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RE	Restricted to a group specified by the consortium (including the Commission Services)	
CO	Confidential, only for members of the consortium (including the Commission Services)	

ACCESS NEWSLETTER

Arctic Climate Change
Economy and Society

Issue No. 5
April 2013

ACCESS Highlights

Fieldwork on the Arctic sea ice with melt ponds as part of the Polarstern cruise ARK-XXVII/3 and Polar 5 airborne campaigns PAMARCMiP and TIFAX in 2012 (see inside). Photo courtesy of Marcel Nicolaus from the Alfred Wegener Institute for Polar and Marine Research

This newsletter is produced three times each year by a consortium of 27 partner organizations from 10 European countries in the 4-year Arctic Climate Change, Economy and Society (ACCESS) project. ACCESS is supported within the Ocean of Tomorrow call of the Seventh Framework Programme. Objectives of the ACCESS Newsletter are to facilitate international, interdisciplinary and inclusive information sharing of our research highlights about natural and human impact associated with sustainable development in the Arctic Ocean in the context of climate change.

SEVENTH FRAMEWORK PROGRAMME

www.access-eu.org

Editorial

This newsletter presents the diverse fieldwork activities undertaken by the ACCESS consortium in 2012 during the second year of the ACCESS project. This was already announced in a previous ACCESS Newsletter N°2 (Fig1) as a tentative plan and this newsletter is a good indicator of the accomplishments of ACCESS during 2012.

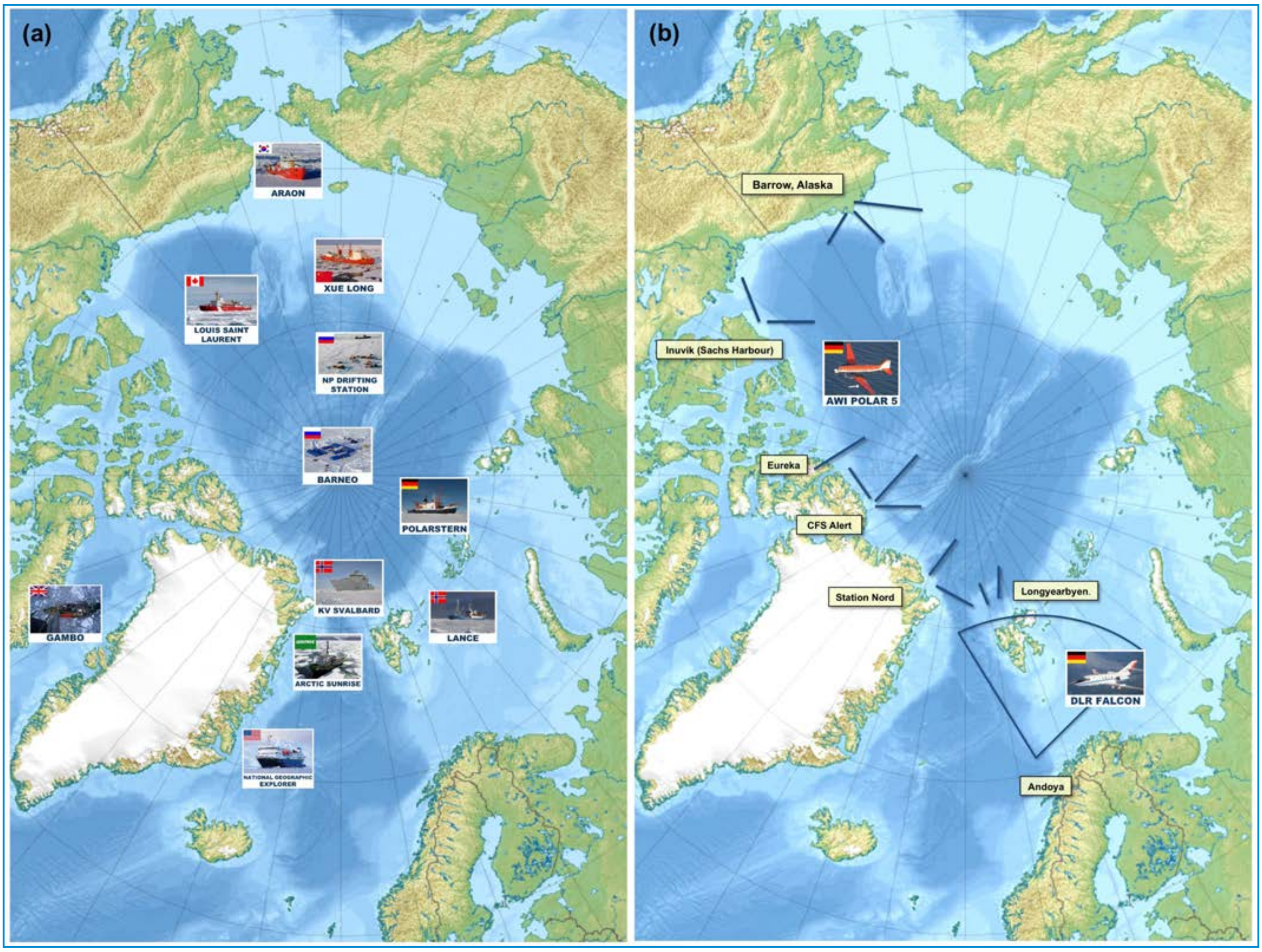

Figure 1: Maps of anticipated (a) shipborne and (b) airborne fieldwork in the ACCESS project in 2012, as described in ACCESS Newsletter No. 2 from 29 February 2012. Locations of the completed fieldwork in 2012 may v ary from these initial images.

