EXPEDITION PROGRAMME No. 85

RV POLARSTERN

ARK-XXV/1
10 June 2010 - 30 June 2010
Bremerhaven - Longyearbyen

ARK-XXV/2
30 June 2010 - 29 July 2010
Longyearbyen - Reykjavik

ARK-XXV/3
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Reykjavik - Bremerhaven

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ARK-XXV/1

10 June 2010 - 30 June 2010

Bremerhaven - Longyearbyen

Greenland Sea and Fram Strait

Chief scientist
Gereon Budéus

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1. ÜBERBLICK UND FAHRTVERLAUF

Der erste Fahrtabschnitt der 25. *Polarstern* Expedition in die Arktis wird am 10. Juni 2010 beginnen. Das Schiff wird von Bremerhaven auslaufen, um in der Grönlandsee sowie, im folgenden Fahrabschnitt, in der Framstraße Forschungen durchzuführen.

Das genannte Gebiet steht seit einigen Jahrzehnten verstärkt im Fokus des wissenschaftlichen Interesses, da sich dort Schlüsselprozesse im Ozean abspielen. Der Transfer zwischen Atmosphäre und Ozean bezüglich mechanischer Energie, Wärme und Süßwasser ist hoch, insbesondere während der kalten Wintermonate. Wassermassen aus niedrigen und hohen Breiten treffen dort aufeinander und interagieren durch Vermischung an Fronten, Überschichtungen, Einmischungen und Winterkonvektion. Meereis wird in den nördlichen und westlichen Teilen des Gebiets gebildet und wird mit den kalten und salzarmen Oberflächenwassermassen im ostgrönländischen Strom gen Süden transportiert. Es werden Wassermassen hoher Dichte erzeugt, die einen wesentlichen Beitrag zur tiefen meridionalen Zirkulation im Atlantik leisten. Dies alles macht die Region ausgesprochen empfindlich gegenüber klimatischen Veränderungen, wobei Rückkopplungsmechanismen bezüglich des nordeuropäischen Klimas besondere Beachtung verdienen. Auch dem Beziehungsgeflecht und den Rückwirkungsmechanismen zwischen dem Ozeanklima und der Biosphäre sowie biogeochemischen Abläufen gilt aufgrund der mittlerweile erkannten Bedeutung das besondere Interesse. Es ist selbstverständlich, dass solche großräumigen klimatischen Betrachtungen auf hochwertigen regionalen Beobachtungen lokaler Veränderungen aufbauen müssen.

Die hydrographischen Arbeiten auf diesem Fahrabschnitt bilden einen weiteren Mosaikstein zu Langzeit-Messreihen, wie sie für die klimabezogene Forschung unverzichtbar sind. In der Grönlandsee, aber auch in der Framstraße, hat das Alfred-Wegener-Institut bereits eine beachtliche Forschungshistorie aufzuweisen, welche die Quantifizierung solch wichtiger Vorgänge wie die des meridionalen Wärmeflusses, der winterlichen Konvektionstiefen, der Speicherung von Wärme und Salz im Ozean und dergleichen mehr gestattet sowie die Variabilitäten und Trends der mit diesen verbundenen physikalischen Parameter bestimmbar macht. In den Projekten werden Stationsarbeiten vom Schiff aus durchgeführt, es finden aber auch innovative autonome selbstprofilierende Verankerungen Verwendung.

Ein besonderes Merkmal der Grönlandsee ist das Zusammentreffen dreier hydrographischer Zonen (polare, arktische und atlantische Zone) auf engem Raum und gleicher geographischer Breite. Dies ermöglicht Studien zur Beziehung zwischen dem pelagischen Ökosystem und veränderlichen Klimaparametern unter gleichbleibenden Belichtungsverhältnissen. Neben den Änderungen des Ozeanklimas finden auch Modifikationen der chemischen Gleichgewichtszustände und des Elementenaustausches in der Oberflächenschicht des Ozeans statt. Diese physikalischen und chemischen Veränderlichkeiten zeitigen höchstwahrscheinlich weitreichende Konsequenzen sowohl für das pelagische Ökosystem als auch für die Kohlenstoffbilanz des Arktischen Ozeans. In den subpolaren Gebieten hat der aktuelle Klimatrend bereits zu einer Verlagerung der charakteristischen Phytoplanktonarten geführt. Da die Spurengasemissionsmenge direkt vom Auftreten bestimmter Planktonarten abhängt, können solche Verlagerungen über die Veränderung der Spurengasemmission sogar Einfluss auf die Chemie der Atmosphäre haben und auch die Strahlungsbilanz der Atmosphäre beeinflussen. Das Vorkommen und das Verhalten von marinen Säugern und Seevögeln ist Gegenstand weiterer Projekte. Die sich verändernde Eisbedeckungsstruktur in der Aktis führt bereits heute zu veränderten Vorkommen einiger

Arten und die zu erwartende Zunahme des Geräuschpegels im Ozean durch die Nutzung der nördlichen Schiffsrouten schon in der näheren Zukunft impliziert die Notwendigkeit, verlässliche Bestandsänderungsabschätzungen unverzüglich vorzunehmen.

Der Fahrtabschnitt wird am 30. Juni 2010 in Longyearbyen auf Spitzbergen enden. Die Fahrtroute ist in Abb. 1 dargestellt.

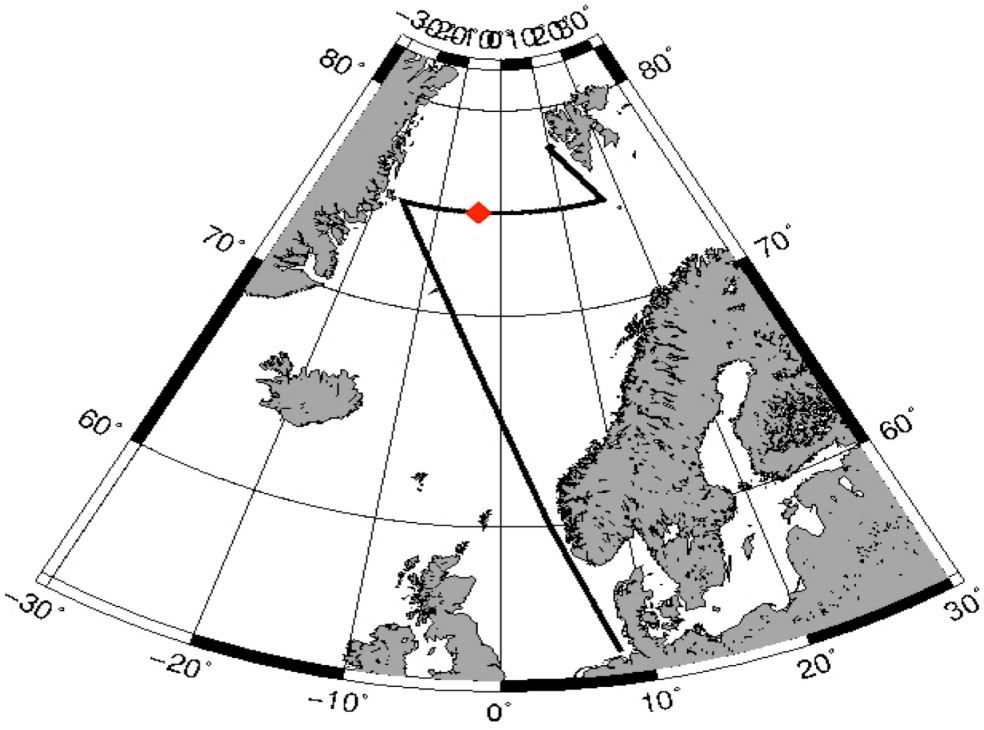

Abb. 1: Die geplante Fahrtroute während der Polarstern-Reise ANT-XXV/1 von Bremerhaven nach Longyearbyen auf Spitzbergen
Fig. 1: The planned cruise track during Polarstern cruise ANT-XXV/1 from Bremerhaven to Longyearbyen on Spitsbergen

OVERVIEW AND ITINERARY

The start of the first leg of the 25. *Polarstern* expedition to the Arctic is scheduled for the 10 June 2010. The ship will depart from Bremerhaven and do research in the Greenland Sea and, during the following cruise leg, in Fram Strait.

This sub-arctic region attains increased scientific attention during the recent few decades due to a number of key properties. The atmosphere-ocean transfers of momentum, heat and freshwater are strong, particularly during the cold winter months. Water masses from low and high latitudes meet and interact by means of mixing at fronts, subduction, entrainment, and winter convection. Sea ice is formed in the northern and western parts and is transported southward with the cold and fresh surface waters in the East Greenland Current (EGC). Dense waters are formed which act as a major contribution to the Atlantic Meridional Overturning Circulation or as the source of deep Arctic Waters. All this makes the region highly sensitive to climatic changes and also leads to feedback mechanisms which vice versa affect the north European climate. Interrelations and feedbacks between the ocean climate and ocean biota and biogeochemical properties have also gained increasing interest recently due to the recognition of their importance. Investigations of these climatic aspects must evidently be based on sound perceptions of local modifications.

The hydrographic work during this cruise leg contributes to the establishment of long term time series as are indispensable to study the ocean climate. Both in the Greenland Sea and in Fram Strait, the Alfred Wegener Institute already has a long research history which allows to quantify meridional heat fluxes, winter convection depths, heat and salt storage in the ocean, and the like, and to determine variability and trends of related physical parameters. The projects include station work, conventional moorings as well as innovative autonomously profiling moorings, and the use of autonomous underwater vehicles.

The Greenland Sea is unique in that three hydrographic domains (Polar, Arctic, Atlantic) which represent different biogeographic climate zones are present on the same latitude at a relatively small spatial scale. This allows to study the relationship between climate variability and pelagic ecosystems under the same light regime. In addition to ocean climate changes, changes in surface ocean chemical equilibrium and elemental cycling are occurring due to ocean acidification. Such physical and chemical changes of the environment will eventually bear enormous consequences for the pelagic system and for the net carbon balance of Arctic ecosystems. In the sub-polar areas climatic change already induced a shift of phytoplankton key species. Since the magnitude of trace gas emission is strongly related to particular plankton groups, such effects can result in variation of trace gases emission by phytoplankton and might have an impact on the atmospheric chemistry, and eventually induce positive or negative feedback in the radiation balance. Furthermore, the occurance and behaviour of marine mammals and seabirds is studied. The changing ice cover in the Arctic leads to modified routes of many species already to date, and the expected increase in ocean noise related to the increasing use of the northern routes by freight ships in the near future necessitates monitoring of its effects now.

The cruise leg will end on 29 June 2010 in Longyearbyen, Svalbard. The cruise track is displayed in Fig. 1.

2. LONG TERM VARIABILITY OF THE HYDROGRAPHIC STRUCTURE, CONVECTION AND TRANSPORTS IN THE GREENLAND SEA (LOTEVA-GS)

G. Budéus, S. v. Egan-Krieger, J. Jacob, M. Lürig, U. Menzel, M. Monsees, S. Moos, R. Wilm, A. Wisotzki, S. Zakrzewski, O. Zenk, N. Zoch (AWI)

Objectives

The region between Fram Strait and Jan Mayen attains increased scientific attention during the recent few decades due to a number of key properties. The atmosphere-ocean transfers of momentum, heat and freshwater are strong, particularly during the cold winter months. Water masses from low and high latitudes meet and interact by means of mixing at fronts, subduction, entrainment, and winter convection. Sea ice is formed in the northern and western parts and is transported southward with the cold and fresh surface waters in the East Greenland Current (EGC). Dense waters are formed which act as a major contribution to the Atlantic Meridional Overturning Circulation or as the source of deep Arctic Waters. All this makes the region highly sensitive to climatic changes and also leads to feedback mechanisms which vice versa affect the north European climate. Investigations of such large scale climatic aspects must evidently be based on sound perceptions of local modifications.

While recent research revealed that many aspects of the internal circulation in the Greenland Sea and also of convection processes turned out to work differently than thought before, certain parts of the general setting of the region are persistent and well established. At the eastern rim of the basin, the warm waters of Atlantic origin move northward as a 600 - 800 m thick layer in the West Spitsbergen Current (WSC). Recent observations show that their average velocity is slow, while local speeds are not. The western boundary of the Atlantic Water (AW) forms a sharp temperature and salinity front which is less pronounced in density. Numerous eddies form and detach from this front with associated lateral exchanges. The large scale meridional flow serves as the most important heat supply for the Arctic, although substantial portions of the waters recirculate already in Fram Strait. In this region, the AWs meet the lighter Polar Waters heading southward, and, together with deeper waters from the Arctic, they form the EGC. The sill depth in Fram Strait limits the downmost extent of the exiting Deep Polar Waters to about 2,600 m. The EGC is much narrower than the West Spitsbergen Current but transports similar water volumes, and, most relevant for the fresh water and heat balance, carries with it also the melting pack ice cover.

The huge cold water dome in the central Greenland Sea has been identified by F. Nansen and Helland-Hansen already in the early decades of the 20th century (by cruises between 1901 and 1905). Since then, the doming of deep water temperatures between the warm rim currents has been regarded as synonymous to the regular occurence of local deep and bottom water formation. In the 80s, this idea has been revised towards the cognition that bottom water formation by surface forcing is a rather rare process but must occur occasionally. With this project we delineate the hydrographic development for more than a decade on a basin wide scale and identify the processes which are responsible for observed changes. The approach is based on a zonal transect at 75°N and autonomously profiling moorings. The transect, with all stations performed to full ocean depth, is executed once per year and extends from the shelf off Bear Island to that of East Greenland, including the area

covered with pack ice. Therefore it includes the water masses at the rims and allows to determine lateral gradients not only in the interior of the Greenland Basin but also towards the water mass end members. This spatial information is essential with respect to a correct perception of advectively caused modifications as e.g. the influence of the deep Arctic outflows. We also employ small station distances in order to obtain a suffcient number of stations which allows to discriminate between spatial and temporal differences. This is important as spatial and temporal variabilities amount to similar magnitudes in the research area. The annual expeditions represent a very adequate approach for the determination of the multi year development and its underlying processes. On the other hand, the annual resolution is a minimum observation frequency, as comparisons of snapshots which are several years apart are adverse to a correct process related interpretation.

The actual situation in the Greenland Basin is fundamentally different from that before which was characterised by a huge cold dome in the gyre's centre. The most important aspect of its present hydrographic structure is a stable vertical interface which establishes a two layer system and parts the waters in an upper and lower layer. This structure is presumably triggered by a fresh water input anomaly in 1990 which is not associated with a high Fram Strait transport and demonstrates that a temporal anomaly of the regional fresh water distribution may lead to persistent structural changes in the ocean. The vertical interface and the two layer structure prevail until today. Due to a descent of the interface, the volume of the deeper layer decreased by roughly 50 % with respect to the state in the early 90ies. The descent of the interface does not show a continous speed, but was fast at first and slower in the most recent years. There are a number of indications that the necessarily associated export in the deeper layer takes place close to the bottom and is concentrated at the western side of the basin.

During the actual two-layer phase, the deeper layer is isolated from surface influences. Thus, it continuously increases in age and is hardly ventilated. However, lateral exchanges with other water masses result in property changes. The deep Arctic outflow surrounds the Greenland gyre and has a determining influence on the waters in the deeper layer of the Greenland Basin. Vertical exchange in the deeper layer (diapycnal mixing) is also apparent in the course of the time series. It plays a minor role during its first part, can be quantified during the later part and may be of increasing relative importance if the descent of the interface is ceasing more permanently.

The most important effect of the interface is that it serves as a barrier against a deep penetration of winter convection. The property development in the interface itself shows only minor changes, but these indicate that some restoring influence must act. The function of the interface as a barrier against ventilation is varying in relevance. When the upper layer is vertically homogeneous, it is indeed the first stability barrier met by winter convection. When the upper layer is substantially stratified, the entire layer hampers deep reaching convection. The time series shows that the upper layer can occasionally be stratified in a manner that the interface is only barely recognised as a stability maximum. This does not lead to a general cease of convection but is apparently a reversible state.

