones and cylindrical homer beacons for tracking the stones at the deep seafloor laid out in a workshop before shipment

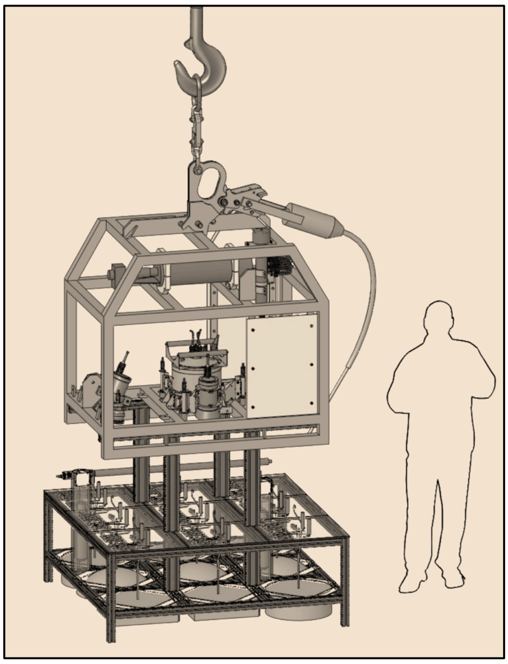

Fig. 2.4: Schematic view of the one-way deployment module (bottom) attached to a launcher system (top)

Expansion of larvae and colonisation of new substrata

Diverse and abundant natural hard-bottom communities have been observed on dropstones (Meyer et al., 2016) and a rocky reef in the HAUSGARTEN area (Meyer et al., 2014), but little is known about how these communities form or develop over time. Almost nothing is known about how new substrata will affect the functioning of the Arctic benthic communities. New substrata could facilitate range expansions of Atlantic fauna into the Arctic, by providing stepping-stones where previously no hard-bottom habitat was available.

In a new experimental approach, we will pursue the following questions: (1) How does the West Spitsbergen Current (WSC) affect larval transport into Arctic waters, and does it carry larvae of Atlantic species north to new areas they might invade? (2) What benthic organisms recruit to new substrata at different depths and in different water masses (WSC waters *vs.* polar waters)? How closely is recruitment coupled with larval supply, and can Atlantic species recruit to new substrata? (3) How does the nature of the settlement surface affect recruitment at the seafloor? And what organisms might recruit to industrial materials such as metal and plastic?

Work at sea

Impacts of reduced food availability on the small benthic biota

By means of the ROV-handled pushcorers we will retrieve sediments from surface sediments covered by four 4 m² cages with solid lids (Fig. 2.1). Three replicate samples will be taken from each cage. Three samples taken outside the cage will serve as controls for the starvation experiment. Push-corer samples will be sub-sampled by means of small plastic syringes to study the small sediment-inhabiting biota as well as to analyse different parameters including bacterial activity and chloroplastic pigment, organic carbon, lipid, and protein contents. Most of the sub-samples will be stored for later analyses at the home lab. In addition to the sediment sampling, a microprofiler unit will be used to assess gradients in oxygen concentrations in the upper 10 - 15 cm of the sediments inside and outside the cages (Fig. 2.1).

Impacts of marine litter in the Fram Strait

By means of the ROVs manipulators, we will lift the plastic plates and the canvasses made of lighter-weight rubbish bin material. A microprofiler will be deployed by ROV to measure *in-situ* oxygen profiles underneath the plastic items. Push-core samples will be taken to assess biogeochemical sediment parameters and changes in meiofaunal communities. The results will be compared with those obtained from reference cores taken nearby. The large sponges covered with plastic bags for one year will be retrieved and examined for signs of tissue damage or any other effects.

Impacts of new dropstones at the deep seafloor

By means of the ROV-handled pushcorers, we will retrieve sediments from surface sediments influenced by the dropstone and nearby undisturbed areas as controls. The cores will be sub-sampled for meiofauna/nematode analyses and different biochemical parameters indicating food availability.

Expansion of larvae and recruitment of new substrata

In order to answer questions (1) and (2) in the objectives section, we will outplant larval traps and settlement plates (Fig. 2.5). These samplers will be deployed at different depths: in the WSC core, in the underlying polar water, and at the seafloor. Larval traps and settlement plates deployed in HAUSGARTEN in summer 2015 will be recovered during a later cruise, allowing >1 year for larvae and recruits to accumulate.

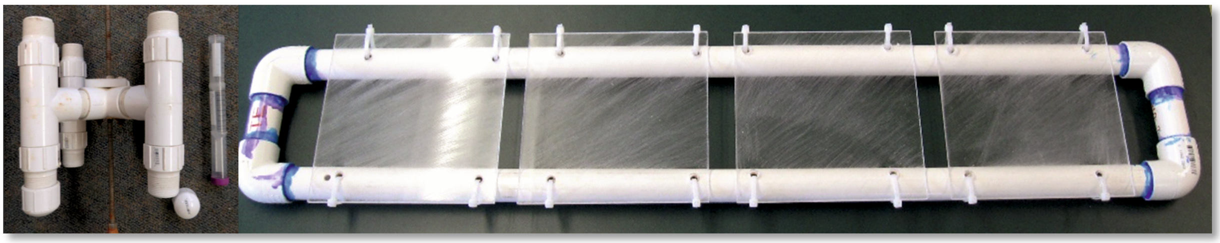

Fig. 2.5. Embedded funnel larval trap design (left side) and settlement plates (right side)

To answer question (3) in the objectives section, we will recover a recruitment experiment that was deployed at the central HAUSGARTEN site already in 1999 (Fig. 2.6). The aluminium-frame, 1.6 m high and of hexagonal shape (each side 90 cm wide) was fitted with 46 artificial hard-substrates to study the colonization of different hard substrata by sessile biota. Twenty plates were made of Perspex (25 x 25 cm), brick (24 x 11.5 cm) and six pieces consisted of wood (50 x 15 x 7 cm). During PS108, we will attempt to recover the whole frame to assess the colonization on the deep seafloor and state of the plastic.