Half of the contributions deal with the Arctic Ocean environment in the context of climate change (ACCESS WP1). The main contributions came from the Arctic and Antarctic research Institute (AARI); the Scottish Association of Marine Sciences (SAMS) along with the British Antarctic Survey (BAS); the Norwegian Polar Institute (NPI); the Alfred Wegener Institute for Polar and Marine Research (AWI); the University Pierre et Marie Curie (UPMC). Several important and critical aspects of air-ice-ocean interactions throughout the year (AARI, UPMC) and in summertime (SAMS, NPI, AWI) were explored at a time of a record minimum Arctic sea ice retreat reached in September 2012.

Two contributions covered fisheries activities (ACCESS WP3). One contribution from the Beijer Institute of Environmental Economics was related to human behavioural responses to potential abrupt changes in fish stock. The second contribution from the Arctic Centre at the University of Lapland was an in depth investigation of the current state of coastal communities in the Barents region under changing environmental, economic and political conditions.

The contribution from Nordic Bulk Carriers (NBC) provided information about shipping activities along the Northern Sea Route (ACCESS WP2). 2012 was a breakthrough in all aspects for NBC that used full vessel capacity including the two most modern and biggest ice class vessels to fulfil the safety requirement along the NSR.

Air pollution impacts from local shipping (ACCESS WP2) and oil platforms (ACCESS WP4) in the Arctic Ocean area as well as from remote sources (Kola Peninsula) were assessed by the German Aerospace Centre (DLR). A total of 13 flights were conducted all along the coast of Norway up to Spitsbergen from the main station of Andoya with the DLR research aircraft "Falcon". These measurements will be used to validate model simulations and will help in turn to improve model predictions of the future development of Arctic pollution.

Some initially planned fieldwork could not be completed in summer 2012 and were cancelled and other fieldwork were postponed until 2013 such as the dedicated iceberg study that will be conducted from the UK schooner Gambo in West Greenland Fjords in spring-summer 2013.

This newsletter concludes with few snapshots of ACCESS fieldwork that is planned in 2013. There will be a new expedition to the North Pole (Barneo Station) in April 2013 to study the Arctic transpolar drift from the North Pole to Fram Strait located more than 1000km to the South. This is a cooperation between ACCESS and the French project IAOOS (Ice Atmosphere Ocean Observing Studies). A second major activity will be another intensive airborne campaign with the AWI Polar 5 aircraft to measure the evolution of sea-ice thickness over a large region of the Arctic Ocean. The third major ACCESS fieldwork activity will be a participation to the French schooner Tara circum Arctic expedition starting in May 2013 from Lorient (France) and ending in Lorient in December 2013. This expedition will cover the North East and North West passages during the same summer season (July to September 2013) collecting samples for studying plankton genome and physical and biogeochemical characteristics of Arctic shelf seas. The 2013 ACCESS fieldwork activities will be presented in a dedicated ACCESS newsletter in 2014.

Interdisciplinary Fieldwork in the ACCESS Project

Ocean-Atmosphere-Ice and Snow interactions

Arctic and Antarctic Research Institute (AARI - Saint Petersburg, Russian Federation)

North Pole Manned Drifting Station (NP-39)

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ACCESS WP 1

The scientific program of observations at Russian North Polar (NP) drifting stations is always arranged as multidisciplinary research, covering all major components of the Arctic climate system (Fig. 2). International cooperation is an essential component of NP functioning. The primary way of such cooperation, at present, is to deploy hi-tech measurement devices provided by partners in Europe. models overestimate the ice coverage in the Barents Sea and thus overestimate the seasonal variability (Fig. 1).

The goal of the NP programme is to provide permanent monitoring of meteorological, ice and oceanographic conditions in the central Arctic Ocean. The ice floe with NP-39 covered 1952 km within 353 days from 18 October 2011 through 11 September 2012 (Fig. 3). Average speed of drift of NP-39 was 5.5 km/day with maximum speed up to 31.4 km/day.