Winter convection has diverse effects on the temperature, salinity and stability development. Temperatures might increase or decrease, salinities might increase or decrease as a result of convection, and the water column might be homogenised or be left in the stratified condition which it attained by lateral exchange after a previous homogenizing event. Much of the previously unexpected effects of winter convection are due to the fact that an import of Atlantic waters is not generally adverse to convection but greatly modifies its results. By the

inclusion of AW derivates, winter convection may lead to effects which resemble those of lateral exchange.

Within the project, a unique hydrographic time series is being established by an annually repeated zonal transect across the Greenland Gyre center and by measurements of autonomous profilers (EP/CC-Jojo, daily profiles, ca. 100 m to full ocean depth, and since 2007 a shallow water profiler between ca. 160 m and the ocean surface, daily profiles, both with a 1 year exchange cycle) which give unprecedented insight to winter convective activity as well as to advective modifications. The major aim is to detect and quantify the interannual and seasonal physical/chemical changes in the Greenland Gyre interiour as well as in the surrounding large currents and to identify the responsible processes for the former.

Work at sea

Due to the large spatial gradients and relatively small spatial scales involved (Rossby radius about 20 km) it is indispensable to perform measurements with comparatively small station spacing and in a sufficient number. Otherwise spatial and temporal differences, which are of the same order in this region, cannot be distinguished and any derived trend is most likely heavily biased. Furthermore, submesoscale vortices (SCVs) have to be identified, distinguished from the background, and skipped from the background trend analysis. According to this, the transect at 75°N is performed with a station spacing of 10 nautical miles or less, what normally results in about 60 CTD stations between Greenland and Bear Island. On the CTD, a double sensor set is used for temperature and conductivity, and various additional sensors will be operated. The most important of these is the electrical oxygen sensor.

In addition to the electrical measurements, water samples are taken by a carousel water sampler. The water samples serve as *in-situ* calibration material and are used to determine oxygen content according to the Winkler method.

Three autonomously profiling EP/CC moorings will be recovered. They are equipped with modified SBE-16 CTDs with Digiquartz pressure sensors. They deliver daily complete profiles, traveling between the parking position at roughly 100 m and the ocean bottom at 3,700m. In order to assess the annual fresh water cycle in the Greenland Gyre, a specialized profiling shallow water yoyo CTD has been installed since 2007, too. This mooring reveals profiles between 160 m and the surface proper, and will be recovered as well.

3. DISTRIBUTION AND REPRODUCTION OF ZOOPLANKTON IN THE GREENLAND SEA IN RELATION TO CLIMATE CHANGES

H.J.Hirche (AWI)

Objectives

The Greenland Sea is unique in that three hydrographic domains (Polar, Arctic, Atlantic), which represent different biogeographic climate zones, are all aligned on the same latitude at a relatively small spatial scale and thus allow the study of the relationship between climate variability and pelagic ecosystems under the same light regime with comparatively little effort.

Each climate zone is inhabited by specific faunas. Some species are also present in other climate zones through advective processes, but they are expatriated and are not able to maintain independent populations. Thus it has been demonstrated that the copepod *Calanus finmarchicus*, a dominant component of the Atlantic fauna, is expatriated in the Greenland Sea Gyre and the Arctic Ocean, showing no reproductive activity and recruitment of young stages further away from the frontal regions. However, the factors inhibiting colonization of Arctic waters by this species are not clear. Low temperature did not inhibit egg production of females in long-term incubations. Eventually both the magnitude and timing of food availability could be important for reproductive success.

Climate change and associated changes in the physical environment could allow advected species to colonize new territories, while local species may suffer from the new conditions. These processes could strongly affect ecosystem functioning and biogeochemical processes. Recent changes in the Greenland Sea, especially the increase in Atlantic water, may alter faunistic composition significantly, leading us to the working hypothesis: Increased "Atlantification" of the Greenland Sea Gyre may cause a faunistic shift in the zooplankton; Arctic key species may be replaced by Atlantic species. The changes in the Greenland Sea may be representative also for the Arctic Ocean.

Work at sea

To test the above hypothesis, the distribution of *C. finmarchicus* and other Atlantic zooplankton species will be studied from vertical tows of a multinet in different water masses and compared with earlier transects in the 1980s. Reproductive activities will be measured as gonad condition of females and egg production in incubation experiments from specimens collected with bongo net tows.

4. ASSESSMENT OF HIGHER TROPHIC LEVELS: DISTRIBUTION VARIABILITY OF SEABIRDS AND MARINE MAMMALS

J. M. Lafontaine, E. Vermeulen, V. Legrand (PolE)
Not on board: C. R. Joiris (PolE)

Objectives

The aim is to quantify the at-sea distribution of seabirds and marine mammals, in order to refine their links with the main oceanological structure: water masses and pack ice, fronts and ice edge. In the frame of a long-term study by the same team – and thus same methodology – to try and identify changes in population numbers. Special attention being payed to medium scale concentrations (large feeding grounds), as well as small scale local ones (fronts and eddies).

Work at sea

Continuous transect (strip) counts from the bridge when *Polarstern* is moving, since at station ships might locally attract very high numbers of birds, visibility conditions allowing (interruptions due to night and/ or foggy conditions).

5. PLANKTON ECOLOGY AND BIOGEOCHEMISTRY IN THE CHANGING ARCTIC OCEAN (PEBCAO)

S. Pfaff, M. Wurst, Tobias Mattfeldt (AWI)
Not on board: E. M. Nöthig, A. Engel (AWI)

Objectives

The Arctic Ocean has gained increasing attention over the past years because of the drastic decrease in sea ice cover and – extent as well as a temperature increase about twice as fast as the global mean rate. In addition, changes in surface ocean chemical equilibrium and elemental cycling are occurring due to ocean acidification. These physical and chemical changes of the environment will eventually bear enormous consequences for the pelagic system and for the net carbon balance of Arctic ecosystems. Our aim is to contribute to a better understanding of the direction and strength of biological feedback processes in the future Arctic Ocean by detection and tracking of large-scale environmental changes.

During ARK-XXV/1 the following aspects will be investigated:

Climatically induced changes will also impact species selection in pelagic ecosystems. A shift in species composition is expected in all size classes of the phytoplankton, however, smallest algae may thrive the phytoplankton in the future Arctic Ocean. Besides diatoms, other smaller planktonic algae will gain more importance in mediating element - and matter - as well as export fluxes. One of them, *Phaeocystis pouchetii*, having an intermediate position regarding size can play a key role in the cycle of sulphur and carbon. However, little is known about the diversity distribution, occurrence and physiology of this species in Arctic pelagic regions.

Based on the awarenes that global change has increasingly changed marine ecosystems, we also intend to examine the 'present day' situation of pelagic micro-biogeochemistry in the Arctic Ocean with emphasis on the turnover of organic matter during production and decomposition processes. The data shall serve as a database for a better evaluation of the relevance of changes that are determined in perturbation experiments, such as the Svalbard CO_2 mesocosm study 2010 (EPOCA). Our overarching goal is to contribute to a better understanding of the direction and strength of biogeochemical and microbiological feedback processes in the future ocean. The investigations will be conducted along the 75°N transect (ARK-XXV/1) and continuing during ARK-XXV/2 in the AWI HAUSGARTEN (ARK-XXV/2) and along the 79°N transect (ARK-XXV/2).

Work at sea

During ARK-XXV/1 the following topics are covered:
1) Investigations on nanoplankton with focus on key species *Phaeocystis pouchetii.*
2) Production, fate and aggregation of organic matter in a changing Arctic Ocean.

We intend to sample Arctic seawater by CTD/rosette sampler along the 75°N transect (ARK-XXV/1), at the HAUSGARTEN stations (ARK-XXV/2) and along the 79°N transect (ARK-XXV/2) to determine the impact of microbial processes on the aggregation and sedimentation of organic matter as part of the work of the PEBCAO group and in close cooperation with the project of Ilka Peeken et. al., AWI, and the Deep-Sea Ecology Group, AWI. Analyses of

water samples will include biogeochemical parameters (dissolved and particulate organic carbon (DOC/POC), dissolved and particulate organic nitrogen (DON/PON), dissolved and total polysaccharides (DCHO/ CHO), dissolved and total amino acids (DAA/AA), transparent exopolymer particles (TEP), Coomassie stainable particles (CSP), pH, total alkalinity (TA) and microbiological parameters (phytoplankton abundance and bacterial cell numbers).

We also intend to sample Arctic seawater by CTD/rosette sampler and hand-net hauls along the 75°N transect (ARK-XXV/1), at the HAUSGARTEN stations (ARK-XXV/2) and along the 79°N transect (ARK-XXV/2) to catch phytoplankton for isolation for later performing clonal cultures, genetic analyses will be carried out with the isolates.

All samples will be preserved or frozen at -20°C and partly at -80° C for further analyses or haltered in the cooling culture container for clonal culturing and physiological experiments in the home laboratory at AWI.

6. CLIMATE INDUCED CHANGES OF ARCTIC PHYTOPLANKTON AND POSSIBLE IMPACTS ON TRACE GAS PRODUCTION

B. Bonsang, V. Gros, S. Tran (CNRS); A. Cherkasheva, A. Theis, B. Wend (AWI); I. Peeken (MARUM/AWI)

State of the art and objectives

The Arctic Ocean is strongly affected by the climate change as it has been stated in the IPCC report, the Arctic climate assessment (ACIA) and the Arctic report card 2008. A proceeding of these dramatic changes will have major implication for the ecosystem of the Arctic with possible impact on the emission of volatile organic compounds (VOCs).

In the surface layers of the oceans (euphotic zone) planktonic biomass through photosynthesis results in production of organic compounds into the surrounding seawater. Some of these volatile species with low Henry's Law coefficients are able to escape to the atmosphere. Among these species some can have a significant influence on the photochemistry of the atmosphere, particularly unsaturated hydrocarbons (such as isoprene: 2-methyl-1,3 butadiene, or light alkenes) and carbon monoxide (CO) which have a strong impact on the OH radical and ozone budget as well as on the formation of organic aerosols.

The subsequent impact in the marine boundary layer (MBL) of isoprene on the photochemistry budget and on the organic aerosol abundance is still subject to large uncertainties, particularly if one considers that the emissions are related to the high seasonal and regional variability of the marine biomass. Besides isoprene, the super-saturation for a large part of the ocean of the surface seawaters is also well established for carbon monoxide (CO) and light hydrocarbons (NMHCs) which are produced by different processes involving the photo-degradation of dissolved organic matter through the influence of UV radiation and direct production by living cells under PAR. There are very few studies available on the quantification of emissions of these volatile organics and the seasonal and geographical variability is still largely unknown. This point is particularly of importance for the polar or sub-polar areas where climatic change already induced a shift of phytoplankton key species.

Since the magnitude of trace gas emission is strongly related to the plankton groups, such effects can result in variation of trace gases emission by phytoplankton and might have an impact on the atmospheric chemistry of boreal zones (through the tropospheric ozone cycle and its precursors), and eventually induce positive or negative feedback in the radiation balance. This project consequently concerns the study of the spatial-temporal variability of reactive gases in seawater in relation to the distribution of phytoplankton species.

The following questions will be addressed:

What is the distribution of alkenes, dienes (isoprene) and carbon monoxide dissolved in the surface seawater as a function of latitude and different parameters including physical (i.e. sea water temperature, radiation) and biological parameters (i.e. chlorophyll concentration, pigment based phytoplankton groups and picoplankton abundance)?

How does the vertical distribution of the concentration of dissolved gases in sea water (alkenes, dienes and carbon monoxide) reflect the different production processes? What is the role of direct emission by plankton metabolism (under PAR) versus photo-production processes by DOC degradation (under UV)? What is the importance of the dark production (below the euphotic zone), with respect to the production in surface waters particularly for carbon monoxide?

What is the budget of these gases in the water column; particularly is it possible to establish a balance between the production rates in seawater by biology and by physico-chemical processes (photo-production) and the losses by sea air exchanges and other bio-chemical or physical losses in the water column (oxidation, microbial consumption)?

How are the production rates of these traces gases in the surface waters of the north Atlantic and Polar oceans, parameterized as a function of e.g. chlorophyll content plankton group? Are these production rates in agreement with the production rates and algorithms established previously in laboratory experiments on monoculture?

To be able to extrapolate the current findings of trace gas measurements in a broader context satellites techniques will be applied. Currently large uncertainty in the determination of planktonic production is a result of the lack of global information on phytoplankton absorption and light penetration depth, which cannot be supplied by the current ocean colour satellite sensors. The spectral resolution of these sensors is not sufficient to extract the relevant information. The variation of phytoplankton absorption in ocean waters also affects the retrieval of chlorophyll *a* concentrations (a measure of phytoplankton biomass) derived from satellite data, which are important input data used in primary production models. The signature of specific phytoplankton absorption can be derived from the high spectrally resolved measurements of the satellite instrument SCIAMACHY (operating on board of the European environmental satellite ENVISAT). This information is used to derive global maps of major phytoplankton groups and is planned to be used for improving the chlorophyll algorithms of the common ocean colour satellite products, such as SeaWiFS, MERIS and MODIS, by developing a global climatology of phytoplankton absorption in addition to *in-situ* measurements of phytoplankton absorption.

Therefore, besides the analysis of satellite data and applied model studies, field measurements in the open ocean of phytoplankton pigment composition, optical characteristics of phytoplankton and other water constituents, reflectance and underwater light measurements are highly precise input parameters for the satellite retrievals,

climatologies and models but also used for the validation of results from the analyses of satellite data and modelling.

Thus the aim of this research project is to improve estimates of global marine primary production and the distribution of major phytoplankton functional groups (PFTs) by using remote sensing data in combination with *in-situ* measurements of ocean optics, phytoplankton productivity and composition and particulate organic carbon. In particular, data will be collected during this cruise to improve our understanding of the oceans' variability in optical properties and to improve/develop remote sensing algorithms for the Arctic Ocean. By combining trace gas *in-situ* data with satellite retrievals on PFTs a first approach of the spatial distribution of alkenes, isoprene and carbon monoxide production at high latitudes will be made.

Work at sea

During this cruise for trace gases, two kinds of measurements will be performed: *in-situ* sampling when the ship is steaming and on-board analyses of CTD-samples taken at different depths during the ship's stations.

In-situ sampling will consist in surface sea water continuously analysed for its content in dissolved organic trace gases, alkenes, isoprene and carbon monoxide. Seawater samples collected from the water pump will be continuously introduced in an equilibration chamber, where dissolved gases will be equilibrated with clean synthetic air, and analysed by gas chromatography (GC). Two instruments will be used: a GC equipped with a PID (photo-ionisation detector) for unsaturated hydrocarbons quantification and a GC equipped with a mercuric oxide detector for CO monitoring. Measurements frequencies are 30 minutes for dissolved hydrocarbons in seawater and 5 minutes for dissolved CO. These data will be corroborated by the sampling of phytoplankton pigments and picoplankton abundance from the pump system (approximately every 3 hours).

In-situ monitoring of CO mixing ratio in the air will be simultaneously performed on board in order to characterize the air masses and determine the super saturation of the surface seawater with respect to the atmosphere. Samples will be collected in canisters (one or two per day) in order to measure the mixing ratios of light hydrocarbon in surface air.

Measurements of the vertical distribution of organic trace gases in the water column will be performed from the samples collected on station by Niskin bottles. These data will be corroborated by the sampling of phytoplankton pigments and picoplankton abundance from the same CTD-casts in the same depth. These measurements will be mainly performed during the second leg.

The number of samples analysed per vertical profile as well as the frequency of the vertical profiles studied will be adapted on board depending on the plankton biomass variability observed, indicated by fluorescence measurements (see below). A focus will be put on sampling of the euphotic zone and the chlorophyll maxima.