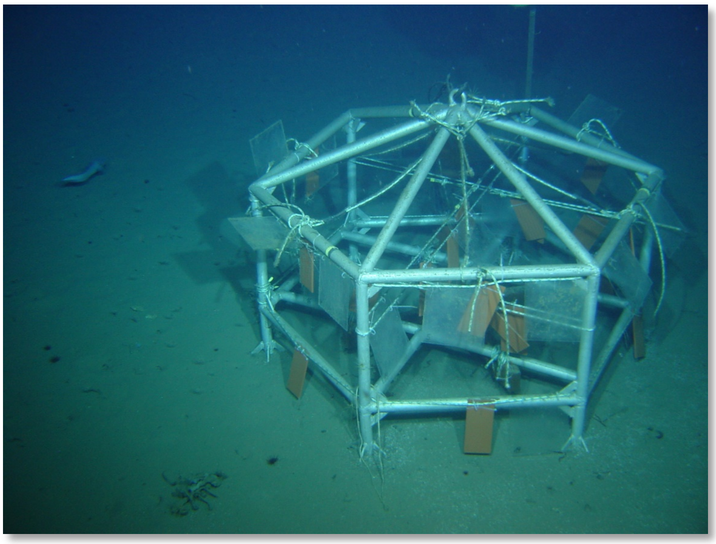

Fig. 2.6: Metal frame with different kinds of hard substrates deployed in 1999 at the central HAUSGARTEN site HG-IV

Data management and samples

Sample processing will be carried out at AWI. Data acquisition from the several types of investigation will be differently time-consuming. The time period from post processing to data provision will vary from one year maximum for sensor data, to several years for organism related datasets. Until then preliminary data will be available to the cruise participants and external users after request to the senior scientist. The finally processed data will be submitted to the PANGAEA data library. The unrestricted availability from PANGAEA will depend on the required time and effort for acquisition of individual datasets and its status of scientific publication.

References

Bergmann, M., Gutow, L., Klages, M., 2015a. Marine Anthropogenic Litter. Springer, Berlin.

Bergmann, M., Sandhop, N., Schewe, I., D'Hert, D., 2015b. Observations of floating anthropogenic litter in the Barents Sea and Fram Strait, Arctic. Polar Biol. 39: 553.

Hasemann, C., Bergmann, M., Kanzog, C., Lochthofen, N., Sauter, E., Schewe, I., Soltwedel, T., 2013. Effects of dropstone-induced habitat heterogeneity on Arctic deep-sea benthos with special reference to nematode communities. Mar. Biol. Res. 9(3): 276-292.

Kukliński, P., Berge, J., McFadden, L., Dmoch, K., Zajaczkowski, M., Nygård, H., Piwosz, K., Tatarek, A., 2013. Seasonality of occurrence and recruitment of Arctic marine benthic invertebrate larvae in relation to environmental variables. Polar Biol. 36: 549–560.

Meyer, K.S., Soltwedel, T., Bergmann, M., 2014. High biodiversity on a deep-water reef in the eastern Fram Strait. PLoS One 9: e105424.

Meyer, K.S., Young, C.M., Sweetman, A.K., Taylor, J., Soltwedel, T., Bergmann, M., 2016. Rocky islands in a sea of mud: biotic and abiotic factors structuring deep-sea dropstone communities. Mar. Ecol. Prog. Ser. 556: 45–57

Tekman, M.B., Krumpen, T., Bergmann, M., 2016. Marine litter on deep Arctic seafloor continues to increase and spreads to the North at the HAUSGARTEN observatory. Deep-Sea Research I, doi.org/10.1016/j.dsr.2016.12.011.

3. HIGH-RESOLUTION LONG-TERM STUDIES ON OXYGEN CONSUMPTION TO ASSESS SEASONAL VARIATIONS IN BENTHIC CARBON MINERALIZATION

M. Hofbauer, C. Kanzog, J. Lemburg, F. Wenzhöfer (AWI); A. Nordhausen (MPI)

Objectives and scientific programme

Polar regions play a central role for the global climate. Rapidly changing physical and chemical conditions, as observed and projected for the future, will affect the ecosystem functioning including productivity, remineralisation, and energy flow between ecosystem compartments. At the HAUSGARTEN deep-sea observatory (FRAM Strait at about 79° N), studies on the pelagic-benthic coupling are performed since 1999, to investigate how benthic life is governed by the food supply from surface waters.

Oxygen is a key molecule in earth ecology and global element cycles. Produced by photosynthesis, oxygen is the ultimate electron acceptor for organic matter mineralization and thus directly connected to the carbon cycle. A lot of our knowledge on oxygen exchange and carbon mineralization at the ocean floor originates from high-resolution studies of oxygen distributions and fluxes at the sediment-water interface. These studies allow determining the amount of organic material that escapes mineralization and is retained in the sediment record.

In-situ measurements in the Arctic are usually limited to the ice-free summer periods, thus limiting our knowledge on the dynamic range of seafloor remineralization processes. The fully autonomous benthic crawler TRAMPER is capable to record sediment oxygen distributions over a full annual cycle with translocation between consecutive measurements. The new generation of optode-based oxygen monitoring system mounted on a fully autonomous crawler will help to establish high-temporal resolution benthic flux measurements in order to determine seasonal variations in organic matter turnover and benthic community respiration activity, and to close the carbon budget for the deep Arctic ocean.

