R/V Maria S. MERIAN
Leg MSM02/4 20. 8.-17. 9. 2006
Longyearbyen (Svalbard) –Reykjavik (Island)
Chief Scientist: Ursula Schauer

Preliminary Cruise Report

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Scientific Programme

The objective of the cruise MSM02/4 was to investigate the variability of the oceanic fluxes through Fram Strait and of marine polar ecosystems. 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 spreading 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 runoff are 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, the only deep connection between the Arctic Ocean and Nordic Seas. Knowledge of these fluxes is a basic requirement for the quantification of the circulation cells of the Arctic and Atlantic Oceans and for understanding their role in climate variability on inter-annual to decadal scales.

To quantify the inter-annual to decadal variation of volume, heat and salt fluxes through Fram Strait, an array of moorings is maintained since 1997 to measure currents, temperature and salinity. The year-round measurements are combined with hydrographic sections taken during the 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). At present the work is part of the EU Integrated Project `DAMOCLES’ (Developing Arctic Modeling and Observing Capabilities for Long-term Environmental Studies). It is associated to the international Arctic-wide study “ASOF”.

While Arctic organisms are highly adapted to extreme environmental conditions with strong seasonal variation, the recent climate change (sea ice extent and thickness, ocean temperature, salinity and nutrients content) challenges the resilience of Arctic life. The stability of Arctic ecosystems is probably not strong enough to withstand the sum of these factors which might lead to a collapse of subsystems. To assess the impact of large-scale environmental changes on an ecosystem in the transition zone between the northern North Atlantic and the central Arctic Ocean, in 1999 the Alfred Wegener Institute for Polar and Marine Research (AWI) established the deep-sea long-term observatory HAUSGARTEN, representing by now the only open-ocean long-term station in a polar region.

In the HAUSGARTEN observatory, 15 sampling sites along a depth transect (1000 - 5500 m) and along a latitudinal transect following the 2500 m isobath are sampled each year. Moorings and different free-falling systems (Bottom-Lander) act as local observation platforms. Visual observations with towed photo/video systems allow the assessment of the large-scale distribution of larger epibenthic organisms. Multidisciplinary research at HAUSGARTEN covers almost all compartments of the pelagic and the benthic marine ecosystem, with focus on benthic processes.

The DFG funded project “Biodiversity and ecology of deep-sea copepods in polar seas – speciation processes and ecological niches in the homogeneous environment of the pelagic realm” addresses biodiversity and feeding ecology of dominant deep-sea copepods in polar Regions. The two copepod families Euchaetidae and Aetideidae are important components of zooplankton communities in the deep ocean and in polar regions. Species of both families can be responsible for one to two thirds of the total energy flow through the carnivorous trophic level, and may consume nearly half of the vertical carbon flux. A characteristic, but still enigmatic feature of Euchaetidae and Aetideidae is the co-occurrence of several closely related species in deep-sea habitats of the Arctic and Antarctic. Since the pelagic deep sea is an almost homogeneous environment without physical barriers, the sympatric co-occurrences of such closely related species raise the questions how the biodiversity of these deep-sea species evolved and what mechanisms minimize inter-specific competition, which would otherwise lead to the extinction of less fit competitors.

The project focuses on differences in vertical distribution, life-cycle strategies, diet spectra and feeding behaviour of different co-occurring deep-sea copepods in order to characterise their distinct ecological niches in the deep-sea pelagic realm. With these objectives, the project covers central issues of international marine biodiversity initiatives, such as Census of Marine Zooplankton (CMarZ) and Census of Marine Life (CoML).

Narrative of the cruise

The cruise started in Longyearbyen at August 20th, 2006 afternoon. Several parts of the deck gear did not work then but the continuation of repairs was postponed to the next port call in Reykjavik.

The working area in Fram Strait was reached in the following night and the first CTD-casts along a strait-wide hydrographical section at 78°50'N were taken. At all casts a lowered ADCP was attached to the CTD/rosette for velocity measurements. In the morning of August 21st we returned eastwards and tried to recover the first mooring F3-8 (Fig.1). Acoustic interrogation failed to evoke a response from either the transponder at the top of the mooring or the bottom releasers and also after a "blind" release the mooring did not surface. After this disappointing start we continued eastwards and successfully recovered moorings F2-9, F1-8 and a PIES (Pressure Inverted Echo Sounder). Due to the malfunction of the 20-t-beam all mooring work during the cruise (altogether 48 mooring movements) was carried out with the A-frame at the afterdeck. The following night was filled again with CTD/lADCP-work and a first Multinet for the biodiversity programme. Due to dense station spacing we kept this day/night working scheme although it lead to some back and forth pattern of the cruise track for much of the cruise.