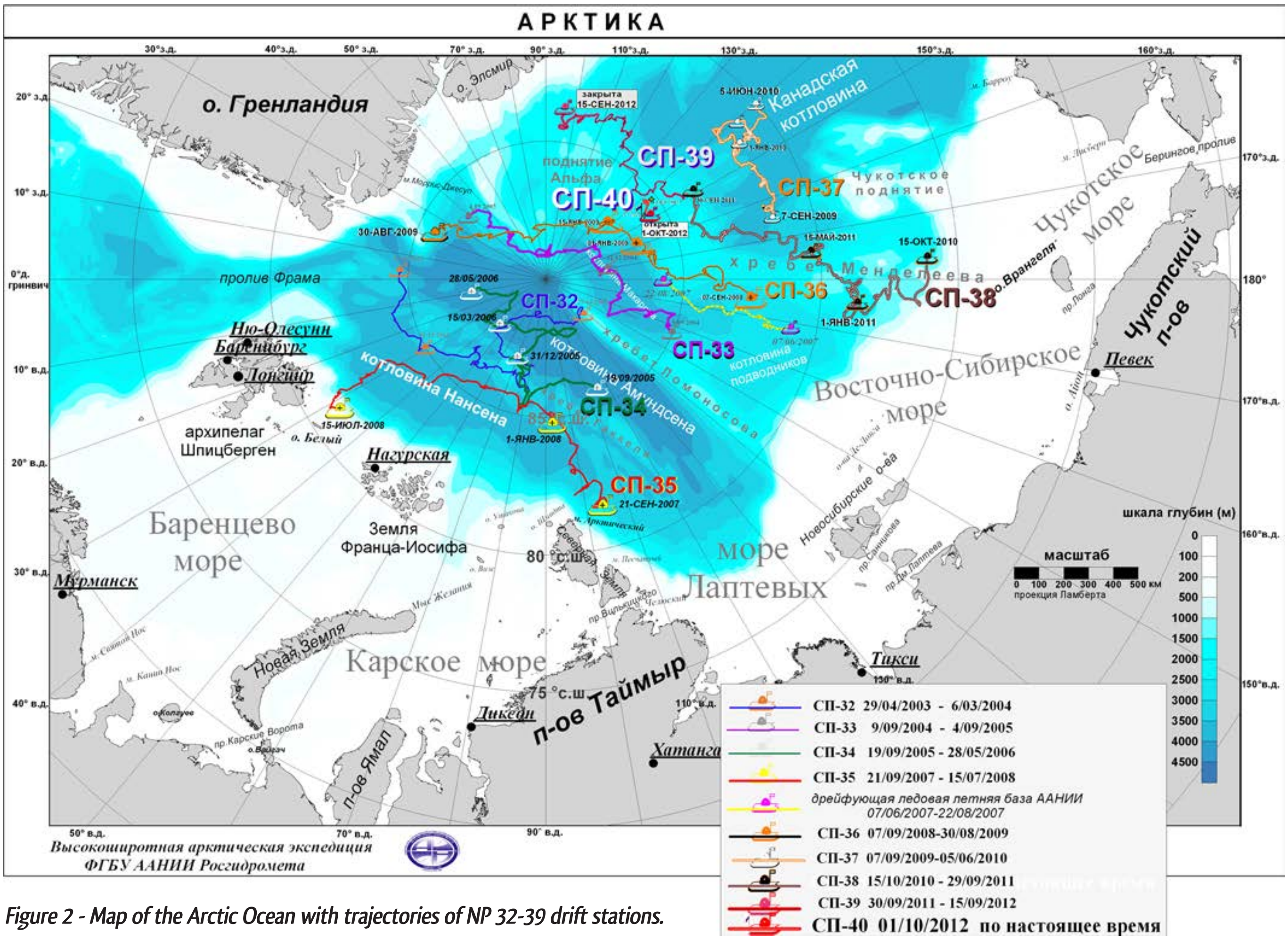

Figure 2 - Map of the Arctic Ocean with trajectories of NP 32-39 drift stations.

The main objectives and accomplishments of NP-39 in 2012 were:

Studies of polar atmosphere

Purpose of these studies was to get new information on various atmospheric properties and their temporal variation.

Surface routine meteorological observations (Fig. 3) were carried out every 8 hours (total number of records is 1408). Every minute sampling by automatic meteorological station MAWS420, CT-25K (total number of records was 504,000).

Actinometrical measurements, including all components of radiation balance (total number of measurements was 222).

Measurements of the atmospheric transparency (37)
Heat balance measurements inside snow, at the ice-snow interface and over the snow cover. Total number of measurements by MAWS420 was 365,760. Total number of measurements by Cambel CR1000 was 504,000.

Total ozone and UV radiation (800 measurements). Every minute registration of ozone (41,760 measurements) as well as greenhouse gases: carbon dioxide (487,480 measurements) and methane (160,160 measurements).

Temperature profiling from the surface to 1 km. Total number of profiles was 45,216.

Spectral albedo measurements (once every 10 days)

Snow cover surveys with RAMSES TriOS Optical Sensors PS101plus (123 measurements)

Aerological observations. Total number of sondes: 331.