Work at sea

TRAMPER was deployed during *Polarstern* expedition PS99.2 in summer 2016 at HAUSGARTEN station HGIV at 2500 (Fig. 3.1). During its mission the crawler, equipped with a multi-optode-profiler, is pre-programmed to perform >52 sets of vertical concentration profiles across the sediment-water interface (one set each week) along a ~1 km transect. During expedition PS108 the crawler will be recovered for data readout. The retrieved oxygen profiles will be used to calculate benthic oxygen consumption rates which can then be converted to carbon equivalents. This allows determining the seasonal variations in organic matter mineralization. Depending on the condition of the crawler, it will be maintained on-board for a re-deployment of a second 12-months' mission.

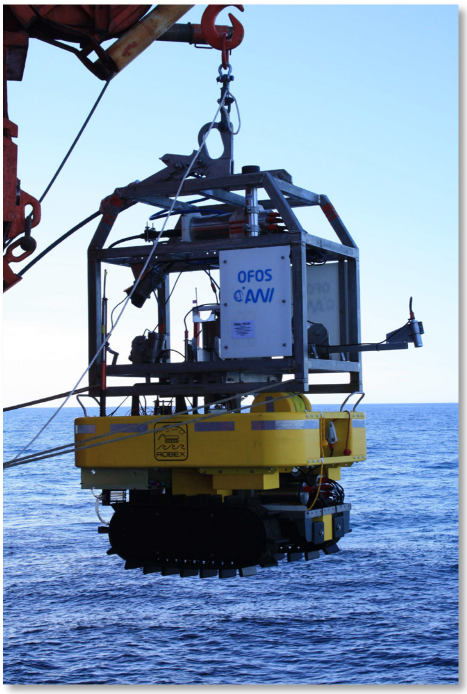

Fig. 3.1: TRAMPER deployment during PS99.2 at HAUSGARTEN station HG IV (2,500m)

Preliminary (expected) results

From the long-term deployment we expect new insights in the benthic oxygen consumption rates over a full seasonal cycle. The use of new underwater technologies will thereby enhance our capabilities to improve our knowledge on the effects of climate change on the Arctic ecosystem.

Data management and samples

Data processing will be carried out at AWI. The finally processed data will be submitted to the PANGAEA data library. The unrestricted availability from PANGAEA will depend on the required time and effort for acquisition of individual datasets and its status of scientific publication.

References

Wenzhöfer F, Lemburg J, Hofbauer M, Lehmenhecker S, Färber P (2016) „TRAMPER - An autonomous crawler for long-term benthic oxygen flux studies in remote deep sea ecosystems“ OCEANS 2016 MTS/IEEE Monterey, 1-6. doi: 10.1109/OCEANS.2016.7761217

4. MANSIO-VIATOR - VESTNESSA POCKMARK REGION - HYDROGRAPHIC, CHEMICAL AND BIOLOGICAL GRADIENTS OF METHANE SEEPS IN SPACE AND TIME

I. Ahrns (AIRBUS DS), T. Berghäuser, S. Flögel , M. Hildebrandt (DFKI), C. Nuber (AIRBUS DS), O. Pfannkuche (iSeaMC) , D. Saturov (GEOMAR), J. Schwendner (Kraken Robotik), D. Wilde (AIRBUS DS)

Objectives and scientific programme

Within the context of this cruise various partners of the HGF Alliance ROBEX will present and test innovative technological concepts that were jointly developed by two scientific communities, deep sea and space research. This resulted in new ways to approach extreme environments of the deep sea. The expanding need for tools to investigate various parts of the world oceans such as the shelf seas and continental margins for scientific reasons is continually increasing while our ability to address questions concerning ocean change is fundamentally limited by the lack of key technologies for enabling *in-situ* experimentation and observation performing persistent sensor measurements in the ocean.

During PS108, we will deploy the newly developed crawler system, MANSIO-VIATOR. Here, the overall aim is to demonstrate the applicability of this new underwater system to investigate the hydrographic, chemical and biological gradients within the vicinity of methane seeps at the Vestnessa pockmark region.

The MANSIO-VIATOR (latin: harborage-traveler, Fig. 4.1) comprises a stationary lander system (MANSIO) and a mobile deep-sea crawler (VIATOR). The hangar is used for transport to the site of investigation and for recovery at the ocean surface as well as to recharge the lithium polymer accumulators (4x2kWh) on the crawler. The hangar facilitates energy transfer from the lander system to the crawler of up to 2kWh. After a video-controlled deployment, the VIATOR is operating fully autonomously and operates within a range of about 100 meters.

Fig. 4.1: MANSIO-VIATOR on deck RV ALKOR

Once on sea-floor, the crawler will leave the hangar and start its scientific mission. After completion VIATOR returns to the lander for energy recharge in the lander. During its mission, the crawler records oceanographic and biogeochemical parameters such as temperature, salinity, pressure, currents, oxygen, pH, pCO_2, CH_4, turbidity, and chlorophyll. The system can be deployed in water depths of up to 6,000 m. In addition to the physical and biogeochemical sensors the system is equipped with a pan and tilt unit (PTU) that includes a camera and a line scanner that is used for navigational puposes and to collect data for a 3D-reconstruction of the sea-floor.