To provide reference spectra and for the validation of remotely sensed bio optical data it is essential to have highly precise phytoplankton absorption measurements and the pigment composition. Beside the above mentioned phytoplankton abundance, particulate absorption in suspension and absorption of CDOM will be measured during the cruise using the point-source integrating-cavity absorption meter (PSICAM) at the same locations. For particulate

absorption additional filters will be taken and measured with the more conventional spectrophotometer measurements for comparison purposes.

For online and *in-situ* optical measurement a FASTtracka Fast Repetition Rate Fluorimeter (FRRF) will be used in a flow-through system with water continuously pumped from the moon pool to provide online data of chlorophyll fluorescence during the cruise. A second FASTtracka FRRF will be operated on the small winch to take measurements in the water column. Radiometric measurements of the underwater light field, sky radiance and solar irradiance will be measured firstly from onboard the ship with a set of three radiometers and secondly in the water column (0 - 150 m) at the stations.

This comprehensive data set will allow establishing a better knowledge of the impact of phytoplankton on the concentration of dissolved reactive gases in boreal and Arctic areas. The budget of the water column in reactive trace gases will be determined and the impact due to changes in the population of plankton species will be evaluated for the first time at these latitudes.

Phytoplankton absorption and radiometric measurements will be finally analyzed back home in the lab. Results will give information on the inherent and apparent optical properties of Arctic waters. This information will be used to construct a regional model of the underwater light field which is used for the analytical models used to derive geophysical parameters (phytoplankton biomass, composition and primary production) from ocean colour measurements.

The chlorophyll fluorescence data will be used to derive information on photosynthetic activity which is used to validate the satellite primary production estimates. Due to higher concentrations or absorbing substances in the water, the profiling optical measurements will give lower values than we obtained in equatorial regions. The exact correlation between water substances and optical properties will be subject to further analysis.

In-situ data of dissolved reactive gases will be further combined with satellite retrievals of phytoplankton biomass and PFTs in order to give a first approach of the spatial distribution of alkenes, isoprene and carbon monoxide production at high latitudes.

7. BETEILIGTE INSTITUTE/ PARTICIPATING INSTITUTES

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LSCE	Centre National de la Recherche Scientifique bât. 12 Av de la terrasse 91198 Gif sur Yvette Cedex / France
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8. FAHRTTEILNEHMER / PARTICIPANTS

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Heckmann	Markus	Heliservice	Technician
Hirche	Hans-Jürgen	AWI	Biologist
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Wisotzki	Andreas	AWI	Oceanographer
Wurst	Mascha	AWI	Environmental scientist
Zakrzewski	Svenja	AWI	Student, oceanography
Zenk	Oliver	Optimare	Engineer, oceanography
Zoch	Nico	FU Berlin	Student, oceanography

9. SCHIFFSBESATZUNG / SHIP'S CREW

No.	Name	Rank
01.	Schwarze, Stefan	Master
02.	Birnbaum, Thilo	1. Offc.
03.	Krohn, Günter	Ch.Eng.
04.	Fallei, Holger	2. Offc.
05.	Gründling, Ulli	2. Offc.
06.	Dugge, Heike	2. Offc.
07.	Erich, Matthias	Doctor
08.	Hecht, Andreas	R.Offc.
09.	Sümnicht, Stefan	1. Eng.
10.	Minzlaff, Hans-Ulrich	2. Eng.
11.	Schaefer, Marc	2. Eng.
12.	Scholz, Manfred	ElecEng.
13.	Muhle, Helmut	ELO
14.	Himmel, Frank	ELO
15.	Stronzeck, David	ELO
16.	Winter, Andreas	ELO
17.	Loidl, Reiner	Boatsw.
18.	Reise, Lutz	Carpenter
19.	Bäcker, Andreas	A.B.
20.	Brickmann, Peter	A.B.
21.	Guse, Hartmut	A.B.
22.	Hagemann, Manfred	A.B.
23.	Scheel, Sebastian	A.B.
24.	Schmidt, Uwe	A.B.
25.	Wende, Uwe	A.B.
26.	Winkler,Michael	A.B.
27	Preußner, Jörg	Storek.
28.	Elsner, Klaus	Mot-man
29.	Pinske, Lutz	Mot-man
30.	Schütt, Norbert	Mot-man
31.	Teichert, Uwe	Mot-man
32.	Voy, Bernd	Mot-man
33.	Müller-Homburg, R.-D	Cook
34.	Martens, Michael	Cooksmate
35.	Silinski, Frank	Cooksmate
36.	Jürgens, Monika	1.Stwdess
37.	Wöckener, Martina	Stwdss/Kr
38.	Czyborra, Bärbel	2.Stwdess
39.	Gaude, Hans-Jürgen	2.Steward
40.	Huang, Wu-Mei	2.Steward
41.	Möller, Wolfgang	2.Steward
42.	Silinski, Carmen	2.Stwdess
43.	Yu, Kwok Yuen	Laundrym.

ARK-XXV/2

30 June 2010 - 29 July 2010

Longyearbyen - Reykjavik

Chief Scientist
Thomas Soltwedel

CONTENTS

1. ÜBERBLICK UND FAHRTVERLAUF

Thomas Soltwedel (AWI)

Der zweite Fahrtabschnitt der 25. *Polarstern* Expedition in die Arktis wird am 30. Juni 2010 beginnen. Das Schiff wird von Longyearbyen (Svalbard) auslaufen, um Untersuchungen in der Framstraße durchzuführen (Abb. 1). Die Arbeiten werden verschiedene Projekte am Svalbard Kontinentalhang (HAUSGARTEN Tiefsee-Langzeitobservatorium) entlang eines kurzen Transekts zum Kongsfjord (KONGHAU-Projekt) und entlang eines Schnittes über die gesamte Framstraße (ACOBAR-Projekt) unterstützen. Die Reise wird am 29. Juli 2010 in Reykjavik (Island) enden.

Im Bereich des HAUSGARTENs sind Probennahmen und *in-situ* Experimente geplant, die Beiträge zu verschiedenen EU-Projekten leisten (ESONET, HERMIONE, HYPOX). Darüber hinaus tragen diese Arbeiten auch zu dem Anfang 2009 begonnenen Forschungsprogramm PACES (Polar regions and coasts in the changing Earth system) des AWI bei. In PACES werden Beiträge zum Topic "The changing Arctic and Antarctic", speziell zum Themenbereich "Sea ice - atmosphere - ocean - ecosystem interactions in a bi-polar perspective" erbracht. Die geplanten Arbeiten stellen einen weiteren Beitrag zur Sicherstellung der Langzeitbeobachtung am HAUSGARTEN dar, in denen wir den Einfluss von klimatisch induzierten Veränderungen auf ein arktisches Tiefseeökosystem dokumentieren. Klimabedingte Veränderungen der Plankton-Zusammensetzung in der Framstraße werden durch die neu am AWI etablierte Arbeitsgruppe PEBCAO (Phytoplankton Ecology and Biogeochemistry in the Changing Arctic Ocean) untersucht.

Im Rahmen des durch die EU und die Norwegische Öl-Gesellschaft Statoil/Hydro finanzierten KONGHAU-Projekts (Impact of climate change on Arctic marine community structures and food webs), werden weitere Probennahmen auf dem Svalbard-Schelf und im Bereich des Kongsfjords durchgeführt. KONGHAU vereinigt Daten aus Langzeitbeobachtungen der letzten 10 Jahre.

Die in das EU-Projekt ACOBAR (Acoustic Technology for Observing the interior of the Arctic Ocean) eingebetteten ozeanographischen Arbeiten haben zum Ziel, Änderungen des Wassermassen- und Wärmeaustauschs zwischen dem Nordpolarmeer und dem nördlichen Atlantik und die Zirkulation in der Framstraße zu quantifizieren. Dafür werden Temperatur und Salzgehalt entlang eines Schnitts bei 78°50’N gemessen sowie Wasserproben genommen, um Spurenstoffe zu quantifizieren. Ozeanographische Verankerungen, die vor zwei Jahren auf diesem Schnitt ausgelegt wurden, werden aufgenommen und mit neuem Gerät wieder ausgelegt, um die mittlerweile 11 Jahre dauernde Langzeitmessung fortzusetzen.

Während des gesamten Fahrtabschnitts werden die Beobachtungen von Seevögeln und marinen Säugetieren aus dem vorhergehenden Abschnitt fortgesetzt.

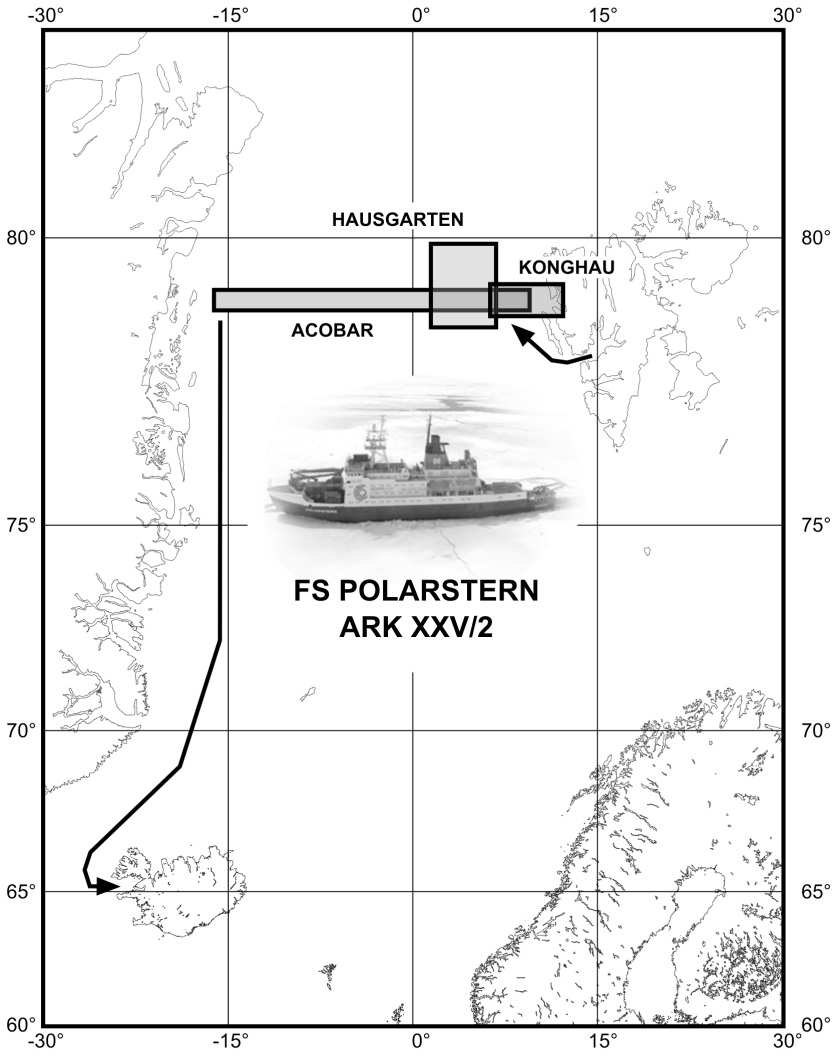

Abb. 1: Geplante Fahrtroute der Polarstern-Expedition ARK-XXV/2
Fig. 1: Planned cruise track during Polarstern expedition ARK-XXV/2

SUMMARY AND ITINERARY

The second leg of the 25th *Polarstern* expedition to the Arctic will start on 30 June 2010. The ship will depart from Longyearbyen (Svalbard) to conduct research all across Fram Strait (Fig. 1). The work will serve various projects and concentrate on the continental margin off Svalbard (deep-sea long-term observatory HAUSGARTEN), a short transect towards Kongfjorden (KONGHAU project), and a transect crossing the entire Fram Strait at 78°50'N (ACOBAR project). The cruise will end on 29 July in Reykjavik (Iceland).

The work planned for the HAUSGARTEN area will contribute to various EU projects (ESONET, HERMIONE, HYPOX) as well as to the new PACES (Polar Regions and Coasts in the changing Earth System) research programme of the AWI, which started at the beginning of 2009. Our planned work is embedded in research

activities through studies on changing Arctic sea ice conditions and their impact on ecosystems and food webs. These changes will be addressed through a dedicated combination of long-term observations and modelling. The research contributes to the time-series studies at HAUSGARTEN, where we investigate the impacts of Climate Change on an Arctic marine deep-sea ecosystem through field studies, observations and models since 1999. Climate-induced changes of plankton communities in Fram Strait will be investigated by the new AWI research group PEBCAO (Phytoplankton Ecology and Biogeochemistry in the Changing Arctic Ocean).

Within the framework of the KONGHAU project (Impact of climate change on Arctic marine community structures and food webs), co-financed by the EU and the Norwegian oil company Statoil/Hydro, we will retrieve additional sediment samples on the continental shelf off Svalbard and inside Kongsfjorden. KONGHAU combines data collected over the past 10 years from time-series work at Kongsfjorden and HAUSGARTEN.

The oceanographic work embedded in the EU project ACOBAR (ACoustic technology for OBserving the interior of the Arctic Ocean) is dedicated to investigate the water mass and heat exchange between the Arctic and the northern North Atlantic with special emphasis on the inter-annual and decadal variability of the circulation in Fram Strait. Hydrographic measurements will be taken along 78°50'N, and water samples for tracer determinations will be collected. Oceanographic moorings with current, temperature and salinity meters deployed two years ago will be recovered and re-deployed with new instruments to extend the existing time-series.

During ARK-XXV/2, the observation and counting of sea birds and marine mammals from the previous leg will be continued.

2. IMPACT OF CLIMATE CHANGE ON ARCTIC MARINE ECOSYSTEMS

I. Schewe, E. Bauerfeind, M. Ginzburg, C. Hasemann, U. Hoge, C. Lalande, S. Lehmenhecker, N. Lochthofen, B. Sablotny, F. Wenzhöfer, T. Wulff (AWI); J. Felden, M. Jacob (MPI-MM); B. Baldyga, M. Czub (IOPAS)

The marine Arctic has played an essential role in the history of our planet over the past 130 million years and contributes considerably to the present functioning of the Earth and its life. The past decades have seen remarkable changes in key arctic variables, including a decrease in sea-ice extent and sea-ice thickness, changes in temperature and salinity of arctic waters, and associated shifts in nutrient distributions. Since arctic organisms are highly adapted to extreme environmental conditions with strong seasonal forcing, the accelerating rate of recent climate change challenges the resilience of arctic life. The stability of a number of arctic populations and ecosystems is probably not strong enough to withstand the sum of these factors which might lead to a collapse of subsystems.

To detect and track the impact of large-scale environmental changes in a transition zone between the northern North Atlantic and the central Arctic Ocean, and to determine experimentally the factors controlling deep-sea biodiversity, the Alfred Wegener Institute for Polar and Marine Research (AWI) established the deep-sea long-term observatory HAUSGARTEN, which constitutes the first, and until now only open-ocean long-term station in a polar region.

Objectives and scientific programme

HAUSGARTEN is located in the eastern Fram Strait and includes 16 permanent sampling sites along a depth transect (1,000-5,500 m) and along a latitudinal transect following the 2,500 m isobath crossing the central HAUSGARTEN station (Fig. 2.1). Multidisciplinary research activities at HAUSGARTEN cover almost all compartments of the marine ecosystem from the pelagic zone to the benthic realm, with some focus on benthic processes. Regular sampling as well as the deployment of moorings and different free-falling systems (bottom-lander) which act as local observation platforms, have taken place since the observatory had been established in summer 1999. Frequent visual observations with towed photo/video systems allow the assessment of large-scale epifauna distribution patterns as well as their temporal development. To determine the factors controlling deep-sea biodiversity, we carry out biological long-term experiments.