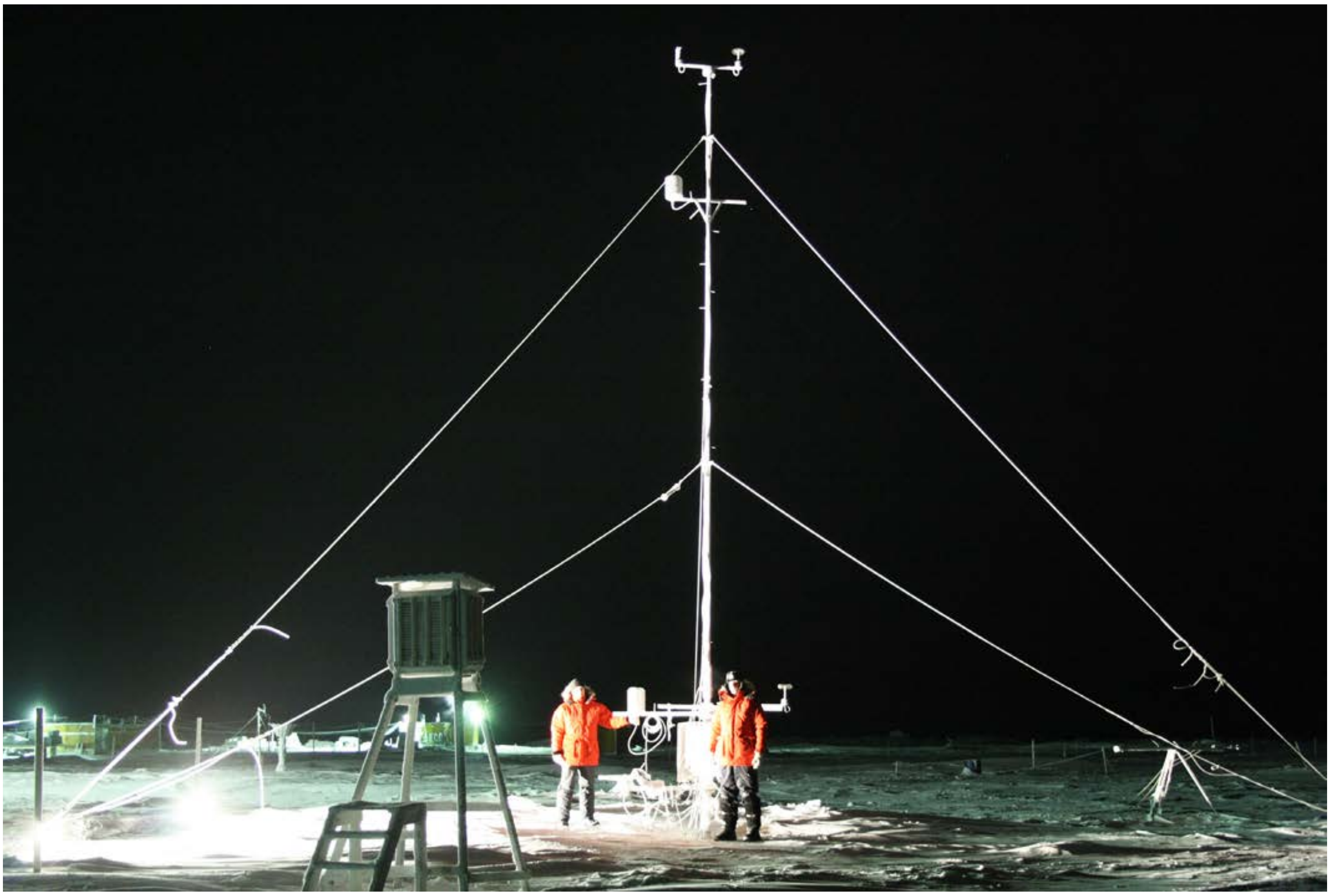

Figure 3 - Meteorological mast of instruments on NP-39. Courtesy of V. Ivanov

Physical oceanography

Purpose of physical oceanography investigations was to study structure and dynamics of water masses. The instrumentation included CTD SBE37SM MicroCat to measure temperature and conductivity at different depths along with the WHS300 Sentinel and WHLS75 LongRanger to measure current speed and direction. Total number of CTD profiles was 325.

Hydrochemistry and hydrobiology

Purpose of these investigations was to study hydrochemical regime and its spatio-temporal variations. The following elements were sampled: dissolved oxygen, nitrates, phosphates and silicates at standard horizons. Total number of hydrochemical samples was 1128. Total number of plankton measurement was 17.

Atmospheric aerosol and, snow

Purpose of these measurements was to assess contamination. Aerosol sampling was done 1-2 times a month. Snow sampling, total number of samples was 24.

Morphometry and dynamic properties of sea ice cover

Purpose of these studies was to determine sea ice seasonal evolution. Direct measurements of ice and snow thickness were carried out over the polygon of 28-36 points. Total number of surveys was 30. Remote measurements were done by means of electromagnetic profiler BM31Ice (28 surveys, with 10 profiles per survey). Dynamical properties of the ice floe were measured with seismic devices.

Université Pierre et Marie Curie (UPMC-LOCEAN, Paris, France)

ACOBAR Ice drift station deployed at the North Pole in April 2012

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Christophe Schaeffer (NKE – France) and Nicolas Lefevre (Aquatec – UK)
ACCESS WP 1

This operation was done in cooperation with the French funded project IAOOS (Ice-Atmosphere-Ocean Observing System) led by C. Provost (UPMC/LOCEAN) and J. Pelon (UPMC/LATMOS) in Paris (France).

From August 23-31, 2012, the Norwegian Coast Guard icebreaker and offshore patrol vessel K/V Svalbard participated in an ACOBAR/ ACCESS campaign in Fram Strait (fig. 4). Part of the mission led by Stein Sandven, director at the Nansen Environmental and Remote Sensing Center (NERSC), Bergen, Norway, was to recover the ACOBAR platform deployed 5 months earlier (April 15, 2012) at the Barneo ice camp (fig. 5) established near the North Pole by Russian logistics operating from Longyearbyen, Svalbard.

The ACOBAR platform (fig.6a), the so-called AITP (Acoustic Ice Tethered Platform) was equipped with a CTD ocean profiler (similar to an Argo float) developed by NKE (France) and an Ice Mass Balance (IMB) system developed by SAMS (UK). The ocean profiler was operating on a daily basis to cast CTD vertical profiles (temperature and salinity versus depth) from surface down to 800m depth approximately. The IMB was measuring ice and snow thickness and vertical temperature profiles across the air-snow-ice and ocean interfaces. Both the IMB and the AITP were equipped with Global Positioning System (GPS) and an iridium modem located in a surface buoy for satellite data transmission in near real time.

Figure 4 - K/V Svalbard - © Marcusroos-(left) and R/V Lance-courtesy of Mats Granskog (Norwegian Polar Institute)-(right) in the Arctic Ocean in 2012

Unfortunately the first attempt made by K/V Svalbard to recover the AITP drifting station in Fram Strait failed because the AITP was still too far North (82.6˚N and 2.93˚E) and out of reach from K/V Svalbard located at about 79˚45˚N and 0˚ longitude at the end of August. We had to wait for another month to pick up the instruments.

On October 4, 2012, the Norwegian Research vessel R/V Lance (Fig.4) from the Norwegian Polar Institute (NPI) working along side the ice edge in Fram Strait, searched for and recovered the AITP deployed 6 months before at the North Pole. At that time the buoy had reached 79.66˚N and 1.8˚E (Fig. 6b). Recovery was time limited and complicated because of darkness. But the AITP was recovered very successfully on board K/V Lance by crew and scientists led by Frank Nilsen from UNIS (Svalbard).