We plan to deploy the master unit with the crawler video-controlled approximately 100 m away from two different seep localities (Fig. 4.2) which are characterized by dense microbial mats and pogonophora as depicted in Fig. 4.3. This allows us to measure chemical gradients from the source to natural background bottom water values. The optical survey conducted by VIATOR will cover a gradient of different chemoautotrophic species to normal heterotrophic fauna, i. e. bacterial mats, pogonophora in different densities, and bathyal heterotrophic organisms (Fig. 4.3).

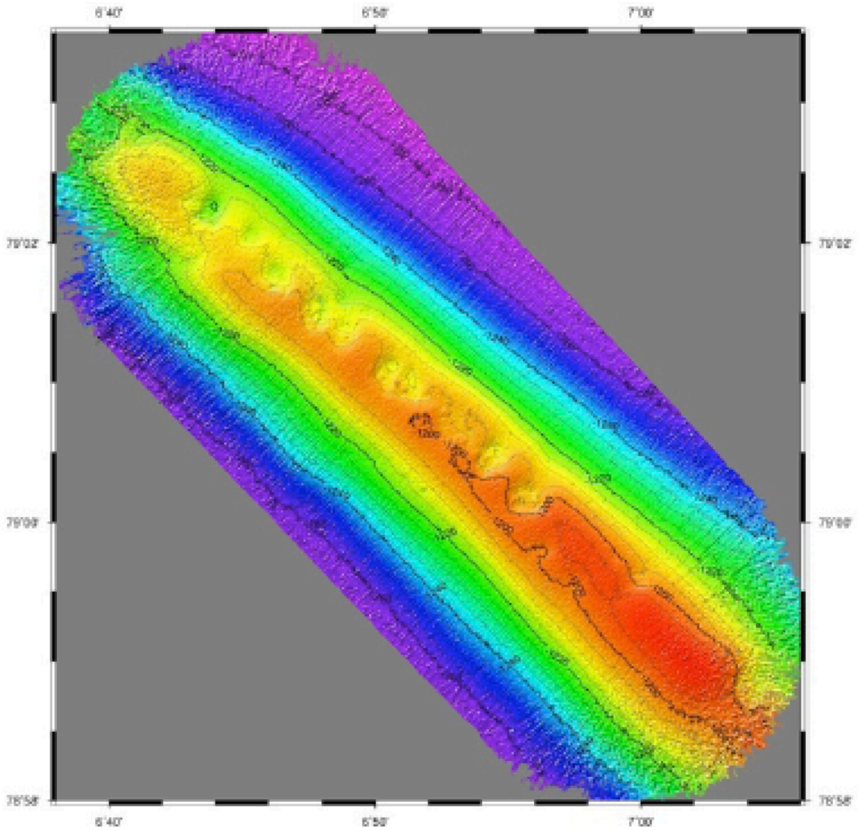

Fig. 4.2: Multibeam image of the working area. Pockmark depressions are clearly visible

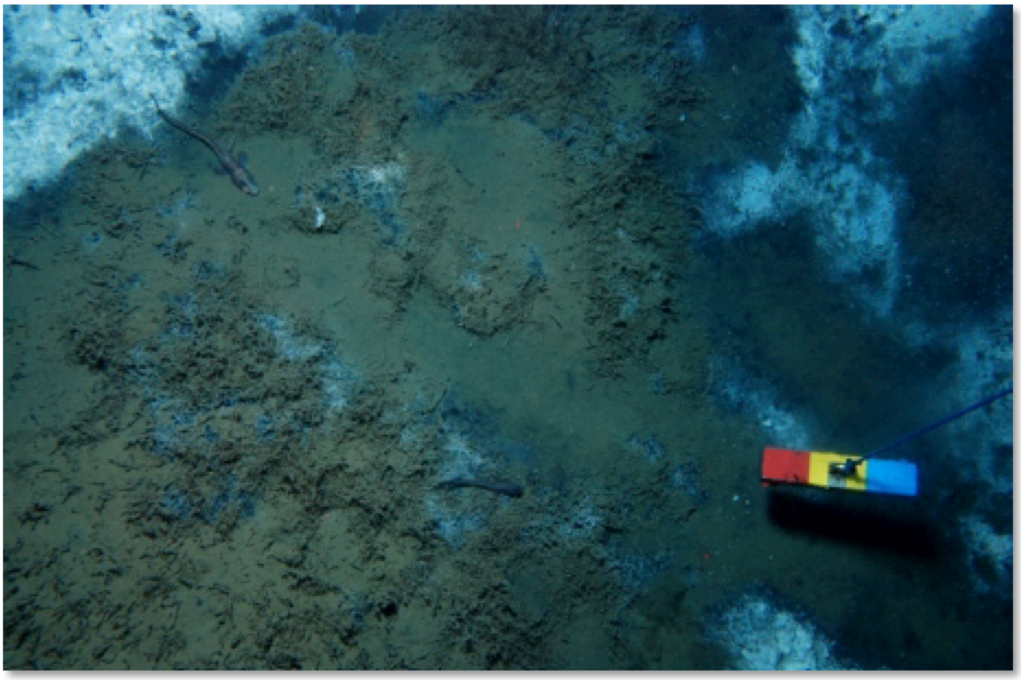

Fig. 4.3: Photo of potential deployment site taken with OFOS. Depicted are bacterial mats (greyish-white) and pogonophora in between individual mats

Work at sea

The work at each site starts with a ROV pre-site survey to identify an active seep and to determine deployment positions. The master unit will be deployed with a videoguided launching device at the selected target position approx. 100 meters from the seep center. After deployment the operation follows the listed protocol:

1. Establish communication with master unit via acoustic modem
2. VIATOR leaves hangar: visual mapping and measurements along transect to seep
3. After 12 hours VIATOR returns to hangar – energy and data exchange
4. VIATOR leaves hangar: visual mapping and measurements along transect to seep
5. After 12 hours VIATOR returns to hangar
6. Acoustic closure of hangar and acoustic release of ballast weights
7. Recovery

Expected results

The focus of the planned deployments is to show the usability of the newly developed system incl. lander and autonomous crawler. We will further test the behavior and energy consumption during multiple measurement transects.