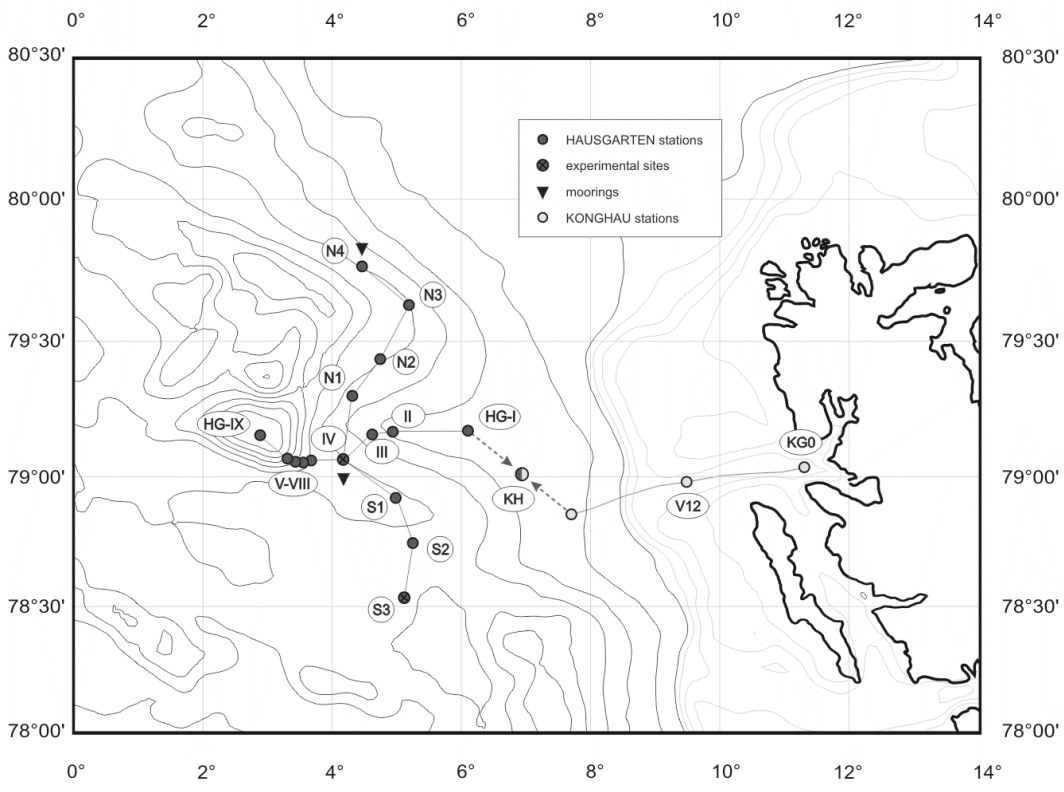

Fig. 2.1: The deep-sea long-term observatory HAUSGARTEN and sampling stations of the Kongsfjorden Time-Series Study in the eastern Fram Strait

Within the framework of the international KONGHAU project (Impact of climate change on Arctic marine community structures and food webs), co-financed by the former EU Integrated Project HERMES (Hotspot Ecosystem Research on the

Margins of European Seas) and the Norwegian oil company Statoil/Hydro, we will retrieve additional sediment samples on the continental shelf off Svalbard and inside Kongsfjorden (Fig. 2.1). KONGHAU combines data collected over the past 10 years from time-series work at Kongsfjorden and HAUSGARTEN.

Work at sea

Hydrographic data will be assessed using a cabled CTD-Rosette and an Autonomous Underwater Vehicle (AUV). The mission schedule of the AUV can be divided into a technical phase at the beginning of the cruise and a subsequent scientific phase. The payload of the AUV will consist of two different devices: an extended version of the water sample collector, which was already used during ARK-XXIV/2, and sensors of the so-called ICASP (*in-situ* chemical analysing and sampling payload) module. The development of the ICASP module is part of the EUROFLEETS project. ICASP is going to offer a wide range of different sensors and total compatibility to other European AUVs.

The main goal of the initial technical phase is to test the vehicle (especially navigation accuracy) and ensure the functionality of the different payloads. During that phase the AUV will execute its first dives, which will lead it under the sea-ice. A successful under-ice mission is a basic precondition to continue with the scientific phase, in which we will run several missions from the open water to ice-covered areas. During these missions, the ICASP sensor package will continuously measure turbidity, fluorescence, PAR intensity, salinity and temperature, and store the data. Water samples will be taken in parallel at preselected intervals for further analyses of e.g. nutrients, chlorophyll *a*, or the plankton composition. Results from these analyses will be used to verify values measured by the ICASP sensors detecting fluorescence.

Measurements of the vertical particle flux are an important parameter to quantify the export of organic matter from the sea surface to the deep sea. This organic material, which is produced in the upper water layers or is introduced from land, is the main food source for deep-sea organisms. To characterise and quantify organic matter fluxes to the seafloor, we use moorings carrying sediment traps at approx. 300 m and 1,000 m below sea-surface, and about 180 m above the seafloor. We will exchange one mooring that was deployed at approx. 2,500 m water depth at the central HAUSGARTEN station in summer 2009. A second mooring equipped with sediment traps and RCMs will be deployed at the northernmost HAUSGARTEN site at about 79°46'N and 04°30'E. Another sediment trap, integrated in a free-falling device supporting a current meter and optical oxygen sensors (optodes) at 2.5 m above ground, will be replaced. At all stations where moorings are operating, CTD casts from the surface to close to the seafloor will be conducted. Water samples will be taken for the analyses of Chl *a*, POC/PON, seston, carbonate, and the stable isotopes $\delta^{15}N$ and $\delta^{13}C$ in the particulate matter. This work will be carried out in close co-operation with the PEBCAO group (see below for details).

The benthic carbon remineralisation will mainly be studied along a latitudinal transect (HAUSGARTEN stations S3, HG-IV, and N3; Fig. 2.1). We plan to measure benthic oxygen consumption rates at different spatial and temporal scales by a variety of *in-situ* instruments (i.e. microprofiler, benthic chamber, and planar optode) mounted on free-falling systems. The benthic O_2 uptake is a commonly used as a measure for the total benthic remineralisation rate. Benthic O_2 consumption is thus used (1) for aerobic heterotrophic activity of fauna and bacteria, and (2) for the re-

oxidation of reduced inorganic products released during the anaerobic heterotrophic degradation. We will distinguish between the bacterial and the total benthic consumption rates, and measure differences in organic matter hydrolysis, pore water nutrients, microbial community biomass and structure, as well as total microbial community biomass and structure.

Two benthic landers will be used to study the benthic oxygen consumption at different spatial scales. These free-falling systems will be equipped with different instruments to investigate the oxygen penetration and distribution as well as the oxygen uptake of arctic sediments: (1) Microprofiler: the profiler carries up to 11 different microsensors (e.g. O_2, pH, T, resistivity). (2) Planar optode: 2D oxygen images will be obtained to investigate the vertical and horizontal distribution within the sediment as faunal activity enhances the oxygen availability in deeper sediment strata. (3) Benthic chamber: incubations will be used to measure the total oxygen consumption and nutrient exchange of the sediment. This measurement integrates all relevant solute transport processes (diffusion, advection and fauna-mediated transport) over an area of 294 cm^2.

A bottom-lander based biological long-term experiment that has been established during last year's *Polarstern* cruise will be sampled. The free-falling device carrying colonisation-cores with azoic, but organically-enriched artificial sediments will be recovered after one year deployment, to study the attraction of "plain" sediments to meiofauna organisms, thereby focussing on nematode communities.

Virtually undisturbed sediment samples are taken using a video-guided multiple corer (MUC). Various biogenic compounds from these sediments are analysed to estimate activities (e.g. bacterial exo-enzymatic activity) and the total biomass of the smallest sediment-inhabiting organisms. Results will help to describe ecosystem changes in the benthal of the Arctic Ocean. Sediments retrieved by the MUC will also be analysed for the quantitative and qualitative assessment of the small benthic biota, ranging from bacteria to meiofauna.

In order to continue the time series work at HAUSGARTEN on the bacterial community, its structure will be investigated and correlated with environmental parameters. Therefore, MUC samples from all 16 stations will be frozen for later DNA/RNA analyses as well as fixed with formalin for bacterial cell counts and fluorescence *in-situ* hybridisation (FISH) analyses at the home lab.

Back in summer 2000, depth related patterns in macrobenthic composition, biomass and diversity were studied on the continental margin off Kongsfjorden as a collaborative effort of AWI scientists and colleagues from the Institute of Oceanology, Polish Academy of Sciences (IOPAS). The samples were collected during the *Polarstern* cruise ARK-XVI on a depth transect spanning shelf, continental slope and rise from 330 to 2977 m water depth (Fig. 2.2). A clear shift in dominants composition along the depth gradient was documented. Density, biomass and number of species per sample decreased with depth. The classic increase of macrobenthic diversity at intermediate depths was not observed. There was no clear depth-related pattern in species diversity measures (Shannon-Wiener or Pielou index).

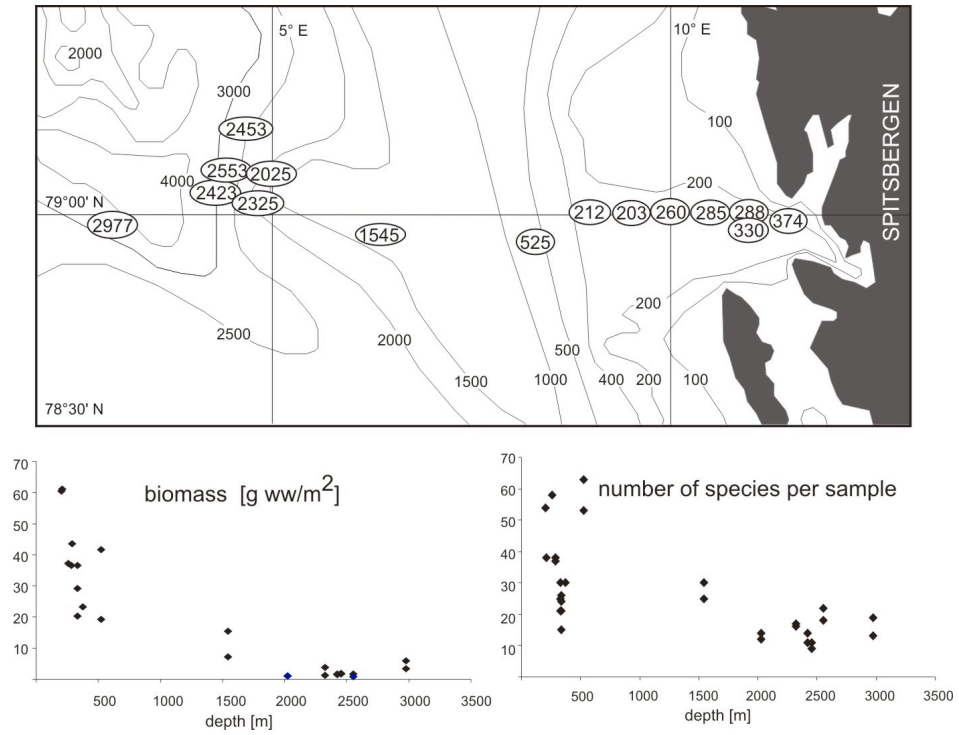

Fig. 2.2: Sampling stations and depth-related patterns in macrozoobenthic biomass and sample species richness documented for material collected in 2000

The objective of the macrobenthic survey in 2010 is to revisit the 2000 sampling stations and to examine if patterns of biomass, diversity and dominant species composition have changed after a decade. The sediments will be collected by taking 0.1 m² subsamples to a depth of 20 cm from a 0.25 m² box-corer. The samples will be sieved through a 0.5 mm sieve and fixed with buffered formalin. All individuals will be identified to the lowest possible taxonomic level and enumerated. The taxonomic analysis will be performed at the IOPAS laboratory.

As megafauna play an important role in ecosystem function and their densities are already in decline (unpubl. data) it is of paramount importance to record changes in abundance, composition and functional diversity over time. The composition and density of megafaunal assemblages can be assessed by analysis of footage from towed underwater cameras. Voucher samples taken by trawl or corer complement camera observations as they allow a direct taxonomic identification (ground-truthing) and thus assessments of diversity. Scanned images taken by an Ocean Floor Observation System (OFOS) are already available for the central HAUSGARTEN site (HG-IV) from the years 2002, 2004, 2007 and 2008. During ARK-XXV/2, we intend to test and use our own newly built OFOS to continue our megafaunal time-series studies. We will use the images gained to compare the composition and density of megafaunal assemblages at HG-IV and other HAUSGARTEN stations with those recorded during previous cruises.

Traditional approaches to trophic studies rely on stomach contents analysis together with field and laboratory observations. Due to restricted access and technical problems, these approaches are somewhat problematic when working in the deep sea. In recent years, stable isotope analysis has been established as an alternative

approach to determine relative trophic positions of organisms. Over the past three years, stable isotope analysis has been done at most HAUSGARTEN stations on demersal fish, macro- and megafaunal organisms, particulate organic matter from surface and bottom waters, and sediments. During ARK-XXV/2, we intend to use the newly-built Agassiz trawl to collect samples at selected HAUSGARTEN stations for stable isotope analysis to understand the links between the water column and the benthic ecosystem. Benthic sampling (multiple and/or box corer and/or trawl) will provide the material required for measurements by continuous flow isotope ratio mass spectrometry. The $\delta^{15}N$ ratio of primary producers from surface waters and bottom particulate organic matter sampled by water samplers provides a reference point for other ecosystem compartments. We will compare the isotopic signatures of selected species with those recorded in previous years at the same location to assess if there are changes in the food web.

3. VARIABILITY OF OCEANIC FLUXES THROUGH FRAM STRAIT

A. Beszczynska-Möller, A. Wisotzki, O. Strothmann, M. Monsees, J. Hülz, J. Jacob, S. Zakrzewski, N. Zoch, R. Wilm, M. Lürig, U. Menzel, S. Moos, S. von Egan-Krieger (AWI)

Objectives

Our aim is to investigate the variability of the oceanic fluxes through Fram Strait. This work contributes to long-term studies addressing the response of the various Arctic subsystems to the rigorous climatic changes of the last decades.

The spread of warmth to high latitudes in the Atlantic is part of the global thermohaline circulation. From the North Atlantic, warm and saline water flows to the Arctic Ocean where it is modified by cooling, freezing and melting and where huge amounts of river run-off is added. Shallow fresh waters, ice and saline deep waters return to the North Atlantic. The outflow from the Arctic Ocean to the Nordic Seas and further to the Atlantic Ocean provides the initial driving of the thermohaline circulation cell. Atlantic water enters the Arctic Ocean either through the shallow Barents Sea or through Fram Strait, which represents the only deep connection between the Arctic Ocean and the Nordic Seas. Just as the freshwater transport from the Arctic Ocean is of major influence on convection in the Nordic Seas and further south, the transport of warm and saline Atlantic water affects the water mass characteristics in the Arctic Ocean, which has consequences for the internal circulation and possibly influences also ice and atmosphere.

The complicated topographic structure of the Fram Strait leads to a splitting of the West Spitsbergen Current carrying Atlantic Water northward into at least three branches. One current branch follows the shelf edge and enters the Arctic Ocean north of Svalbard. This part has to cross the Yermak Plateau which poses a sill for the flow with a depth of approximately 700 m. A second branch flows northward along the north-western slope of the Yermak Plateau and the third one re-circulates immediately in Fram Strait at about 79°N. Evidently, the size and strength of the different branches largely determine the input of oceanic heat to the inner Arctic

Ocean. The East Greenland Current, carrying water from the Arctic Ocean southwards has a concentrated core above the continental slope.

The aim of the oceanographic work is to quantify the inter-annual to decadal variation of volume, heat and salt fluxes through Fram Strait. Since 1997, an array of moorings has been maintained to measure currents, temperature and salinity. The year-round measurements are combined with hydrographic sections taken during summer cruises. Until 2005, the observations were done in the framework of the European Union projects VEINS (Variability of Exchanges in Northern Seas, 1997-2000) and ASOF-N (Arctic-Subarctic Ocean Fluxes, 2002-2005), with a support from the national funding. Since 2006, the work had been carried out as a part of the EU Integrated Project DAMOCLES and the new EU project ACOBAR (Acoustic Technology for Observing the Interior of the Arctic Ocean) started in 2009, which embraces also oceanographic measurements in Fram Strait.