Figure 5 - Barneo Ice Camp in the Arctic Ocean.
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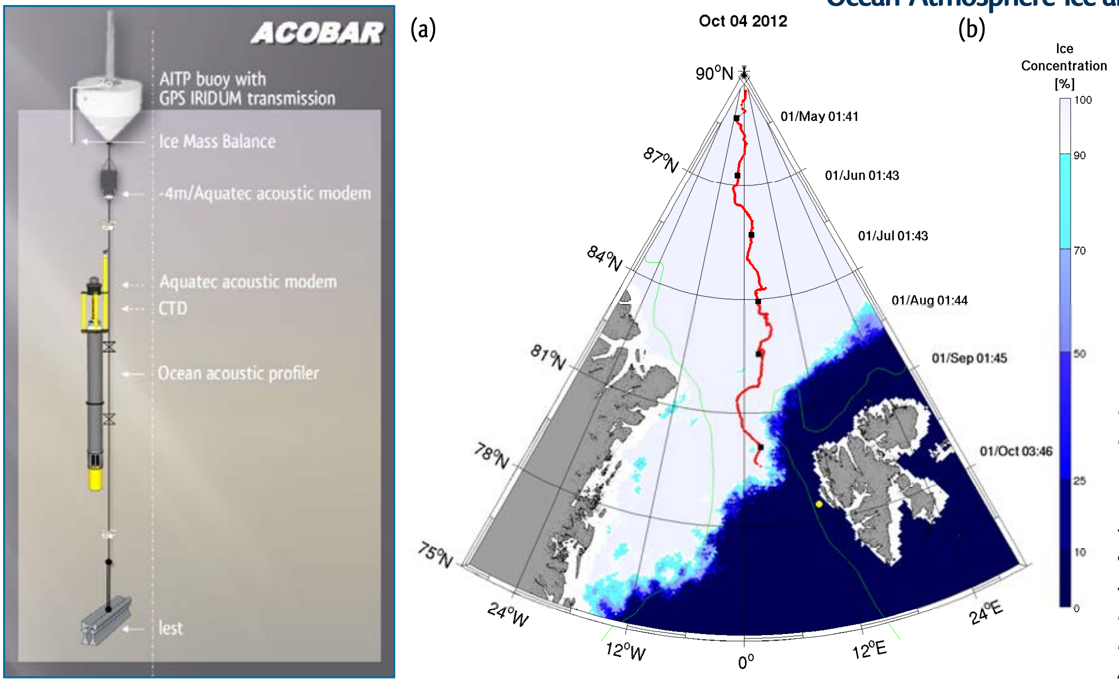

Figure 6 - (a) Acoustic Ice Tethered Platform (AITP) that was deployed from the Barneo Ice Drift station at the North Pole and recovered in the Fram Strait in October 2012 by the R/V Lance after (b) drifting in the Arctic Ocean since April 2012

First results:

Due to an early iridium transmission failure of the AITP, but thanks to the good functioning of the SAMS IMB, the recovery of all the instruments was very profitable to establish a diagnostic of the problems and to retrieve number of ocean CTD vertical profiles. These profiles will be compared with those taken 10 years ago along a similar track and at about the same period (May). Both set of profiles revealed the presence of a surface salinity front at about 87°N separating the Arctic Ocean in two distinct regions influenced by the North Atlantic Ocean on one side and by the North Pacific Ocean on the other side.

Taking advantage of the full functioning of the IMB data transmission, we were able to analyze the thermistors chain data (Fig. 7). The SAMS IMB not only measures snow and ice temperature at loosely spaced intervals (2 cm), but also snow depth and ice thickness versus time. This is possible due to heating resistances incorporated into thermistors chain.

Essentially the thermistors are heated during 120 seconds and the temperature increase is measured twice at 30 and 120 seconds intervals respectively. The ratio between these two temperatures increases, allows us to determine the position of the air/snow/ice/ocean interfaces. As it is shown in Figure 8, orange red areas correspond to the ocean layer; yellow green areas identify the ice layer and the light blue domain is related to the snow.

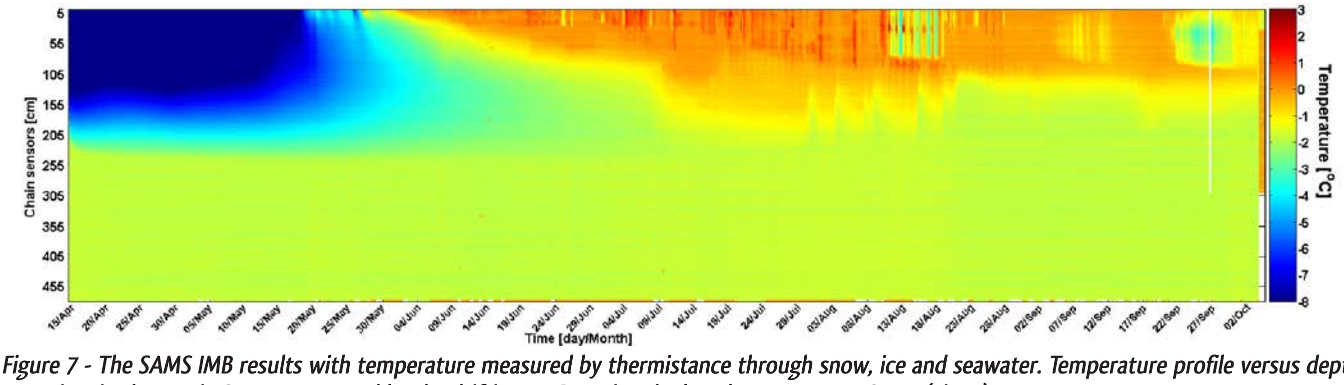

Figure 7 - The SAMS IMB results with temperature measured by thermistance through snow, ice and seawater. Temperature profile versus depth over time in the Arctic Ocean, measured by the drifting AITP station deployed at Barneo Ice Camp (Fig. 6)

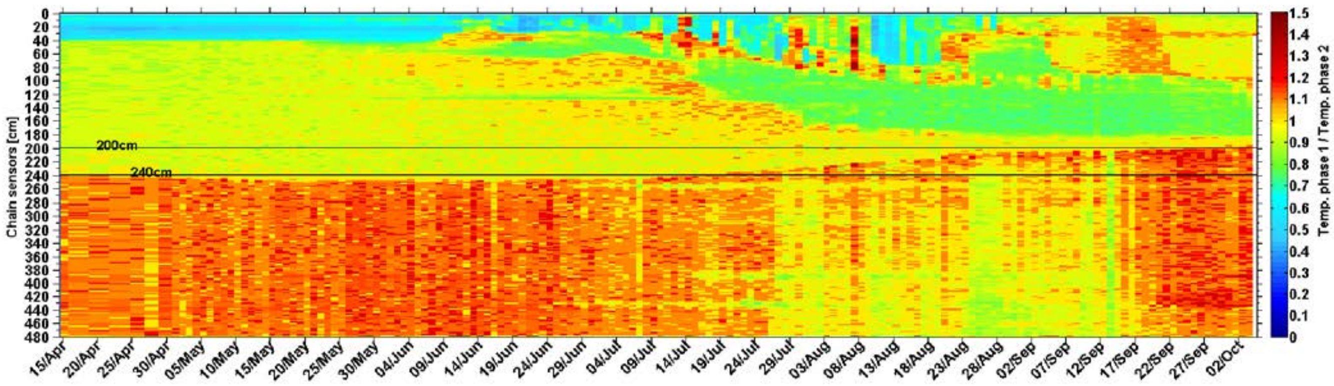

Figure 8 - SAMS IMB results showing the ratio between increased temperatures (by heated thermistance) measured after 30 s and 120 s, revealing the snow-ice and ice-ice water interfaces