Data management

All the collected data such as camera images and sensor data will be stored at https://portal.geomar.de/metadata/leg/show/PS108 and additionally mirrored on https://www.pangaea.de.

5. UNDERSTANDING METHANE DYNAMICS IN THE BENTHIC BOUNDARY LAYER OFF SPITSBERGEN USING NOVEL SENSOR TECHNOLOGY

S. Sommer, M. Schmidt, S. Cherednichenk, J. Soto-Neira (Geomar)

Objectives and scientific programme

Technological aims

The overall aim is to demonstrate the successful underwater application of emerging sensor technology including an *in-situ* membrane inlet mass spectrometre (MIMS) and lab on a chip (LOC) technology for the measurement of nutrients. These sensor technologies have been developed within the Helmholtz Alliance ROBEX (ROBOTIC Exploration of Extreme Environments).

Despite the huge potential for the wide application of *in-situ* MIMS the use of this technology in aquatic sciences is still largely restricted (Chua et al. 2016 and references therein). Those few systems that exist are used predominantly for mapping of volatile hydrocarbons where a study addressing the Deepwater Horizon oil spill represents a prominent example (Camilli et al. 2010). Other recent examples of mapping volatiles focus on the methane source strength of a blow out in the central North Sea UK (Sommer et al. 2015) or volcanic degassing of carbon dioxide around the Panarea island (Aeolian Islands, Italy, Schmidt et al. 2015). These studies (amongst others, see Chua et al. 2016) demonstrated that MIMS is a promising technology for the simultaneous detection as well as the quantification of volatiles. The latter two studies both conducted by GEOMAR were however *ex-situ* and relied on continuous in-line measurements on water that was pumped from the measurement site on board the ship. During cruise PS108 GEOMAR will apply its first underwater MIMS system.

While Lab on a chip technology (LOC) is rapidly expanding in medicine and pharmaceutical industries it is still in its infancies in space- and marine sciences. Within ROBEX bringing together space- and ocean science/technologies the enormous potential of LOC technology for planetary and oceanic missions is explored and tested. LOC technology offers broad applications ranging from miniaturized bioreactors for the synthesis of e.g. biomolecules, all kind of analytics to cellular assays and experiments. Obvious advantages of LOCs include small size, low weight, low energy demand, low sample and reagent volumes, and fast processing times, which render them particularly suitable for their deployment on a variety of different vehicles such as rovers, lander systems or gliders. Due to the various applications their complexity might vary from simple test stripes to highly complex, autonomous system architectures for the continuous and simultaneous measurements of multiple parameters. In collaboration with the National Oceanography Centre Southampton first nutrient (nitrate, nitrite) time series measurements close to the seafloor in 170 m water depth offshore Mauritania using self-calibrating LOCs has proven this technology as robust and reliable tool for under water deployments (Yücel et al. 2015, Beaton et al. 2011). During this cruise we will deploy a system for the measurement of dissolved iron, which has been strongly modified after the design by Milani et al. (2015).

Scientific aims

The Svalbard archipelago and its main western island Spitzbergen is located at a key juncture at the Arctic Ocean-Atlantic Ocean boundary. Particular importance of the area arises from the presence of gas hydrates (Vogt et al., 1994; Vanneste et al. 2005) and active venting at the upper limit of the gas hydrate stabilization zone (GHSZ) (Westbrook et al., 2009). Specifically, methane flares were found along a 25 km-long stretch at the ~390 m isobath (Westbrook et al. 2009, Berndt et al. 2014). Venting was also found to be vigorous. Recent work showed that the mode of the West Spitzbergen Current (WSC) flowing over the GHSZ zone influence the retention of methane in the water column (Steinle et al. 2015). These authors showed that with short-term variations in the WSC, new water masses can move in causing the replacement of the established methane- consuming microbial communities. Therefore, the source strength of methane seepage and its fate in the water column is strongly linked to hydrodynamic patterns over the Spitzbergen GHSZ seeps. The combined influence of hydrodynamics in association with distinct changes of water mass movements, changes in the source strength and microbial activity render the GHSZ extremely difficult to quantify the actual CH_4 emission.

We will implement an integrated approach to resolve the temporal and spatial dynamics of seabed methane release at the Spitzbergen GHSZ. Our objectives are

(i) to obtain *in-situ* time series (2-3 days) of physical and biogeochemical parameters including concentrations of methane, oxygen, and pCO_2, using a bottom boundary layer (BBL) lander carrying state-of-the-art chemical sensors and

(ii) to determine spatial variability with chemical mapping over the seeps using the towed video system OFOS (Ocean Floor Observation System), which is equipped with CH_4, pCO_2 sensors (Kongsberg) and an underwater MIMS. Additional measurements will be conducted using the Kiel ROV 6000.