Work at sea

An array of 18 moorings covers the entire deep part of Fram Strait along 78°50'N from the eastern to the western shelf edge (Fig. 3.1). Twelve moorings in the eastern and central part of the strait are maintained by AWI, while 6 moorings in the western part are operated by the Norwegian Polar Institute.

In 2009, only six easternmost moorings were exchanged during the summer *Polarstern* cruise. Six remaining AWI moorings as well as four bottom moorings with PIES (Pressure Inverted Echo Sounders), deployed in 2008, have remained in the water for two years. During ARK-XXV/2, all twelve AWI moorings will be exchanged and all PIES will be recovered. The additional relay mooring, deployed in 2009 and carrying an acoustic modem will be also recovered. For a sufficient vertical resolution, each mooring carries 3 to 8 instruments (current meters from Aanderaa, Acoustic Doppler Current Profilers (ADCP) from RDI, and temperature and salinity sensors from Seabird), distributed at nominal levels: 50 m (subsurface layer), 250 m (Atlantic water layer), 750 m (lower boundary of the Atlantic water), 1,500 m (deep water), and 5 m above bottom (near-bottom layer). Horizontal distances between moorings are smaller at the upper slope (moorings F1 to F3) and increase towards the deep part of the strait (ca. 20 km). Three moorings deployed in the eastern Fram Strait in 2009 were equipped with the low-frequency modems to test underwater acoustic data transfer. The modems will be recovered during ARK-XXV/2 for evaluation of the acoustic data transmission. In 2010, two additional moorings will be deployed, aimed in testing the profiling sensors, which will cover the upper water column up to the surface. One of them will be equipped with an underwater winch and TS profiler with Iridium modem for data transfer, the second mooring will consist of the NEMO profiling float tethered to the subsurface mooring. Both will be deployed next to the mooring F6 at the offshore boundary of the West Spitsbergen Current.

Hydrographic stations with a CTD system SBE 9/11+ in combination with a SBE 32 Carousel Water Sampler (Seabird) and an *in-situ* oxygen sensor and ship-borne ADCP measurements will be conducted along the mooring line to supply temperature, salinity and velocity with the higher spatial resolution than given by moorings (Fig. 3.2). Water samples will be analysed for salinity with an Autosal 8400A salinometer (Guildline). In the eastern and central part of Fram Strait the CTD stations will be measured in between mooring work and after completing

mooring operations, the hydrographic section will be continued farther westward, according to available ship time.

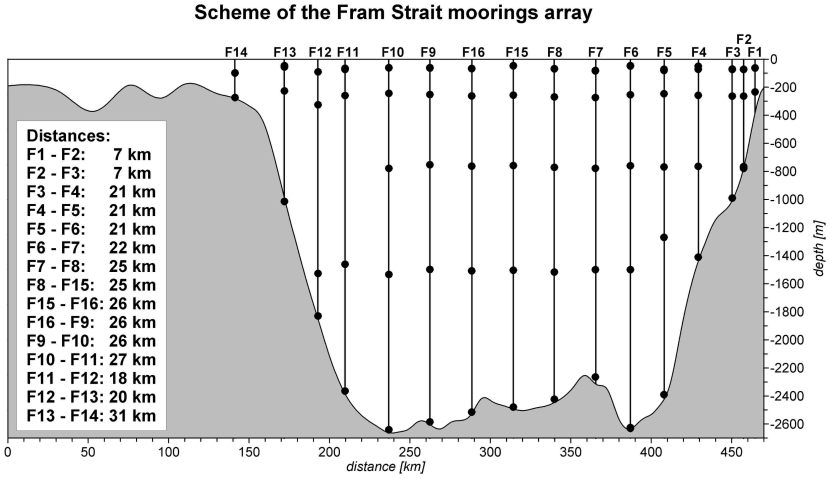

Fig. 3.1: Scheme of instrumentation at the Fram Strait moored array (moorings F1 to F10 will be exchanged during ARK-XXV/2)

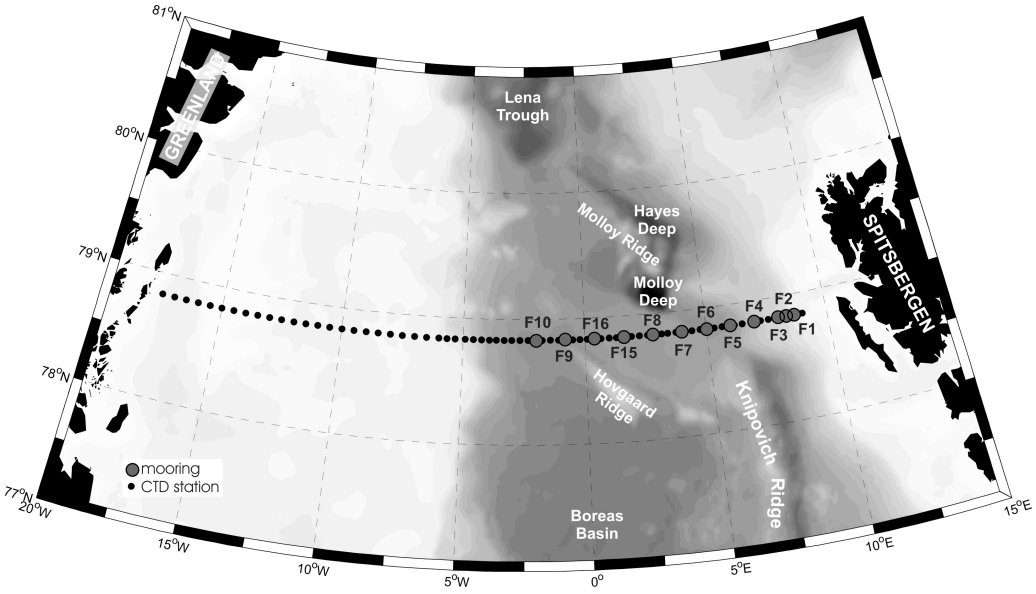

Fig. 3.2: Positions of moorings and CTD stations in Fram Strait

Seaglider, autonomous buoyancy driven profiling vehicles equipped with pressure, temperature, conductivity, oxygen sensors as well as with RAFOS hardware will be deployed in Fram Strait during ARK-XXV/2. This will be the third summer mission of the AWI glider, after two successful deployments in summer 2008 and 2009. The Seaglider will be operated from the pilot station in Bremerhaven during an approx. 3-month long mission, aiming to profile the upper 1,000 m layer along sections in the open water part of Fram Strait (mostly to provide repeated snapshots of the high

resolution hydrography along the mooring line). To test and develop the underwater acoustic navigation system, the Seaglider will receive and register RAFOS transmissions, provided by RAFOS sound sources moored in Fram Strait. During ARK-XXV/2 two sound sources deployed in 2009 will be recovered and four new sound sources (two RAFOS sources from Teledyne Webb Research and two prototypes from develogic GmbH) will be deployed across the strait. Two of them will be deployed in an ice-covered area for testing the acoustic propagation of RAFOS signals under ice. This is a crucial knowledge required for future under-ice missions of acoustically navigated gliders. The Seaglider deployed in summer 2010 will also receive RAFOS signals transmitted by three tomography moorings, deployed in Fram Strait in the frame of the ACOBAR project.

4. PLANKTON ECOLOGY AND BIOGEOCHEMISTRY IN THE CHANGING ARCTIC OCEAN (PEBCAO)

E.-M. Nöthig, K. Metfies, M. Wurst, A. Kraft, S. Pfaff, N. Knüppel (AWI)

Objectives

The Arctic Ocean has gained increasing attention over the past years because of the drastic decrease in sea ice cover and ice extent as well as a temperature increase about twice as fast as the global mean rate. In addition, changes in surface ocean chemical equilibrium and elemental cycling are occurring due to ocean acidification. These physical and chemical changes of the environment will eventually bear enormous consequences for the pelagic system and for the net carbon balance of Arctic ecosystems. In order to understand and track these expected changes, long-term investigations in the Arctic Ocean are needed to contribute to a better understanding of the direction and strength of biological feedback processes in the future Arctic. Investigations of phytoplankton ecology, carried out since several years as a sub-programme of the analysis of the regularly deployment of sediment traps in the Arctic at the HAUSGARTEN observatory, were very sporadic. Because the Arctic Ocean experiences rapid environmental changes, we intend to extend our sampling programme by conducting molecular investigations on pico- and nanoplankton, with focus on key species like *Phaeocystis pouchetii*, amphipods and on changes in the composition of organic matter.

During *Polarstern* cruise ARK-XXV/2 the following aspects will be investigated in the HAUSGARTEN area and along the 79°N oceanographic transect:

- Investigations on selected phyto- and zooplankton and related biogeochemical parameters (A. Kraft, N. Knüppel & E.-M. Nöthig)

- Investigations on pico- and nanoplankton including key species *Phaeocystis pouchetii* (S. Pfaff, K. Metfies & S. Gäbler-Schwarz)

- Production, fate and aggregation of organic matter in a changing Arctic Ocean (M. Wurst & A. Engel)

Climatically induced changes will impact species selection in pelagic ecosystems. A shift in biomass and in species composition is expected in all size classes of the phytoplankton, however, smallest algae may thrive the phytoplankton in the future Arctic Ocean. Besides diatoms, other smaller planktonic algae will gain more importance in mediating element and matter fluxes as well as export fluxes. One of them, *Phaeocystis pouchetii*, having an intermediate position regarding size can play a key role in the cycle of sulphur and carbon. Little is known about the diversity, distribution, occurrence and physiology of this species in Arctic pelagic regions.

In order to enable assessment of plankton, including the smallest fractions, and to cut down the effort and the costs required carrying out observations in the arctic marine environment, molecular methods are well suited to serve as a basis for the development of innovative smart observation methods and strategies to survey the biodiversity within the arctic phytoplankton. They provide the possibility to facilitate the investigation of physiology, ecology, and distribution of species at the base of the marine food web, especially of those that are size limited or missing distinct morphological features.

In the zooplankton, amphipod species can eventually serve as indicators for warming water masses in the Fram Strait. Sampling for detailed species analyses of the dominating groups will reveal additional insight to results already obtained in the swimmer fraction within the sediment-trap-monitoring-programme at HAUSGARTEN.

Based on the awareness that global change has increasingly changed marine ecosystems, we also intend to examine the 'present day' situation of pelagic microbiogeochemistry in the Arctic Ocean, with emphasis on the turnover of organic matter during production and decomposition processes. The data shall serve as a database for a better evaluation of the relevance of changes that are determined in perturbation experiments, such as the Svalbard CO_2 mesocosm study 2010 (EPOCA). Our overarching goal is to contribute to a better understanding of the direction and strength of biogeochemical and microbiological feedback processes in the future ocean. The investigations will be conducted along the 75°N transect during ARK-XXV/1 and continued during ARK-XXV/2 in the HAUSGARTEN area and along the 78°50'N transect.

Work at sea

During ARK-XXV/2 we intend to sample arctic seawater by CTD/rosette sampler at the HAUSGARTEN stations and along the 78°50'N transect to catch phytoplankton for isolation and molecular biological investigations as well as to determine the impact of microbial processes on the aggregation and sedimentation of organic matter as part of the work of the PEBCAO group and in close co-operation with the project of Ilka Peeken et al. (AWI), and the AWI Deep-Sea Research Group. Analyses of water samples will include biogeochemical parameters such as chlorophyll *a* (Chl *a*), particulate biogenic silica (PbSi), dissolved and particulate organic carbon (DOC/POC), dissolved and particulate organic nitrogen (DON/PON), dissolved and total polysaccharides (DCHO/CHO), dissolved and total amino acids (DAA/AA), transparent exo-polymer particles (TEP), Coomassie stainable particles (CSP), pH, total alkalinity (TA) and some microbiological parameters (e.g. phytoplankton abundance and bacterial cell numbers).

We also intend to sample arctic seawater by CTD/rosette sampler and hand-net hauls at the HAUSGARTEN stations and along the 78°50'N transect to catch

phytoplankton for isolation and later performing of clonal cultures. Genetic analyses will be carried out on the isolates. Molecular methods, based on the analysis of the rRNA gene will be used for the assessment of biodiversity, e.g. the development of molecular probes used for the surveillance of organisms in combination with a wide variety of hybridization based methods, such as RNA-based nucleic acid biosensors or DNA microarrays (PHYLOCHIPS). Nucleic acid biosensors and PHYLOCHIPS are chip based formats that allow a parallel identification and quantification of multiple taxa in a single experiment. The identification is based on solid phase hybridization of molecular probes, immobilized to the surface of the sensor chips to the rRNA or rDNA of the target species. Bongo-net hauls will be carried out at five stations in order to obtain amphipods which will be sorted on board in a cooling container for later biochemical and eventually genetic analyses at the home laboratory.

All samples will be preserved or frozen at -20°C and partly at -80°C for further analyses or haltered in the cooling culture container for clonal culturing and physiological experiments at AWI.

5. CLIMATE INDUCED CHANGES OF ARTIC PHYTOPLANKTON AND POSSIBLE IMPACTS ON TRACE GAS PRODUCTION

I. Peeken, A. Cherkasheva, B. Wend (AWI); V. Gros, S. Tran (CNRS)

Objectives

The Arctic Ocean is strongly affected by the climate change as it has been stated in the IPCC report, the Arctic climate assessment (ACIA) and the Arctic report card 2008 (ACIA 2005; IPCC 2007; Richter-Menge et al. 2008). A proceeding of these dramatic changes will have major implication for the ecosystem of the Arctic with possible impact on the emission of volatile organic compounds (VOCs).

In surface layers of the oceans (euphotic zone), planktonic biomass production through photosynthesis results in the release of organic compounds into the surrounding seawater. Some of these volatile species with low Henry's Law coefficients are able to escape to the atmosphere. Among these species, some can have a significant influence on the photochemistry of the atmosphere, particularly unsaturated hydrocarbons (such as isoprene:2-methyl-1,3 butadiene, or light alkenes) and carbon monoxide (CO), which have a strong impact on the OH radical and ozone budget as well as on the formation of organic aerosols (Claeys et al. 2004).

The subsequent impact in the marine boundary layer (MBL) of isoprene on the photochemistry budget and on the organic aerosol abundance is still subject to large uncertainties, particularly if one considers that the emissions are related to the high seasonal and regional variability of the marine biomass (Arnold et al. 2009). Besides isoprene, the super-saturation of surface waters is also well established for carbon monoxide (CO) and light hydrocarbons (NMHCs) which are produced by different processes, involving the photo-degradation of dissolved organic matter through the influence of UV radiation and the direct production by living cells under

photosynthetically active radiation (PAR). There are very few studies available on the quantification of emissions of these volatile organics and the seasonal and geographical variability is still largely unknown. This point is particularly of importance for the polar or sub-polar areas where climatic change already induced a shift of phytoplankton key species (e.g. Tremblay et al. 2009). Since the magnitude of trace gas emission is strongly related to the plankton groups (Bonsang et al., submitted; Gros et al. 2009), such effects can result in variation of trace gases emission by phytoplankton and might have an impact on the atmospheric chemistry of boreal zones (through the tropospheric ozone cycle and its precursors), and eventually induce positive or negative feedback in the radiation balance. This project consequently concerns the study of the spatial-temporal variability of reactive gases in seawater in relation to the distribution of phytoplankton species.

The following questions will be addressed:

What is the distribution of alkenes, dienes (isoprene) and carbon monoxide dissolved in the surface seawater as a function of latitude and different physical and biological parameters (sea water temperature, radiation as well as chlorophyll concentration, pigment based phytoplankton groups and picoplankton abundance)?