Scottish association for Marine Sciences (SAMS- Oban,UK)

Collaboration with the Korean Polar Research Institute on the Araon

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ACCESS WP 1

Synopsis of the cruise (Purpose and Scope):

During the summer of 2012 two SAMS scientists (Phil Hwang & Bernard Hagan) participated in a Korean Polar Research Institute (KOPRI)-led Arctic campaign on-board the South Korean icebreaker Araon. This interdisciplinary and multinational research cruise included scientists from South Korea, Japan, China, United Kingdom and Germany. Scientific areas of research included: hydrological and geological surveys; atmospheric observations; chemical oceanography; plankton ecology; biodiversity; ocean optics; and sea ice dynamics. Our primary purpose was to deploy ACCESS and KOPRI sea ice mass balance buoys (IMBs) as part of our Work Package 1 deliverables. Other responsibilities included the deployment of buoys from other collaborative programmes, such as the SATICE buoys and CRREL IMBs. We also obtained auxiliary information on sea-ice properties and ocean wave dynamics.

The original cruise plan was extended to 79°N, covering the Chukchi Borderland and Mendeleyev Ridge (south). However, because of the extreme 2012 sea-ice melt, no suitable sea-ice floes for the buoy deployment were found at this latitude. In fact, it was only when the ship traveled to more than 82°N that adequate sea-ice conditions were found (more than 80% ice concentration). The deployment region was the north-most tip of the cruise track shown in Figure 9. This was a very unusual year and meant a significant deviation from the original cruise plan. We are very thankful to KOPRI for their support, flexibility and understanding. We successfully deployed ACCESS/KOPRI IMBs and other collaborative buoys, conducted helicopter surveys and acquired satellite SAR (Synthetic Aperture Radar) over the region.

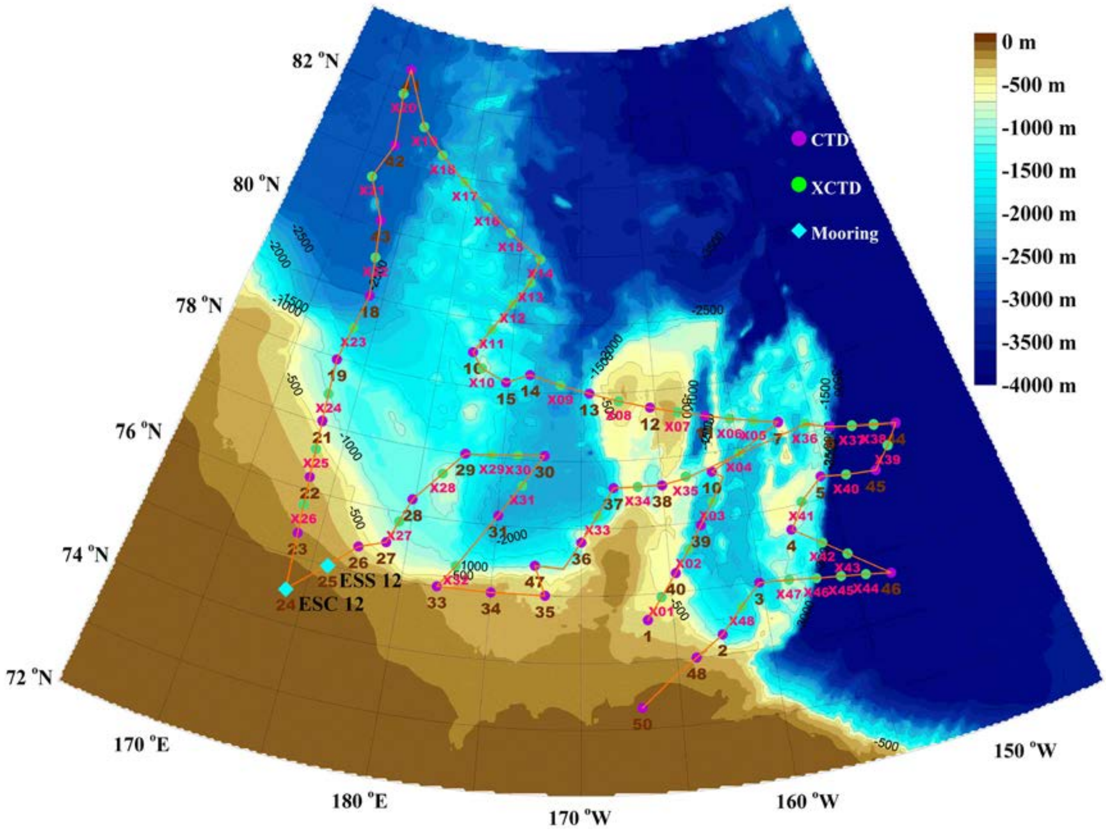

Figure 9 - Cruise tracks and CTD/XCTD stations during 2012 Araon Arctic cruise

In early August, near the start of the cruise, the ship encountered a violent storm, cited as 'The Great Arctic Cyclone of August 2012' in a recent paper (Simmonds and Rudeva 2012). The pressure at the centre of the storm was reported to be as low as 964 hPa (NSIDC, 2012). The wind speed observed on the ship was about 30 knots or more. During this period we observed a rapid reduction of sea ice concentration in the vicinity of the storm.