Work at sea

To understand the temporal and spatial dynamics of methane seepage at the top of the GHSZ in water depths of 350 to 400m off Spitzbergen the BBL lander and the OFOS system will be deployed. Depending on water column geochemical conditions the study site for the BBL and the towed OFOS system will be at 78°35.109 N 09°27.4001 E. This site has been already investigated during Poseidon cruise POS 419 in 2011 (PI: O. Pfannkuche). The spatial survey using the OFOS system needs to be conducted at the same time as the BBL Lander for measuring the time series. In order to achieve our objectives we plan to do the following work:

The ROV Kiel 6000 will be used to survey potential sites for BBL deployments. Active methane seep sites will be documented. Features such as microbial mats or megafaunal assemblages will be observed. Both video and still images will be recorded. Sensors for the measurement of CH_4, pCO_2 and O_2 will be deployed.

In-situ measurements – time series with lander: The BBL lander is a conventional GEOMAR type lander that can be moored on the seafloor. To record the current regime and physical conditions, an upward looking ADCP and CTD will be mounted within the lander frame. Concentrations of oxygen will be measured using optodes (Aandaraa). For the measurement of pCO_2 and CH_4 Kongsberg sensors will be deployed. For dissolved iron measurements, a novel LOC sensor will be used to measure temporal variations that might be associated with the changing current regime. The lander will also be equipped with 2 syringe samplers that sequentially will take bottom water samples. The samples will be analyzed for CH_4 in the laboratories of GEOMAR.

The BBL Lander deployments will last 3 days to record CH_4 variability on temporal scales of hours to days. We plan to conduct three such deployments. Spatial mapping of volatiles (CH_4, O_2, pCO_2, N_2, Ar) over the gas plumes will be conducted using the OFOS. The OFOS will include CH_4, pCO_2 sensors as well as an *in-situ* MIMS for the simultaneous mapping of various dissolved gases. Chemical mapping over the seeps will be conducted at the same time as the time-series measurements of the BBL. Each towed OFOS transect will last between 6 and 12 hours to cover the tidal regime.

Preliminary and expected results

Recent work showed that the mode of the West Spitzbergen Current (WSC) flowing over the GHSZ zone influences the retention of methane in the water column (Steinle et al. 2015). During this study we were able to show that with short-term variations in the WSC, new water masses can move in causing the replacement of the established methane-consuming microbial communities. Therefore, the source strength of methane seepage and its fate in the water column is strongly linked to hydrodynamic patterns over the Spitzbergen GHSZ seeps. Furthermore a 36 h short-term time series study on the methane variability in the same area conducted during Poseidon cruise POS419 by Sommer, Greinert, Bussmann & Pfannkuche (unpublished data) demonstrated the high CH_4 and O_2 variability caused by tidal periodicity and other temporal fluctuations masks the actual CH_4 seabed release. During this cruise we expect to better constrain the actual CH_4 source strength influenced by hydrodynamics. We further intend to get better insights into the methane plume dynamics by the simultaneous investigation of the various dissolved gases in conjunction with CTD and current measurements.

Data management and samples

Data will be generated by sensors to be deployed on towed systems such as the OFOS, the BBL lander as well as by instruments attached to the ROV Kiel 6000. These instruments include pCO_2, CH_4 sensors from Kongsberg, the *in-situ* MIMS, CTD Sensors and ADCP for current measurements. Furthermore, video footage and still photographs from the seafloor will be obtained during these deployments. Water samples retrieved from the Lander syringe samplers and the Niskin bottles of CTD casts will be used for CH_4 analytics at GEOMAR based laboratories.

After post-processing and validation the data will be transferred to AWI and the Kiel Data Management Team (KDMT), which maintains a data sharing system for marine research at GEOMAR and Uni. Kiel. This Ocean Science Information System (OSIS-Kiel) is accessible for all project participants and can be used to share and edit common expedition information and share ongoing research data. Some KDMT members are PANGAEA data curators and will assist in the preparation of sample archives in a World Data Center, WDC (e.g. PANGAEA), to ensure long-term data archival. General data and information generated during laboratory work will be stored in OSIS-Kiel at least until publication.

References

Beaton AD, Sieben VJ, Floquet CFA, Waugh EM, Abi Kaed Bey S, Oglivie IRG, et al. (2011) An automated microfluidic colourimetric sensor applied *in-situ* to determine nitrite concentration. Sens. Actuators B, 156, 1009-1014.

Berndt C, Feseker T, Treude T, Krastel S, Liebetrau V, Niemann H, Bertics VJ, Dumke I, Dünnbier K, Ferré B, Graves C, Gross F, Hissmann K, Hühnerbach V, Krause S, Lieser K, Schauer J, Steinle L (2014) Temporal constraints on hydrate-controlled methane seepage off Svalbard. Science, 343, 284-343.

Chua EJ, Savidge W, Short RT, Cardenas-Valencia AM, Fulweiler RW (2016) A review of the emerging field of underwater mass spectrometry. Frontiers Marine Sciences, 3, 209 doi:10.3389/fmars.2016.00209.

Milani A, Statham PJ, Mowlem MC, Conelly DP (2015) Development and application of a microfluidic *in-situ* analyser for dissolved Fe and Mn in natural waters. Talanta, 136, 15-22.

Schmidt M, Linke P, Sommer S, Esser D, Cherednichenko S (2015) Natural CO_2 seeps offshore Panarea: A test site for subsea CO2 leak detection technology. Marine Technology Society Journal, 49, 19-30.

Sommer S, Schmidt M, Linke P (2015) Continuous inline mapping of a dissolved methane plume at a blow out site in the Central North Sea UK using a membrane inlet mass spectrometer – Water column stratification impedes immediate methane release into the atmosphere. Marine and Petroleum Geology, 68, 766-775.