How does the vertical distribution of the concentration of dissolved gases in sea water (alkenes, dienes and carbon monoxide) reflect the different production processes?

What is the role of direct emission by plankton metabolism (under PAR) versus photo-production processes by DOC degradation (under UV)?

What is the importance of the dark production (below the euphotic zone), with respect to the production in surface waters particularly for carbon monoxide?

What is the budget of these gases in the water column; particularly is it possible to establish a balance between the production rates in seawater by biology and by physico-chemical processes (photo-production) and the losses by sea air exchanges and other bio-chemical or physical losses in the water column (oxidation, microbial consumption)?

How are the production rates of these traces gases in the surface waters of the North Atlantic and the Polar oceans parameterized (e.g. as a function of chlorophyll content or plankton group)?

Are these production rates in agreement with the production rates and algorithms established previously in laboratory experiments on monoculture (Bonsang et al., submitted; Gros et al. 2009)?

To be able to extrapolate the current findings of trace gas measurements in a broader context satellites techniques will be applied. Currently large uncertainty in the determination of planktonic production is a result of the lack of global information on phytoplankton absorption and light penetration depth, which cannot be supplied by the current ocean colour satellite sensors. The spectral resolution of these sensors is not sufficient to extract the relevant information. The variation of phytoplankton absorption in ocean waters also affects the retrieval of chlorophyll *a* concentrations (a measure of phytoplankton biomass) derived from satellite data, which are important input data used in primary production models. Results by Vountas et al. (2007) and Bracher et al. (2009) show that the signature of specific

phytoplankton absorption can be derived from the high spectrally resolved measurements of the satellite instrument SCIAMACHY (operating on board of the European environmental satellite ENVISAT). This information is used to derive global maps of major phytoplankton groups (see Bracher et al. 2009) and is planned to be used for improving the chlorophyll algorithms of the common ocean colour satellite products, such as SeaWiFS, MERIS and MODIS, by developing a global climatology of phytoplankton absorption in addition to *in-situ* measurements of phytoplankton absorption.

Therefore, besides the analysis of satellite data and applied model studies, field measurements in the open ocean of phytoplankton pigment composition, optical characteristics of phytoplankton and other water constituents, reflectance and underwater light measurements are highly precise input parameters for the satellite retrievals, climatologies and models but also used for the validation of results from the analyses of satellite data and modelling.

Thus the aim of this research project is to improve estimates of global marine primary production and the distribution of major phytoplankton functional groups (PFTs) by using remote sensing data in combination with *in-situ* measurements of ocean optics, phytoplankton productivity and composition and particulate organic carbon. In particular, data will be collected during this cruise to improve our understanding of the oceans variability in optical properties and to improve/develop remote sensing algorithms for the Arctic Ocean.

By combining trace gas *in-situ* data with satellite retrievals on PFTs, a first approach of the spatial distribution of alkenes, isoprene and carbon monoxide production at high latitudes will be made.

Work at sea

During this cruise, two kinds of measurements for trace gases will be performed: *in-situ* sampling when the ship is steaming and on-board analyses of CTD-samples taken at different depths during the ship's station work.

In-situ sampling will consist in surface seawater continuously analysed for its content in dissolved organic trace gases, alkenes, isoprene and carbon monoxide. Seawater samples collected from the water pump will be continuously introduced in an equilibration chamber, where dissolved gases will be equilibrated with clean synthetic air, and analysed by gas chromatography (GC). Two instruments will be used: a GC equipped with a PID (photo-ionisation detector) for unsaturated hydrocarbons quantification and a GC equipped with a mercuric oxide detector for CO monitoring. Measurements frequencies are 30 minutes for dissolved hydrocarbons in seawater and 5 minutes for dissolved CO. The data will be corroborated by the sampling of phytoplankton pigments and picoplankton abundance from the pump system (approximately every 3 hours).

In-situ monitoring of CO mixing ratios in the air will be simultaneously performed on board in order to characterize the air masses and determine the super saturation of the surface seawater with respect to the atmosphere. Samples will be collected in canisters (one or two per day) in order to measure the mixing ratios of light hydrocarbon in surface air.

Measurements of the vertical distribution of organic trace gases in the water column will be performed from the samples collected on station by Niskin bottles. These data will be corroborated by the sampling of phytoplankton pigments and picoplankton abundance from the same CTD casts in the same depth.

The number of samples analysed per vertical profile as well as the frequency of the vertical profiles studied will be adapted on board depending on the plankton biomass variability observed, indicated by fluorescence measurements (see below). A focus will be put on sampling of the euphotic zone and the chlorophyll maxima.

To provide reference spectra for the validation of remotely sensed bio-optical data, it is essential to have highly precise phytoplankton absorption measurements and the pigment composition. Beside the above mentioned phytoplankton abundance, particulate absorption in suspension and absorption of CDOM will be measured during the cruise using the point-source integrating-cavity absorption meter (PSICAM) at the same locations. For particulate absorption additional filters will be taken and measured with the more conventional spectrophotometer measurements for comparison purposes.

For on-line and *in-situ* optical measurements a FastTracka Fast Repetition Rate Fluorometer (FRRF) will be used in a flow-through system with water continuously pumped from the moon-pool to provide online data of chlorophyll fluorescence during the cruise. A second FastTracka FRRF will be operated on the small winch to take measurements in the water column. Radiometric measurements of the underwater light field, sky radiance and solar irradiance will be measured onboard the ship with a set of three radiometers, and in the water column (0-150 m) at various stations.

Expected results

The comprehensive data set will allow establishing a better knowledge of the impact of phytoplankton on the concentration of dissolved reactive gases in boreal and arctic areas.

The budget of the water column in reactive trace gases will be determined and the impact due to changes in the population of plankton species will be evaluated for the first time at these latitudes.

Phytoplankton absorption and radiometric measurements will be analyzed at the home lab. Results will give information on the inherent and apparent optical properties of Arctic waters. This information will be used to construct a regional model of the underwater light field which is used for the analytical models used to derive geophysical parameters (phytoplankton biomass, composition and primary production) from ocean colour measurements.

The chlorophyll fluorescence data will be used to derive information on photosynthetic activity which is used to validate the satellite primary production estimates. Due to higher concentrations or absorbing substances in the water, the profiling optical measurements will give lower values than we obtained in equatorial regions. The exact correlation between water substances and optical properties will be subject to further analysis.

In-situ data of dissolved reactive gases will be further combined with satellite retrievals of phytoplankton biomass and PFTs in order to give a first approach of the

spatial distribution of alkenes, isoprene and carbon monoxide production at high latitudes.

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6. HIGHER TROPHIC LEVELS: DISTRIBUTION OF SEABIRDS AND MARINE MAMMALS

D. Sevrin, V. Legrand, NN (PoIE)

Objectives

Among the most numerous seabird and pinniped species of the Greenland Sea, little auks *Alle alle* and harp seals *Pagophila (Phoca) groenlandica* are very abundant in mixed/polar arctic waters at the front between both water masses, or in eddies. This must reflect the presence of very high concentrations of their food, Arctic zooplankton and small fish, massively attracting their predators. Such a high biological production seems to be depending on new primary production bound to upwelling and high nutrient concentration. This "normally" takes place at the ice edge, but hydrological conditions can modify its position, east of the front in open waters caused by a sub-surface eddy, or in ice covered areas if westerly winds push the pack ice to the east, eventually covering an eddy.

On the other hand, a dramatic decrease of pack ice coverage can move this water mass farther north and west, making it inaccessible to little auks during their breeding season, and apparently causing breeding failure as e.g. on Jan Mayen in July 2005. In future years, if a much stronger diminution of ice coverage like in 2005 and 2007 will take place, the breeding failure might also affect the Spitsbergen population, and thus cause a real threat to the little auk species as a whole.

The main aim of our study is to improve the knowledge and understanding of the factors influencing the distribution of seabirds and marine mammals and, since we are the only team accumulating data, to detect long-term changes in their distribution patterns.

Work at sea

We will quantify the at-sea distribution of seabirds and marine mammals in the Fram Strait, as a function of the main hydrological parameters (water temperature, salinity) allowing to identify the main water masses (Atlantic Water, Polar Water) and front structures between water masses and the ice edge.

Transect counts will take place when *Polarstern* is sailing, since at stations seabirds can be massively attracted by ships.

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ARK-XXV/3

31 July 2010 - 10 October 2010

Reykjavik - Bremerhaven

Chief Scientist
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CONTENTS

1. ÜBERBLICK UND FAHRTVERLAUF

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Die Expedition ARK-XXV/3 wird am 31. Juli 2010 mit dem Forschungsschiff *Polarstern* in Reykjavik beginnen und in die nördliche Baffin Bay führen. Die Fahrt endet am 10. Oktober in Bremerhaven.

Schwerpunkt des wissenschaftlichen Forschungsprogramms bilden multidisziplinäre geowissenschaftliche Untersuchungen zur Klärung des strukturellen Aufbaus und der tektonischen Entwicklung der nördlichen Baffin Bay sowie der angrenzenden Kontinenträndern vom Nordteil von Baffin Island bis Ellesmere Island auf kanadischer Seite und dem konjugierenden Kontinentrand Grönlands.

Der gegenwärtige Kenntnisstand zur plattentektonischen Entwicklung der Baffin Bay und der nördlich angrenzenden Nares Strait im Paläozän und Eozän läßt grundlegende geodynamische und tektonische Fragen offen, die sich aus der Überlagerung der bislang bekannten Dehnungsstrukturen in der Baffin Bay und den quer dazu verlaufenden Kompressionsstrukturen des Eureka-Faltengürtels in Nordgrönland und Ellesmere Island ergeben. Die zeitliche Abfolge von Krustendehnung und Kompression in Zusammenhang mit einer Rotation der grönländischen Platte sowie die magmatischen Ereignisse im Laufe dieser Entwicklung sind dabei von Bedeutung für die Bildung weiträumiger sedimentärer Becken in der nördlichen Baffin Bay, denen nach probabilistischen Studien ein erhebliches Potential an Kohlenwasserstoffen zugesprochen wird.

Die Zeitlichkeit und Ablauf dieser plattentektonischen Prozesse sind aber auch von Bedeutung für den Flachwasseraustausch zwischen dem arktischen und dem atlantischen Ozean. Die geodynamische Rekonstruktion der Öffnung dieses arktischen Gateways bildet somit die Grundlage für paläobathymetrische Modelle und darauf aufbauende Vorstellungen zu Änderungen globaler Strömungsprozesse und die Paläoklimaentwicklung.

Durch Einsatz seismischer, gravimetrischer und magnetischer Methoden sollen den Öffnungsprozess charakterisierende dominante Verwerfungszonen lokalisiert, die Geometrie und physikalische Eigenschaften von Kruste und oberem Mantel, sowie die Stratigraphie sedimentärer Strukturen analysiert werden. Darauf aufbauend soll ein strukturelles und sedimentäres Entwicklungsmodell für die Öffnungsgeschichte der Baffin Bay abgeleitet werden. Darüber hinaus soll durch die Untersuchung thermischer und organisch-geochemischer Eigenschaften einzelner Sedimentbecken deren Potential für die Bildung von Kohlenwasserstoffen abgeschätzt werden. Geomikrobiologische Untersuchungen ergänzen diese Studien.

Die marinen Arbeiten werden flankiert durch eine aeromagnetische Kartierung im Bereich Jones Sound und der angrenzenden kanadischen Küstenregion um Devon Island unter Nutzung der Helikopter des Forschungseisbrechers *Polarstern*.

Als Projektpartner sind in dieses Vorhaben, das unter Federführung der BGR durchgeführt wird, das AWI Bremerhaven und der Geological Survey of Canada eingebunden.

Zusätzlich soll im Expeditionszeitraum eine dänische Wetterstation auf Littleton Island (Smith Sound) versorgt und gewartet werden.

Abbildung 1 gibt einen Überblick über die Fahrtroute und das Arbeitsgebiet der Expedition ARK-XXV/3.

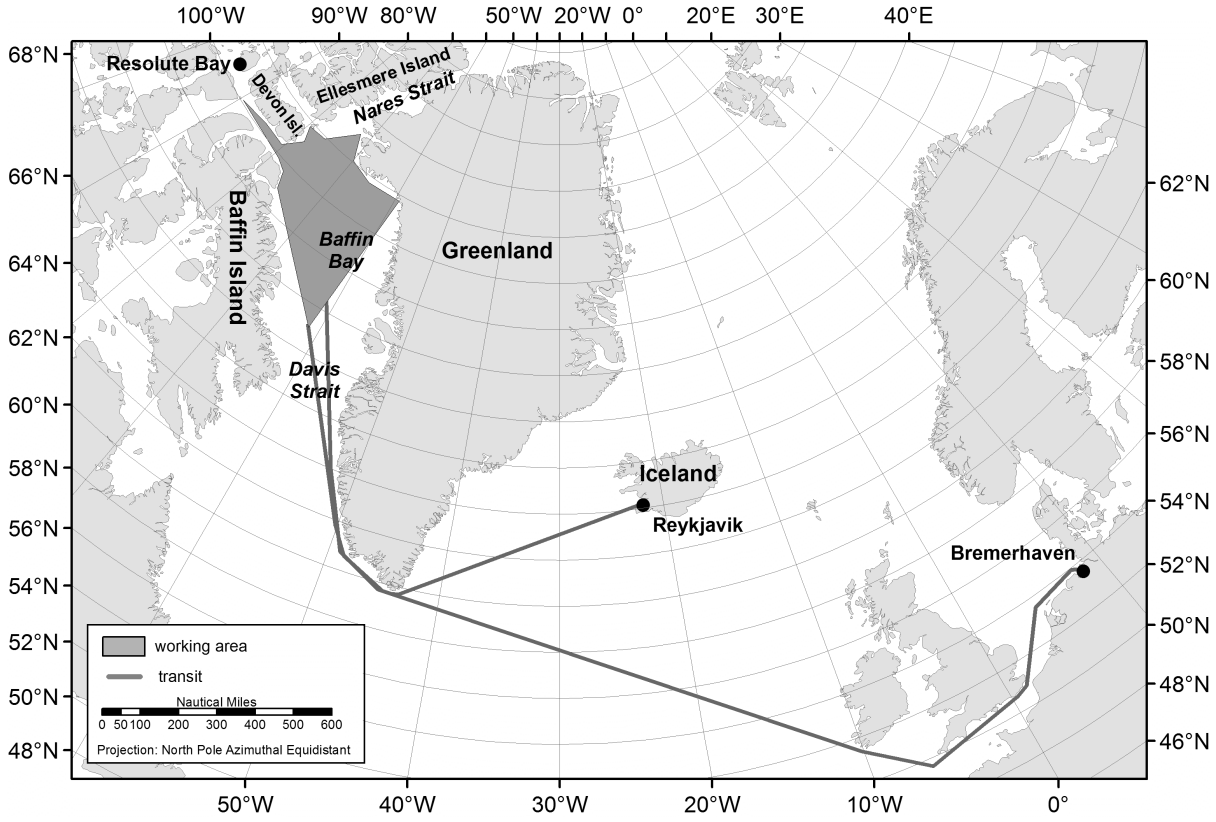

Abb. 1: Geplantes Arbeitsgebiet der Polarstern-Expedition ARK-XXV/3
Fig. 1: Planned area of operations of the Polarstern expedition ARK-XXV/3

SUMMARY AND ITINERARY

The *Polarstern* expedition ARK-XXV/3 will start on 31st July 2010 in Reykjavik (Iceland) and is planned to be conducted in the Northern Baffin Bay. The cruise will terminate on 10th October in Bremerhaven.

The focus of the scientific programme is multi-disciplinary geoscientific investigations to explain the structural and tectonic evolution of the crust in the Northern Baffin Bay and the adjacent continental margins at both the Canadian side, namely from Northern Baffin Island as far as Ellesmere Island, and the conjugate Greenland continental margin.