Discussion of preliminary results:

A total of 8 IMBs (ACCESS and KOPRI) were deployed at different locations on the same ice floe on 13 August 2012 at 82° 3'N and 170° 44'E. The deployment site represented thin (1 m) smooth ice and thick (3 m) ridged ice. This ice was most-likely first-year ice. This deployment allowed us to measure differential melt and growth rates at different ice types under the same oceanic and atmospheric forcings. So far the data show alternations of warm and cold water temperatures, depending on the ice drift. The warm water temperature was observed when the buoys drifted into an area where less sea-ice concentration was observed, and thus more solar warming. The data also revealed some indication of surface flooding and snow loading effects.

The collaboration between SAMS (via ACCESS) and KOPRI has been very productive for both sides. Collaborative research papers are being written, and more research opportunities are being planned in the future. Our hope is that the collaboration continues for the foreseeable future and develops into a long-lasting relationship. In summer 2013, we plan to continue to deploy IMBs and wave buoys from Araon.

The 2012 minimum sea ice extent in the Arctic Ocean broke all records. The vulnerability of the Arctic ecosystem was clearly witnessed during this cruise when, on 1 September 2012, the ship encountered a polar bear swimming in the ocean. The nearest land was more than 400 km to the south, and the nearest ice edge was more than 600 km to the north – nowhere to go for the polar bear except a very small isolated ice floe (Fig. 10). The tag on the polar bear's ears indicated that he had human contact. He approached the ship three times, but finally went back to the floe and floated away, looking tired and hungry. The fate of the bear is unknown, yet it is a dramatic realisation of the impact climate change can have on the Arctic ecosystem.

Figure 10 - A lonely polar bear on a very small isolated ice floe floating in the ocean. Courtesy of Phil Hwang (SAMS)

Réferences

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Norwegian Polar Institute (NPI- Tromso, Norway)

The Ice Cruises on R/V Lance

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The energy balance of spring/summer first year Arctic sea-ice were the primary focus for the sea ice/oceanography group of the Norwegian Polar Institute (NPI) during the 2012 field season. ACCESS activities were carried out in three locations in the Arctic Ocean. The season started as early as March in Barrow, Alaska, where the scientists from NPI in collaboration with scientists from Cold Regions Research and Engineering Laboratory (USA) established a study site on level landfast ice off Point Barrow. Since the seasonal changes in the optical properties and topography of sea ice surface were the primary goal of the work, the site was revisited later on a daily basis in May-June. The Barrow campaign was not terminated until fast ice became unsafe to work on, yielding a detailed record of the surface topography, melt pond area, ice/snow albedo and transmissivity of sea ice from winter conditions to advanced melt and melt pond formation. Special focus was put on the melt ponds, which are important for the transmission of solar energy to the ocean below the sea ice.

The work continued during two cruises onboard research vessel R/V "Lance" to the north of Svalbard at ca. 83oN in late July-early August and in Fram Strait at 79oN in August–September. The July–August ICE cruise, with its eight day-long ice station features the most comprehensive set of experiments of the energy budget of the current thinner Arctic first-year ice pack. The sea ice station was established on an approximately 600 m long first-year ice floe with an average thickness of about 0.8 m according to the EM-measurements.

The timing of the ICE cruise appeared to be perfect: the surface of drift ice in the study area was covered by well-developed melt ponds and this appeared to be representative for the study region (Fig. 11). Most of the melt ponds were connected with the ocean as some ponds had already melted through.

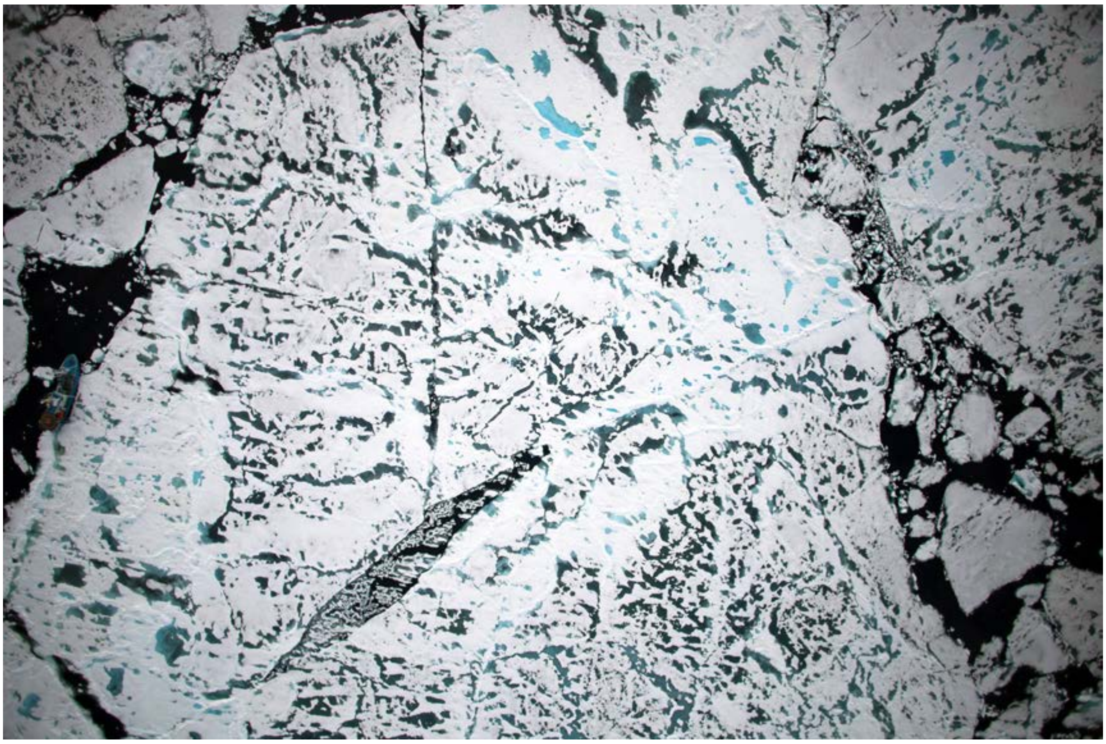

Figure 11 - Aerial photo of sea ice floe occupied during the ICE cruise on R/V Lance taken with the ICE stereocamera system. R/V Lance can be seen at the left of the ice floe (length of ship about 60 m). Courtesy of the Norwegian Polar Institute