Steinle L, Graves CA, Treude T, Ferré B, Biastoch, Bussmann I, Berndt C, Krastel S, James RH, Behrens E, Böning CW, Greinert J, Sapart C-J, Schienert M, Sommer S, Lehmann MF, Niemann H (2015) Water column methanotrophy controlled by a rapid oceanographic switch. Nature Geoscience, DOI:10.1038/NGEO2420.

Vanneste M, Guidard S, Minert J (2005) Bottom-simulating refelctions and geothermal gradients across the western Svalbard margin. Terra Nova, 17, 510-516.

Westbrook GK, Thathcer KE, Rohling EJ, et al. (2009) Escape of methane gas from the seabed along the West Spitsbergen continental margin. Geophysical Research Letters 36, S.L15608.

Vogt PR, Crane K, Sundvor E, Max MD, Pfirman SL (1994) Methane generated (?) pockmarks on young thickly sedimented oceanic crust in the Arctic: Vestnessa Ridge, Fram Strait. Geology, 22, 255-258.

Yücel M, Beaton AD, Dengler M, Mowlem MC, Sohl F, Sommer S (2015) Nitrate and nitraite variability at the seafloor of an oxygen minimum zone revealed by a novel microfluidic *in-situ* chemical sensor. PLOS ONE, doi:10.1371/journal.pone0132785,

6. INVESTIGATING PHYSICAL AND ECOLOGICAL PROCESSES IN THE MARGINAL ICE ZONE USING AN AUTONOMOUS UNDERWATER VEHICLE AND UNMANNED AERIAL VEHICLES

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Objectives and scientific programme

In terms of biological activity, the polar marginal ice zones (MIZ) are among the most relevant regions in the world. Previous observations suggest the high biological activity to be triggered by physical and chemical processes which take place in the upper water column in the MIZ. Until today these processes are understood insufficiently – at least partly caused by the challenge of observing various processes with high spatial and temporal resolution simultaneously. We aim at investigating the complex physical processes at the MIZ as well as their impact on the biological activity using the Alfred Wegener Institute´s (AWI) Autonomous Underwater Vehicle (AUV) “*PAUL*” (Fig. 6.1).

The physical mechanisms governing the conditions in the MIZ will be observed with a set of physical sensors such as comprising of a conductivity, temperature and depth probe (CTD), an acoustic doppler current profiler (ADCP), a microstructure probe (MSP) and a sensor for photosynthetically active radiation (PAR). With these instruments, we will be able to distinguish different water bodies, determine small scale mixing processes at their interfaces, estimate fluxes, measure the water column´s stability and gather data on the underwater light field. These physical parameters are essential to understand the ecological response. To observe the respective biological activity, the AUV is equipped with a chlorophyll *a* fluorometer, a fluorometer for colored dissolved organic matter (CDOM) and a nitrate sensor to determine the water column´s nutrient inventory. A water sample collector which is able to collect 22 samples with an overall volume of 4.8 liters is used to calibrate the nitrate as well as the chlorophyll *a* sensor and to study the composition of plankton communities.

Fig. 6.1: PAUL prior to a deployment during PS99 in summer 2016

Within the framework of the Helmholtz Alliance “Robotic Exploration of Extreme Environments – ROBEX”, which brings together deep-sea and space research institutes, AWI’s AUV team cooperates with the University of Würzburg. The main objective of this cooperation is to conduct joined operations between *PAUL* and Unmanned Aerial Vehicles (UAVs) (Fig. 6.2). The “Landing UAV” will land on the ice to observe the ice´s drift. While staying on the ice for several hours, it will constantly determine its own position via GPS and transmit the position via radio signal. Additionally, it will record light levels – thus serving as a surface reference for *PAUL*´s PAR sensor. Furthermore it enables us to estimate the amount of light penetrating through the ice into the water body below the ice.

Along with *PAUL*´s data, we will be able to gather a holistic data set of the dynamic processes in the MIZ.

Fig. 6.2: Landing UAV during a flight

Work at sea

In order to prepare *PAUL*'s missions, the ice edge will be monitored several days in advance using satellite imagery. Special attention will be paid to ice structures that indicate high regional dynamics (e.g. ice tongues or jets) or highly stable ice edges (no drift for several days). To determine the existence and orientation of an expected front, the thermosalinograph in the bow of *Polarstern* will be monitored while steaming in a zig-zag-pattern along the front.

Prior to *PAUL* commencing its mission, the "Landing UAV" will take off from *Polarstern* to land on the ice. Landing will be executed by a human pilot controlling the vehicle via a camera providing a first person view (FPV). For long range video transmission, a high gain antenna will automatically track the vehicle and permanently align itself to point towards the location of the vehicle.

PAUL will be deployed several kilometers off the ice. The missions will be planned such that it crosses the front and advances several kilometers into the ice-covered waters. However, whether both objectives (crossing the front + under ice dive) can be achieved within one single mission, heavily depends on the distance between meltwater front and the ice edge.

The mission depth will vary between 3 and 50 meters about every 300 m – either propeller driven in a zig-zag manner or free floating after the thruster has been deactivated it has deactivated its thruster. Thus, numerous high-resolution vertical profiles will be recorded. Water samples will be taken at the end of each mission. During the missions, which will last approx. 8 hours each, *PAUL* will operate several kilometers away from *Polarstern*. Up to a distance of 2.5 km, the AUV can be tracked using an Ultra Short Baseline (USBL) System. Missions that go beyond that range will be conducted "unattended". After completing a mission, *PAUL* will guide itself to the pre-programmed recovery location. Water samples will then be processed in a cold room and stored deep frozen. Biological, chemical and physical data will be checked aboard to avoid unperceived sensor malfunction.