The current knowledge about the plate tectonic evolution of the Baffin Bay and Nares Strait during Paleocene and Eocene times is not well understood. Extensional structures in the Baffin Bay are superimposed by transverse compressional structures of the Eurekan fold belt which runs from Northern Greenland to Ellesmere

Island. The temporal sequence of the tectonic processes and interaction between crustal extension and compression, rotation of Greenland and related magmatic events are of special importance for the formation of large scale sedimentary basins in the area, which are - according to probabilistic studies - supposed to have a significant hydrocarbon potential.

Additionally, changes of the plate tectonic constellation of the area in time play an important role in the shallow water exchange between the Arctic and the Atlantic Ocean. Paleo-bathymetric models, a comprehensive knowledge about the geodynamic evolution of the region and the opening process of this Arctic gateway are essential for the understanding of ocean water circulation in geological history and to decipher the paleo-climate evolution.

By means of seismic, gravimetric and magnetic methods we aim for localisation of suggested dominant transfer faults, which characterise the tectonic processes and for parameters to deduce thickness and physical properties of the crust and upper mantle. Seismostratigraphy will be used to investigate extension and subsidence processes and to derive a crustal evolution model of the Northern Baffin Bay. Moreover, the hydrocarbon potential of the area will be estimated based on additional geothermal and geochemical data. These investigations will be supplemented by geomicrobiological studies.

In addition to the marine working programme an aeromagnetic survey is planned covering the Jones Sound and adjacent coastal areas of Devon Island. This survey will be performed using the helicopters of *R/V Polarstern*.

The project is under the direction of BGR Hannover and performed in cooperation with AWI Bremerhaven and the Geological Survey of Canada (GSC). The onshore aeromagnetic survey is lead by the Canadian project partner.

Additionally, a Danish meteorological station on Littleton Island (Smith Sound) will be served during the cruise ARK-XXV/3.

Figure 1 gives an overview of planned cruise tracks to and from the working area and planned areas of operation during cruise ARK-XXV/3.

2. STRUCTURE AND EVOLUTION OF THE CRUST AND SEDIMENTARY BASINS IN THE NORTHERN BAFFIN BAY

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M. Koch (University Jena)
not on board: W. Jokat (AWI)

Objectives

The geodynamic evolution of the Eastern Canadian and West Greenland continental margins is very complex and still poorly known. Several phases of Mesozoic and Cenozoic crustal thinning/rifting occurred during the opening of the oceanic basin, while counterclockwise rotation of the Greenland plate simultaneously produced compression observed in the Eurekan Fold Belt on Ellesmere Island. The geometry of the plate boundaries and the timing of the plate motions and basin development are disputed.

A recently proposed "two-vector" model of relative plate motion between Greenland and Canada remains untested due to lack of data especially from key areas in Northern Baffin Bay: the regions of Smith Sound, Lancaster Sound, and Jones Sound. These areas offer an excellent opportunity to collect data essential for a better understanding of the relative plate motion between Canada and Greenland in space and time and to decipher the evolution of the thick sedimentary basins of this region. Coordinated airborne and marine geophysical data acquisition will provide basic information to prove or disprove the existence of a plate boundary and if present, to quantify the offset of the basement structures. The investigations will contribute to the understanding of regional tectonic processes and the development of the sedimentary basins of the Eastern Canadian Arctic continental margins and their hydrocarbon potential.

The field activity comprises marine geophysical surveying of the Northern Baffin Bay including the adjacent Jones, Lancaster and Smith Sounds, and airborne magnetic and gravity surveying to define the nature of the crust beneath the sedimentary basins plus onshore aeromagnetic surveying of Ellesmere and Devon Islands to map the possible continuity of Achaean basement structures across Northern Baffin Bay.

The results of the multi-disciplinary survey work will be integrated into a regional synthesis of the rift margins, the basin development and evolution, and the implications on the hydrocarbon resource potential.

Work at Sea

The primary objective of the marine program is to collect seismic reflection and refraction seismic data in key areas of the Northern Baffin Bay to improve the understanding of the geometry of the plate boundaries and the stratigraphy within

the sedimentary basins. Additional multibeam bathymetry and sub-bottom profiling will be carried out to identify appropriate locations for seafloor sampling.
An estimated 2500 km of wide angle seismic refraction lines along 3 profiles and an estimated 4000 km of multichannel seismic reflection data are planned to be acquired during the survey operations. Reflection seismic data will be acquired along all refraction lines; however 3 additional lines are planned with only seismic reflection acquisition. Final details of the locations of the individual survey lines will be subject to weather and ice conditions. If weather and ice conditions are favourable, additional lines may be considered.

The reflection acquisition system will include an acoustic source of 6 G-guns SERCEL (8.0 litres each; total volume of 51.0 litres) and a 4500 meter Sercel Streamer with flexible hydrophones (total number 5760 @ 360 channels). For seismic refraction data acquisition 2 additional G-guns (8.0 litres each) will be used.

Up to 30 ocean-bottom seismometers (OBS) will be deployed along each refraction profile. The spacing of the instruments ranges between 9 and 13 km. Three seismic land-recorders are planned to be deployed on Bylot Island, at Pond Inlet and at the west coast of Greenland in prolongation of one refraction line to extend the lengths of the offshore profile.

BGR10-201/BGR10-2R1 (reflection and refraction) extends from the western Greenland margin across the extinct spreading axis in Northern Baffin Bay into the Lancaster Sound along the centre of the suggested “failed rift" arm. This line will connect with line *BGR10-204* to continue the stratigraphic correlations from the ODP site 645.

BGR10-202/BGR10-2R2 (reflection and refraction) crosses the Northern Baffin Bay from the coast of Bylot Island to the northern end of the Melville Bay Graben. This line will identify the COB positions for the (nearly) conjugate sections of the Canadian and Greenland margins. The line will cross the extinct Eocene axis and (presumably) Paleocene oceanic crust. This line is critical to the understanding of the highly asymmetric nature of the conjugate continental margins and the question of whether the basins along the margin are underlain by oceanic crust or attenuated continental crust.

BGR10-203/BGR10-2R3 (reflection and refraction) extends from normal Archean crust southward across the COB and crosses onto (presumably) Paleocene oceanic crust and continues across the extinct Eocene spreading axis. This line will establish whether the basins along the margin are underlain by oceanic crust or attenuated continental crust.

BGR10-204 (reflection only) extends from the northern end of a BGR seismic reflection survey acquired during the previous cruise MSM09/2 in 2008, crosses the ODP site 645 on the Baffin Shelf and continues to Jones Sound. A portion of this line will be coincident with the GSC refraction line east of Devon Island, where the Continent-Ocean-Boundary (COB) has been identified. This line will provide direct correlation of the stratigraphy identified at the ODP well into the eastern end of the Lancaster Sound Basin.

BGR10-205 (reflection only) connects the northern tip line BGR10-204 with the eastern end of line BGR10-201 and ties to the other seismic refraction/reflection lines. It crosses the suggested COB in the western part and allow for additional seismostratigraphic correlation along the Greenland margin.

BGR10-206 (reflection only) extends from the central Melville Bay Graben on the West Greenland margin seaward across the COB and onto (presumably) Paleocene oceanic crust and ends up at the northern end of the BGR MSM09/3 seismic survey

area of 2008. This line will provide an improved cross-section of the Greenland margin to compare with the conjugate Baffin Margin and allows for seismostratigraphic correlation with the reflection seismic data of the 2008 MSM09/3 cruise.

All seismic reflection data will be processed onboard using a ProMAX system and interpreted by means of an onboard GeoFrame interpretation system.

Deployment of land-based seismometers

For one of the planned seismic refraction lines (BGR10-202), deployment of land station seismometers on Bylot Island are proposed to extend the line and to better define the geometry of the continental margin of northern Baffin Island.
Three land-station seismometers are planned: two on Bylot Island (within the Sirmilik National Park) and a third station at Pond Inlet.

Station	Latitude	Longitude	Location	Land Status
SS-1	73° 06’ 30” N	76° 42’ 00” W	North-East Bylot Is.	Parks Canada
SS-2	72° 52’ 45” N	77° 20’ 30” W	South-East Bylot Is.	Parks Canada
SS-3	72° 40’ 45” N	77° 58’ 30” W	Pond Inlet	Hamlet

Additional land stations are also planned for the northwestern end of the line. Deployment is subject to available instruments and permissions. All stations will be deployed using the shipboard helicopters of *R/V Polarstern*. Location of seismic lines is outlined in Figure 2.

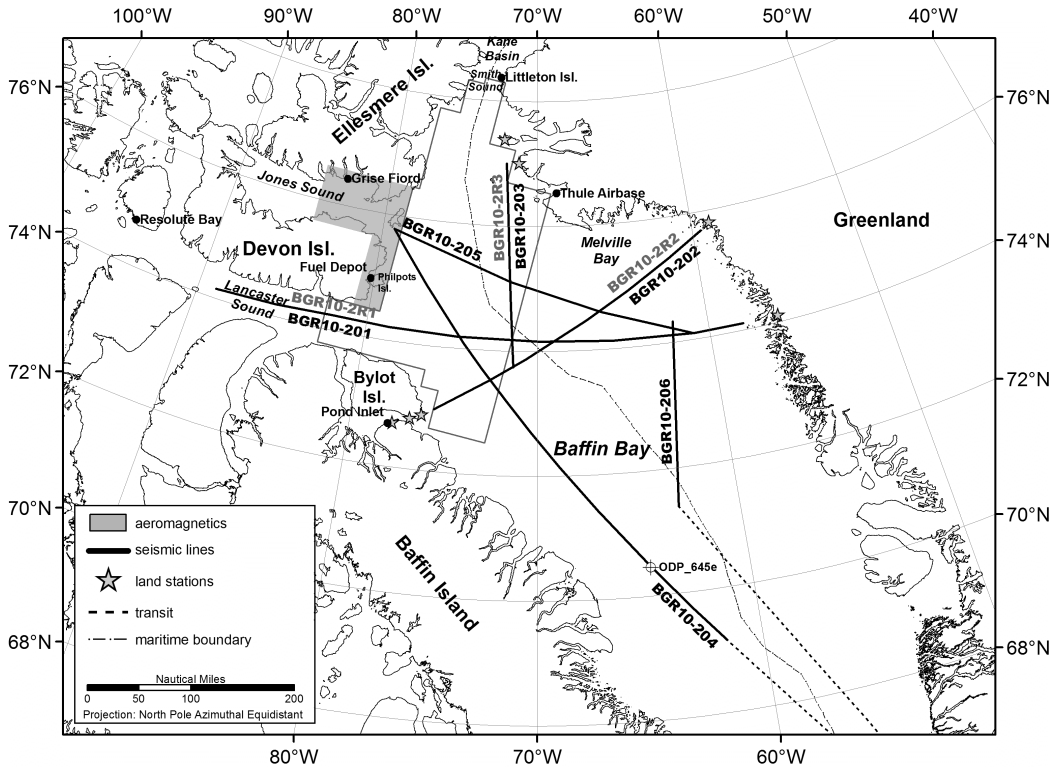

Fig. 2: Location of seismic reflection and refraction lines and land based seismic stations during Polarstern expedition ARK-XXV/3. The planned helicopter aeromagnetic survey is shown in grey colour. The framed area covering the central part of Northern Baffin Bay indicates an aeromagnetic survey using a fixed wing aircraft scheduled for 2011.

Expected results

This experiment is designed to investigate the crustal structure of the Eastern Canadian and Western Greenland continental margins. The seismic data will be processed to produce models of the geometry and composition of the continental/oceanic crust. The results will provide new constraints on plate motions between Canada and Greenland and improve the understanding of the development and evolution of the sedimentary basins and their hydrocarbon potential.

3. MARINE MAGNETIC MEASUREMENTS AS AN INDICATOR FOR VOLCANIC AND MAGMATIC PHASES DURING THE CRUSTAL EVOLUTION

H.-O. Bargeloh, J. Deppe, B. Schreckenberger (BGR)
Q. Li (GSC Calgary)

Objectives

The deep water parts of Northern Baffin Bay are most probably of oceanic origin but details of the timing and the geometry of the opening process between the Baffin and other Canadian Islands and Greenland are still not very well known. The main objective of the magnetic measurements during the cruise is the identification of anomalies that would give us constraints on the age of the oceanic crust. Magnetic data are also required to support an integrated interpretation of continental margin structures.

Work at sea

Three different magnetic instruments will be used:

(a) A towed marine gradient magnetometer consisting of two Overhauser sensors (SeaSPY system). The gradient configuration allows the distinction between magnetic anomalies and magnetic variations. This is an important feature, because strong magnetic disturbances must be expected in the survey area.

(b) A vector magnetometer integrated in the towed gradient magnetometer system. Under favourite conditions vector measurements on single lines give information about the strike of magnetic anomalies in the absence of parallel profiles. This is important because of the lack of regular parallel lines planed for the survey.

(c) The shipboard vector magnetometer. This system will be helpful on any kind of lines where the towed gradient and vector magnetometers can not be deployed.

It is intended to deploy the towed instruments on all seismic and longer transit lines. Processing and evaluation of the profiles will partly be done on the vessel. Magnetic data from Canadian and Greenland magnetic observatories will be used after the cruise to make additional corrections of magnetic variations.

Expected results

The most important outcome would be the identification of lineated magnetic seafloor-spreading anomalies. This would give direct evidence of the oceanic origin

of Baffin Bay crust and its age. Ideally also the direction of the opening of the basin could be determined. Successful determination of these parameters would have a fundamental impact on plate tectonic models for the history of the surrounding continents and oceans. Additionally, magnetic data provide valuable constraints on crustal structures, e.g. the presence of volcanic material, when they are evaluated together with seismic and gravity data.

4. MARINE GRAVITY MEASUREMENTS

H.-O. Bargeloh, J. Deppe, I. Heyde (BGR)

Objectives

The survey area in the Northern Baffin Bay and southern Nares Strait is situated in a transition area concerning the character of the plate boundary between Greenland and North America. The gravity field should provide constraints concerning the boundary between continental and oceanic crust. Moreover the gravity data will allow quantitative statements concerning the density structure of the continental margins and in particular sediment thicknesses taking into account the seismic results.

Work at sea

The KSS31 seagravimeter, which is permanently installed onboard *R/V Polarstern*, will be used for the gravity measurements. Tie measurements to onshore reference stations with known absolute gravity values will be carried out with an appropriate land gravimeter. Shipboard gravity measurements will be conducted during the entire cruise on all profile and transit lines. The measured free-air gravity anomalies will be compared with other data sets especially those derived from satellite altimetry. Our experience on numerous cruises showed that gravity anomalies derived from satellite altimetry are of great importance to get an overview of the gravity field in an oceanic area. For detailed investigations, however, shipboard gravity measurements are more accurate and thus indispensable.

Expected Results

Detailed free-air gravity and Bouguer anomaly maps of the survey area will be produced. The maps will allow qualitative statements concerning the lateral distribution of different density units. In particular, the interpretation will include forward modelling of anomalies along a number of key profiles to develop sound density models. The corresponding results of the reflection seismic interpretation and refraction seismic data will be taken into account and integrated. The models will provide constraints on sediment thicknesses and basement structures. It should be possible to indicate the transition from continental to oceanic crust (COB) due to their different thicknesses. This parameter would have impact on plate tectonic models for the survey region.

5. HEAT FLOW MEASUREMENTS

J. Deppe, M. Zeibig (BGR)
not on board: G. Delisle (BGR)

Objectives

Paleo-temperatures and geothermal gradients affect the maturation of organic sequences. Basin modelling is based on sediment thicknesses and paleo-temperatures for assessment of the hydrocarbon potential of sedimentary basins.

As an additional tool, heat flow measurements might assist in restraining age estimates of the crust in the Northern Baffin Bay. Heat flow data spread over the survey area may help to identify the areal extent of oceanic floor or stretched continental crust, type of extension and sea-floor spreading.