At the next day we gave F3-8 one more try and with slightly changed parameters of the deck unit we were able to hear the mooring. This told us that it was still in place at 1000 m water depth although released and this meant that we had to dredge it. We used 3000 m of lines and all available dredge anchors and recovered what was left from F3-8: the lowest instruments and the two releasers. At August 23rd the first moorings, F3-9, PIES-F2-10, F2-10, F1-9, were deployed and F4-8 was recovered. During one of the deployments, the mooring capstan broke. Fortunately we could by-pass the mooring rope and use a belayer capstan instead. Thanks to the calm weather we could go on with the heavy mooring programme despite of various other failures of the decks gear that continued during the rest of the cruise: several times sudden stoppings of the A-frame winch, malfunction of the A-frame itself, failure finally also of the belayer capstan (which could be repaired), etc. During the mooring procedures the Posidonia system was successfully used. However, for the entire cruise, we were not able to enable the transponders in the water directly with Posidonia. We had to use a hydrophone instead. Once enabled, Posidonia worked fine to locate the transponders in all depths.

In the evening of August 26th, the next threat to our expedition was the failure of the second of 4 Diesels - any other Diesel failure would have required immediate port call.

Fortunately we could continue and start our biological programme in the Hausgarten between the West Spitsbergen slope and the Molloy Deep, where Multicorer stations were taken and a Lander was deployed for the first out of three times for 24 hours for respiration experiments. That was followed by the recovery of a lander and a mooring that had been deployed for one year and further mooring recovery and deployments and CTD work along 78°50’N. At all Hausgarten positions also Multicorer casts were taken.

Until 31st August we had no contact with sea ice and the weather was very calm. Ice information was not accessible through internet since due to the northern position Inmarsat communication was not possible. Instead we were provided with low resolution sea ice images sent by email from the University of Hamburg (Lars Kaleschke). The ice maps showed open water up to 81°N north of Svalbard so that we decided that we could carry out a planned CTD section across the slope of the Yermak Plateau to study the western branch of the West Spitsbergen Current.

At 1st September we headed northward along the prime meridian. At 79°22’N we met the ice edge and headed eastward to get back to open water. Only at 3°E we could move northward again. We proceeded with the CTD stations north-eastward in a loose field of thin (< 1m thick) ice which was covered with a several decimeters thick layer of snow - obviously marked by the heavy storm that had splintered large parts of the central Arctic ice cover this summer. At the 3rd September we reached the northernmost position at 81°22’N, 7°58’E at the eastern flank of the Yermack Plateau and took in addition to the CTD cast a Multicorer and a multiple net cast. The sea ice field became denser and drifted northward with 1 kn so that we decided to return south-eastward. During the entire excursion CTD stations were taken in about 8 nm distance and every third station an Apstein net was taken for phytoplankton samples. At 4th September we finished the last CTD cast at the southern slope of the Litke Trough and returned southeast-wards to the “Hausgarten” area in time to recover a 24-h respiration experiment bottom lander.

During the 5th September we sampled 4 Multicorer/CTD stations and recovered a long-term biological mooring FEVI-11. A swivel near the sediment trap showed strong corrosion so that we were lucky to have recovered the mooring in due time. In the meantime, westerly winds had spread the sea ice field eastwards into the Hausgarten area. Because of the ice we had to remove Posidiona from the moon pool and to close the moon pool with a lid. At the eastern rim of the Molloy Deep a thin (ca. 1 km) strip of thick ice with ridges moved southward with up to 1.8 kn indicating a strong anticyclonic motion around the Deep. In the night of the 7th September we finished operating in the Hausgarten with deployment of a lander for continuation of long-term visual sediment observations and sampling and returned to 78°50’N to complete the oceanographic mooring and CTD section.

Steaming westward, we came quickly in denser ice coverage. At the position of mooring F9-8 the ice cover was more than 8/10 and the flows were several 100 m wide. After reinstalling Posidonia we verified exactly the position of F9-8. Fortunately the local ice field and the excellent manoeuvrability of the ship allowed to establish temporarily a small ice-free area so that the mooring could be released in open water. Soon the ice cover closed again but the mooring could be recovered in dense ice without problem. Since steaming back and forth through the ice would have been too time-consuming we deployed the new mooring during the same night. We were rewarded with a bright full moon which at times was surrounded by a halo. During the night we continued with CTD stations and - every 20 nm - with Multiple Net stations.