Preliminary (expected) results

From the simultaneous AUV / UAV deployment we expect to gather a holistic picture of the small scale processes occurring in the marginal ice zone. We hope this will help to understand the complex interactions in this dynamic zone and ultimately help to understand the reasons for its high biological productivity.

Data management

Completely corrected navigation data and preliminary biogeochemical and physical (CTD) data will be stored on *Polarstern*´s servers. Charts providing an overview on preliminary results will be made available on the ship within 24 hours after the mission to support further expedition planning. As sample processing will be carried out at AWI, time periods for data provision will vary from two to four months depending on the parameter. The ADCP and MP data processing is still under review and thus no time period can be given at this point. The finally processed data will be submitted to the PANGAEA data library.

7. PROBING THE UPPER 200 M OF THE WATER COLUMN WITH A NEWLY DEVELOPED UNDERWATER GLIDER

C. Waldmann, S. Meckel (Uni Bremen), U.Soppa, B. Langpap (AIRBUS DS), M. Ruffer (Uni Würzburg)

Objectives and scientific programme

The main objective of the glider deployments is to demonstrate the capabilitiy of this platform in regard taking undisturbed measurements of salinity, density and oxygen in the upper 200 m of the water column. Undisturbed means that platform movements will be minimal as there is no propeller used and the sensors are integrated at a position that causes no interference with the boundary layer of the platform. The underwater glider (Fig. 7.1)has been developed as part of the Helmholtz Alliance „Robotic Exploration of Extreme Environments-ROBEX“ and is meant to support biochemical investigations in future deployments. In comparison to legacy glider systems the payload capability is about 10 times higher and another specific is the small gliding angle that allows for a better horizontal coverage of the related depth range which is for instance highly relevant for video investigations of particle fluxes.

The underwater glider has been developed as part of cooperation between MARUM, AIRBUS, DLR, and University of Würzburg inside ROBEX. The deployment will be the first field operation from board a vessel. The risks oft hat type of mission will be lowered by following similar deplyoment routines as with the AUV PAUL of AWI.

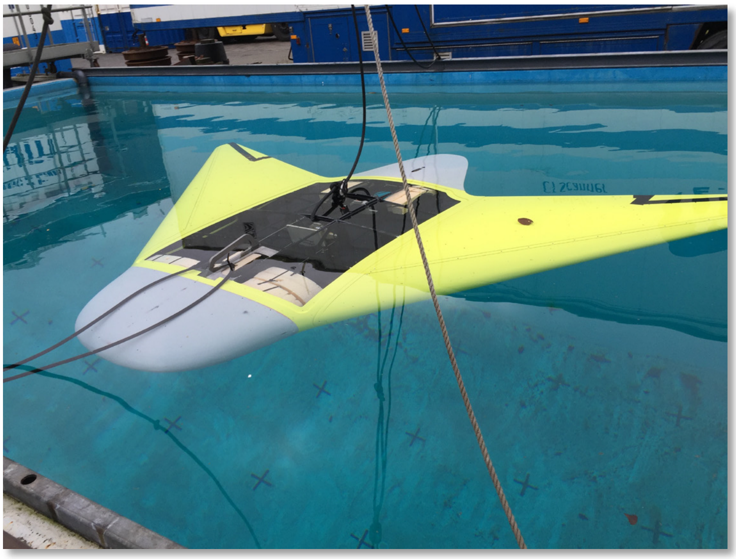

Fig. 7.1: The underwater glider being weight balanced in the test basin of MARUM

Work at sea

At the current development stage all operational phases of the system have to be closely monitored. In particular one has to avoid drifting ice which again is very similar to the AUV operation scenario. Another critical point of the glider operation is the weight adjustment of the vehicle. Although a prelimary weight balancing will be done at MARUM one has to do the final ballasting at sea. With ice shields close by one has to consoder that fresh water lenses can cover the upper part of the water column which can prevent the system from resurfacing. Thus the stratification of the upper water column has to be closely monitored.

A mission for the glider will typically require 8 hours which includes deployment and recovery time. Hopefully we will be able to carry out three deplyoments. The mission range will be about 10 km where *POLARSTERN* should stay in a range of 2-3 km of the glider. The position can then be tracked with the GAPS system that the AUV group of AWI is using.

After completing a mission the glider will be located and retrieved a at pre-programmed position. In case of any malfunction an emergency IRIDIUM transmitter will transmit the position information.

Preliminary (expected) results

We will have a SEABIRD CTD with oxygen sensor integrated into the glider which which will be evaluated and compared with other data that have been collected at the same location. In regard tot he performance oft he underwater glider we will evaluated the time record of thevehicle motions together with the collected scientific data to explore what added value can be expected from using that type of platform. This is in particular relevant as there is an interest to integrate turbulence sensors into the platform. The company Rockland Scientific already indicated their interest in using this platform for testing purposes.

Data management

The collected geo-referenced scientific data will be submitted to PANGAEA. We expect a time period of 4 weeks for data submission.

References

Waldmann C et al (2014) MOTH- An underwater glider design study carried out as part of the HGF alliance, IEEE/OES Autonomous Underwater Vehicles (AUV), DOI: 10.1109/AUV.2014.7054401

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18.	Reise, Lutz	Carpenter
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21.	Scheel, Sebastian	A.B.
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23.	Brück, Sebastian	A.B.
24.	Wende, Uwe	A.B.
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29.	Rhau, Lars-Peter	Mot-man
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39.	Silinski, Carmen	2.Stwdess
40.	Duka, Maribel	2.Steward
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42.	Sun, Yong Shen	2.Steward
43.	Chen, Dan Sheng	Laundrym.