Work at Sea

All heat flow measurements are planned to be conducted in areas where seismic lines give us information on the sediment thickness and a rough estimate on likely sedimentation rates. This way the true heat flow value, corrected for sedimentation effects, can be determined.
We plan to restrict the heat flow measurements to areas with water depths in excess of about 1200 m. The points of measurement should be dispersed throughout the area of investigation in the hope to determine a systematic heat flow pattern. The total number of stations for heat flow measurements is planned to be limited to 30.

Since we expect relatively hard ground (drop-stones, relatively coarse, ice-rafted debris), we plan to deploy primarily the hard-ground heat flow probe of BGR.

The planned locations for heat flow measurements along the seismic lines are concentrated to the area shown in Figure 3.

Expected Results

Oceanic crust underlying the Nares Strait should be fairly young, since the most likely development occurred sometime during Paleocene/Eocene times. Therefore, we expect high heat flow values. In combination with the results of the seismic measurements we expect to resolve the influence of high sedimentation rates on the heat flow. Measured heat flow values might assist to constrain the age estimate by using the so called Sclater curve to determine a least age limit.

6. GAS GEOCHEMISTRY AND BASIN MODELLING

Th. Pletsch, St. Schlömer (BGR)

Objectives

Both the structural style and the tectonic evolution of the Northern Baffin Bay are poorly explored and remain a matter of ongoing debate. Geophysical testing of the contrasting tectonic models is expected to shed light on the geometric and thermal evolution of this basin. Since basin evolution has a major effect on hydrocarbon generation and migration, we intend to study the quantity, the chemical and the isotopic compositions of gases in the water column and of gases adsorbed by surface sediments in the study area. These compositional data shall be interpreted in the context of the measured basin geometry and heat flow to be integrated into a model of hydrocarbon generation and migration.

Work at Sea

We intend to take short piston core samples by means of a gravity corer or a multi-corer along different transects of the basin to measure the quantity, the chemical and isotope composition (methane) of free and adsorbed gases. The chemical composition (permanent gases and hydrocarbons) of the free gases will be measured on board with a Micro-GC (Varian CP-4900), isotopic composition of methane with a portable methane isotope analyzer based on high-resolution direct absorption cavity ring-down spectroscopy (Los Gatos Research). Representative samples will be frozen immediately for later laboratory analysis of adsorbed hydrocarbons (ethane and propane) and other parameters (e.g. carbonate content, total organic carbon).

Coring is planned to be performed along a part of seismic lines BGR10-202/BGR10-2R2 and BGR10-202/BGR10-2R2, preferable coinciding with positions for OBS deployment. Sampling positions at the sites shall be screened and evaluated prior to piston core deployment on the basis of sediment echosounder data. Coring will be limited to about 30 piston core stations. Additional piston core stations are planned where sediment echosounder data suggest the existence of seep structures.

In order to select core samples for geochemical analyses we will perform visual estimates of the type and amount of detrital sedimentary components (both organic and inorganic) using smear-slide microscopic preparations and both classical transmitted-light and epi-fluorscence microscopic techniques.

Provided that sediment echosounder data indicate active gas vents, a deepwater methane sensor (Capsum METS) combined with the heat flow probe will be deployed and water samples will be taken (on-board CTD) and degassed immediately for similar analysis.

The area of locations for coring and water sampling are shown in Figure 3.

Expected Results

Methane concentration and isotopic composition of both free gas in sediments and the sea water can be used to identify areas of gas seepage from the sediments as well as water masses with active microbial methane generation.

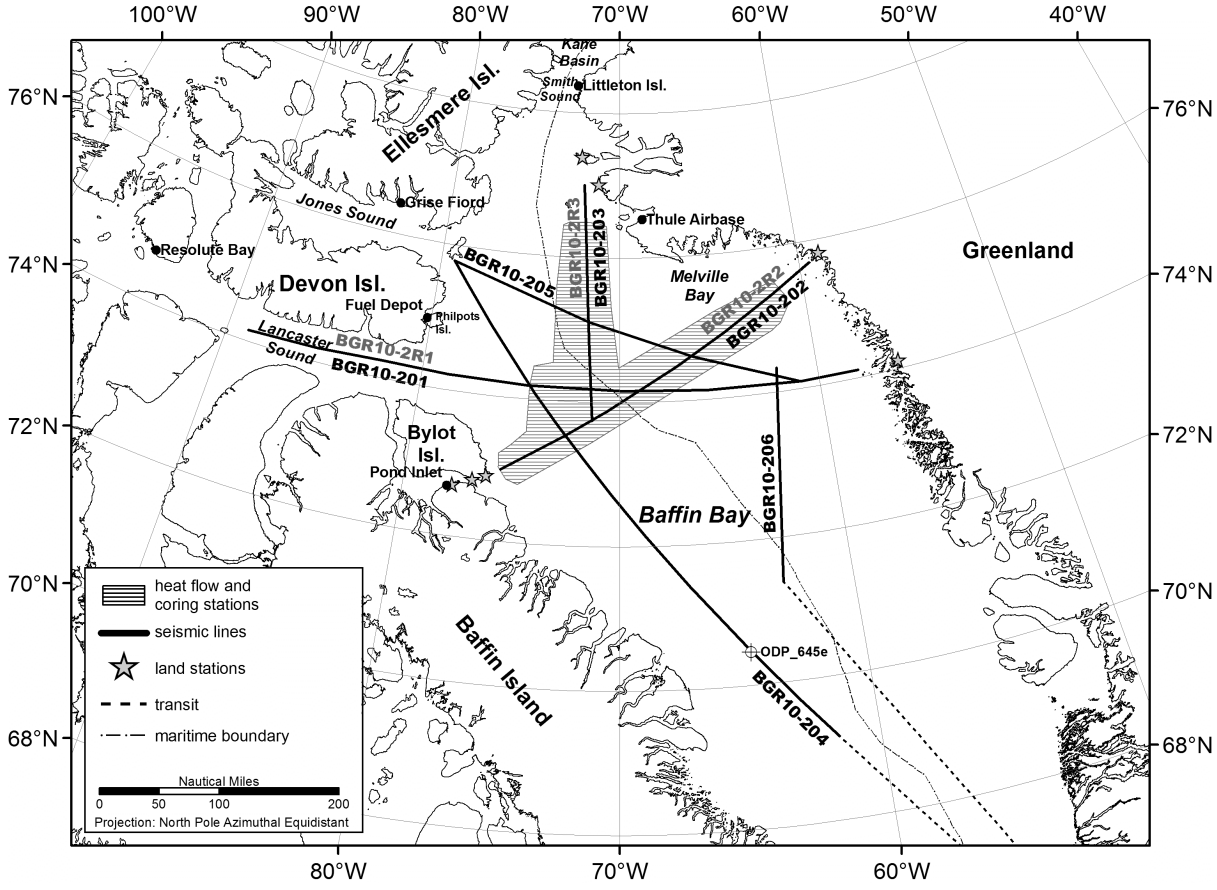

Fig. 3: Location of stations for heat flow measurements and coring during the expedition ARK-XXV/3.

7. BIOGEOCHEMISTRY AND GEOMICROBIOLOGY

F. Gründger (BGR), C. Algora (UFZ)
not on board: M. Krüger (BGR), Ch. März (ICBM), L. Adrian, H.-H. Richnow (UFZ)

Objectives

Besides its structure and tectonic evolution, also the geological and biogeochemical characteristics of the Northern Baffin Bay are largely unknown. In addition to geophysical and gasgeochemical approaches, knowledge on geochemical and microbiological sedimentary features can support modelling and exploration for the hydrocarbon potential of a selected region. Consequently, a detailed geochemical characterisation of the sedimentary environments in the Northern Baffin Bay will be conducted. This will be accompanied by microbiological investigations of the hydrocarbon degradation potential of indigenous microbial communities. Together with sediment echosounder and gasgeochemical investigations in the water column

this will allow the identification even of very low-intensity gaseous or oily hydrocarbon seepage as indicators of possible subsurface reservoirs.

Work at Sea

We intend to use parts of the short piston core samples taken for the gas geochemical investigations described above.

Sediment and, if possible, porewater samples for geochemical analyses will be taken in short intervals along the cores and subsequently analysed onboard. These will then be prepared and fixed for the determination of total organic carbon, elemental (especially Fe-, Mn-species) composition, stable C and H-isotopes, microbial substrates, sulfate/sulphide concentration, and profiles of methane and CO_2. All other samples will be fixed or frozen immediately for later laboratory analysis.

Microbiological samples for the quantification of microbial activities and communities will be collected from the same depths as the geochemistry samples. Sediment microcosms will be set-up onboard to measure on site rates of important microbial processes, i.e. sulfate reduction, methane and carbon dioxide formation and consumption, as well as the degradation of different higher hydrocarbons. This will be done using non-radioactive techniques, GC and photometric analyses.

Samples for molecularbiological studies of the quantitative and qualitative microbial community composition will be collected, partially fixed for FISH (Fluorescence in situ hybridisation) and stored frozen until further onshore analyses.

8. AEROMAGNETIC PROGRAMME

D. Damaske, B. Schreckenberger (BGR)
not on board: G. Oakey (GSC Atlantic), Ch. Gaedicke (BGR), C. Kopsch (AWI),

Objectives

Detailed geophysical mapping will improve the understanding of the development of the offshore sedimentary basins and the structural framework. This survey is designed to tie the offshore geology and geophysical findings to mapped onshore areas. In particular, the aeromagnetic survey plan is designed to map the geometry of the bounding faults of the eastern edges of the Lancaster and Jones Sound basins. It also covers the linear belt of “flower structures”, which are assumed to be inverted Cretaceous and/or Paleogene basins.
The helicopter aeromagnetic data will complete the aeromagnetic database for the whole Northern Baffin Bay and the adjacent Canadian continental margin, which will be available after an supplementary fixed-wing (magnetic and gravity) survey scheduled for 2011. The geometry of the helicopter survey will ensure a seamless continuation of the data coverage into Jones Sound and over onshore areas where rugged terrain limits fixed wing operations.

Planned Work

The airborne surveying group will comprise of scientists and technical personnel from GSC and BGR. The group will operate the aeromagnetic equipment and process the data after the survey.

Airborne operations will be done from the community of Grise Fiord and a remote field camp on Philpots Island. The survey is planned to be performed within in an anticipated minimum time frame of 2-week between mid-August and mid-September. The specific dates must remain flexible to accommodate weather conditions that may restrict air travel.

Aviation fuel for helicopter use in the survey operation is available at Grise Fiord. A fuel cache at Philpots Islands (east of Devon Island) will be installed by GSC, through the Canadian Polar Continental Shelf Programme (PCSP), prior to the survey operations. The precise location of the fuel cache is dependent on the final survey design and acquisition of land-use permits. GSC will be providing the field logistics to carry out the helicopter surveying.

The airborne surveying group will be under the direction of GSC. BGR will provide the data acquisition systems for the survey operations. The ship based helicopters of *R/V Polarstern* are planned to operate the airborne survey from an onshore flight base located at Grise Fiord and the suggested field camp at Philpots Island.

The approximate requirements for helicopter time are 150 hours, including surveying, base stations, and test flight(s). Survey lines are 2 km spacing, and the tie-lines are 10 km spacing. The flight elevation will be between 300 m over water and draped over land. The start/end of flights will be Grise Fiord or fuel cache location.

The planned aeromagnetic survey area is shown on the map in Figure 2.

Expected Results

The Creataceous/Paleogene plate boundary from Northern Baffin Bay northward to the Nares Strait is supposed to be represented by a major sinistrial strike-slip fault between Canada and Greenland. Recent aeromagnetic surveying across Kane Basin mapped continuous basement structures in the southern part of the Nares Strait (Kane Basin), suggesting that the Archean terrain of south-east Ellesmere Island has always been rigidly attached to the Greenland plate.
The onshore continuity of aeromagnetic mapping will directly help to correlate the magnetic and gravity anomalies offshore with mapped geology and to explain the development of the Baffin Bay rift basin, variable inversion of sedimentary basins around northernmost Baffin Bay and intense deformation associated with the Eocene Eurekan Orogeny within Ellesmere Island further north.

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10. FAHRTTEILNEHMER / PARTICIPANTS

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Algora	Camelia	UFZ	Biologist
Altenbernd	Tabea	AWI	Student, geophysics
Bargeloh	Hans-Otto	BGR	Technician, geophysics
Behrens	Thomas	BGR	Technician, geophysics
Berglar	Kai	BGR	Geologist
Block	Martin	BGR	Geophysicist
Brent	Tom	GSC Calgary	Geophysicist
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Fraenznick	Jürgen	ARD	Journalist
Goldmann	Felix	BGR	Technician, geophysics
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Koch	Michael	University Jena	Student, geology
Korger	Edith	AWI	Student, geophysics
Läderach	Christine	AWI	Geophysicist
Li	Qingmou	GSC Atlantic	Geophysicist
NN		HeliService	Pilot
NN		HeliService	Pilot
NN		HeliService	Pilot
NN		HeliService	Technician, helicopter
NN		HeliService	Technician, helicopter
NN		DWD	Meteorologist
NN		DWD	Technician, meteorology
Pitschmann	Dirk	BGR	Technician, geophysics
NN		ARD	Journalist
Pletsch	Thomas	BGR	Geologist
Rohardt	Ann-Kathrin	AWI	Student, bathymetry
Schlömer	Stefan	BGR	Geologist
Schnabel	Michael	BGR	Geophysicist
Schrader	Uwe	BGR	Technician, geophysics
Schreckenberger	Bernd	BGR	Geophysicist
Sievers	Joachim	BGR	Technician, geophysics
Slabon	Patrizia	AWI	Student, bathymetry
Steinbach	Volker	BGR	Geologist
Suckro	Sonja	AWI	Geophysicist
Zeibig	Michael	BGR	Technician, geophysics

11. SCHIFFSBESATZUNG / SHIP'S CREW

No.	Name	Rank
1.	Pahl, Uwe	Master
2.	Birnbaum, Thilo	1.Offc.
3.	Ziemann, Olaf	Ch. Eng.
4.	Hering, Igo	2. Offc.
5.	Janik, Michael	2. Offc.
6.	Reinstädler, Marco	2. Offc.
7.	Stüwe, Ursula	Doctor
8.	Koch, Georg	R.Offc.
9.	Kotnik, Herbert	2.Eng.
10.	Schnürch, Helmut	2.Eng.
11.	Westphal, Henning	2.Eng.
12.	Holtz, Hartmut	Elec.Eng.
13.	Dimmler, Werner	ELO
14.	Feiertag, Thomas	ELO
15.	Fröb, Martin	ELO
16.	Nasis, Ilias	ELO
17.	Clasen, Burkhard	Boatsw.
18.	Neisner, Winfried	Carpenter
19.	Burzan, Gerd-Ekkeh.	A.B.
20.	Hartwig-Lab.,Andreas	A.B.
21.	Kreis, Reinhard	A.B.
22.	Kretzschmar, Uwe	A.B.
23.	Moser, Siegfried	A.B.
24.	Pousada Martinez, S.	A.B.
25.	Schröder, Norbert	A.B.
26.	Schultz, Ottomar	A.B.
27.	Beth, Detlef	Storek.
28.	Dinse, Horst	Mot-man
29.	Fritz, Günter	Mot-man
30.	Kliem, Peter	Mot-man
31.	Krösche, Eckard	Mot-man
32.	Watzel, Bernhard	Mot-man
33.	Fischer, Matthias	Cook
34.	Tupy, Mario	Cooksmate
35.	Völske, Thomas	Cooksmate
36.	Dinse, Petra	1.Stwdess
37.	Hennig, Christina	Stw/Nurse
38.	Hischke, Peggy	2.Stwdess
39.	Hu, Guo Yong	2.Steward
40.	Streit, Christina	2.Stwdess
41.	Sun, Yong Sheng	2.Steward
42.	Wartenberg, Irina	2.Stwdess
43.	Ruan, Hui Guang	Laundrym.