West of 1°W the ice flows became larger but also the leads became wider. The westernmost mooring, F10-8 at 78°50’N 2°W, was critical since the top element had surfaced in June and it was unclear how much of the mooring was still on the ground. At the mooring position, it turned out that the releaser was still at the bottom. A wide ice-free area seemed to allow us to release the mooring and to have enough time even for potential salvage operations. The mooring started to rise but the rising slowed down until the mooring remained 100 m below the surface. In the meantime the ice field had accelerated and the mooring got under the ice. We remained at the site until the following morning tracking the mooring with Posidonia and hoping that the ice situation would change again to our favour but it remained below a kilometre-wide ice flow so that it was finally lost.

The dense ice field forced us to leave our CTD/lADCP/Multinet line along 78°50'N and make a detour to the south. A low pressure system centred at 74°N and wind up to 7 Beaufort drove the ice at 78°30'N westward with speeds up to 2 kn. According to available ice maps an ice-free tongue extended north-westwards towards Greenland so that at 11th September we made a last try to get northward. After three last northern CTD, multinet and Multicorer stations we headed southwards towards Iceland. On our way south, we moved along an ice stream which was aligned with the shelf edge where we took 3 Multicorer stations at about 2000 m for a study of meridional nematode distribution. At the lovely and sunny morning of 13th September we reached 74°N 18°W close to the Greenland coast and, surveyed by one of the rare gyrfalcons, successfully recovered a last mooring from the IfM Hamburg which had been unaccessible under heavy ice during MSM02/2 when the recovery was planned originally.

Because of the many failures of crucial ships equipment of the shipyard management had asked us to skip on of the research days in favour of additional repair time in Reykjavik. Due to the excellent work of crew and scientists as well as to optimal weather conditions this was possible with only little loss in the scientific programme so that we reached Reykjavik

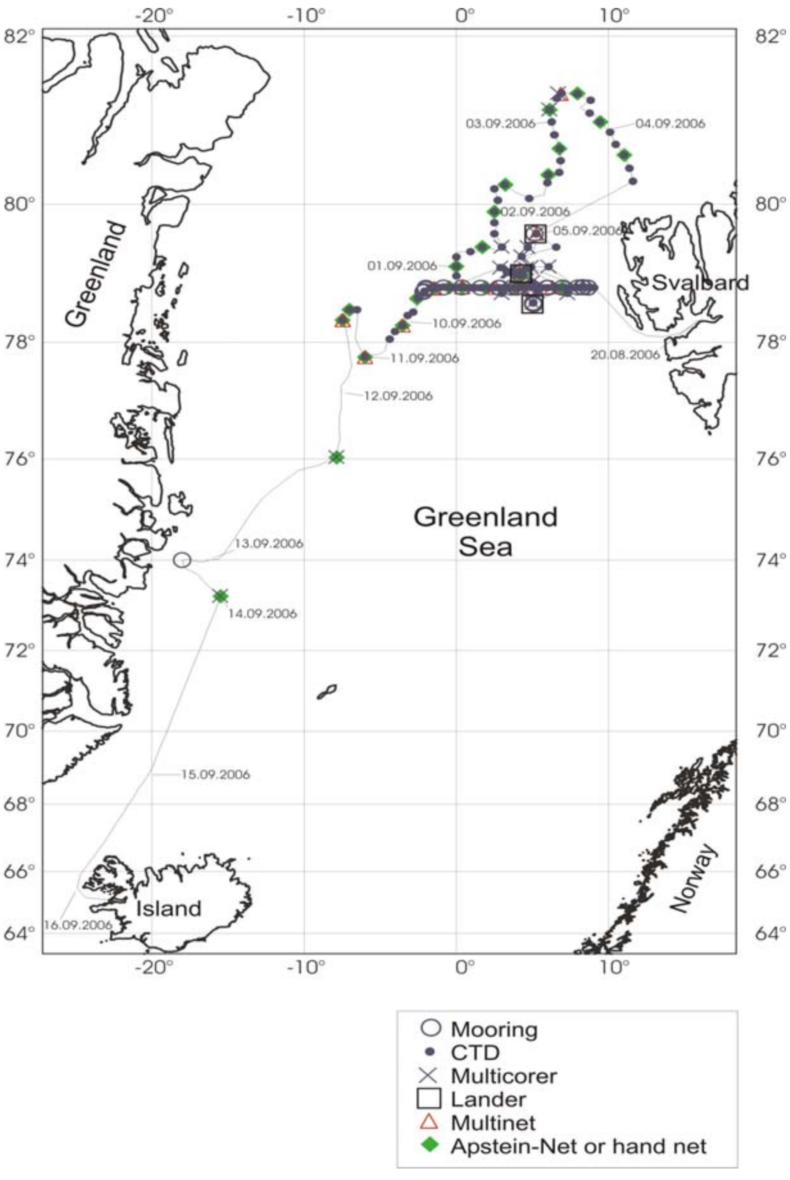

Figure 1: Cruise track of MSM02/4, August 20 to September 16, 2006