The objective was to gather the first complete set of measurements of the energy balance of thin first-year sea ice in the high Arctic. The ocean component measured the heat flux from the ocean to the bottom of the ice using a set of various sensors mounted on a 5-m long submerged mast. The on-ice measurements were carried out using a mobile "radiation sled" platform (Fig. 12) to measure the surface radiation energy balance and an automatic weather station to measure the other atmospheric heat fluxes. At two selected sites the rotary laser was used for mapping the sea ice surface topography including melt ponds. The diving team worked in parallel along some selected transects quantifying the light transmission through ponded sea ice (Fig. 13). Ice thickness, small-scale sea ice topography and melt pond area fraction were studied from helicopter equipped with EM-bird instrument and ICE stereo-camera system.

During the 2012 summer field season NPI deployed for the first time the ICE stereo-camera system intended for mapping the sea ice surface topography and aerial photography. The system comprises two Canon 5D Mark II cameras, combined GPS/INS unit and a laser altimeter mounted in a single enclosure outside the helicopter (photo). The unit is controlled by a PC-chassis mounted inside the helicopter cabin. Being highly automated it requires a minimal human supervision during operation.

Figure 12 - Scientists from NPI measuring radiative energy balance of ponded sea-ice using the "radiation sled." Courtesy of Tor Ivan Karlsen (Norwegian Polar Institute)

Figure 13 - SCUBA diving under the sea ice to measure ambient irradiance. Courtesy of Peter Leopold (Norwegian Polar Institute)

The first season of the camera system appeared to be very successful. It has proven to be highly reliable and was used in about 30 flights over Arctic sea-ice during July-September. The deployment of the camera system was mostly done in combination with EM-bird, which measures sea ice thickness, providing an integrated view of sea ice cover along the flight tracks. Some 35000 images of sea ice/water surface captured per camera sums into 6 Tb of data collected during its first field season.

During the flight the cameras shot sequentially with a time interval of 1 second each to ensure sufficient overlap between subsequent images. The reconstruction of the 3D scenes of sea ice surface will be done using available commercial software. Refraction at water/air interface will be taken into account, providing the valuable data on melt pond coverage, depth and bottom topography –the primary goals for the system at its present stage. Preliminary analysis of the images has already clearly demonstrated a good potential of the ICE stereo-camera system (Fig. 14).

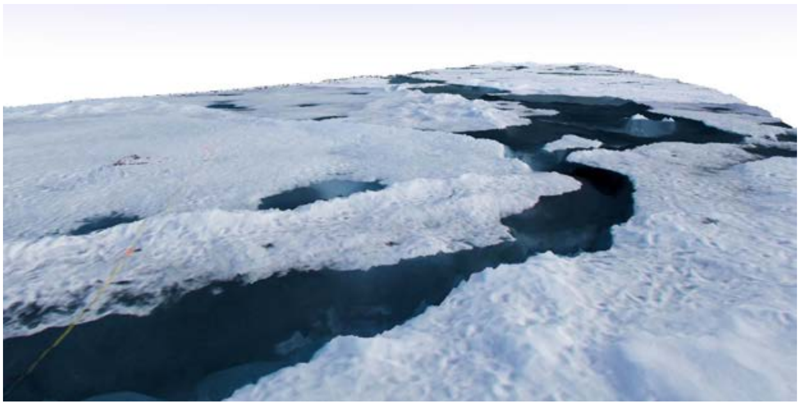

Figure 14 - Images of the first reconstructed 3D scene of the sea ice topography. Courtesy of Dmitry Divine and Harald Faste Aas (Norwegian Polar Institute)

The last major sea ice-related cruise of the season in Fram Strait in August-September featured a successful recovery and redeployment of the moorings equipped with upward looking sonars (ULS). The array of 5 moorings is revisited annually providing continuous data series on sea ice draft and hence an estimate of sea-ice thickness variability across Fram Strait. Most of the sea ice work was carried out remotely using the EM-bird and ICE stereocamera system; specific attention was devoted to flying downstream the positions of the moored ULSs. The on-ice work was limited to relatively short ice stations mainly for ice thickness drilling/ground-based EM scanning and ice cores retrieval. The sea ice cover observed in Fram Strait was generally thicker, featuring a range of ages from nilas to multiyear ice, and more ridged than the pack ice north of Svalbard observed earlier this year. The data analysis from the summer campaigns has just begun and we hope for new promising results to contribute to a better understanding of the physical processes behind the recent rapid changes in Arctic sea ice.

The Alfred Wegener Institute for Polar and Marine Research (AWI- Bremerhaven, Germany)

Polarstern cruise ARK-XXVII/3 and Polar 5 airborne campaigns PAMARCMIP and TIFAX in 2012

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Over the last 30 years, the areal extent of summer sea ice has declined at a rate of 11.2% per decade. Sea ice thickness is the key property for summer minimum sea ice extent. During the last decade, an increased advection of thick multi-year ice that originates from an area north of Greenland, out of the Arctic through the Fram Strait has been observed. A replacement of this old and thick sea ice by much thinner ice might precondition for rapid sea ice retreat in summer. The AWI sea ice group participated in a Polarstern cruise (ARK-XXVII/3) to the interior Arctic and conducted the PAMARCMIP and TIFAX campaigns with the polar research aircraft Polar 5.

The expedition ARK-XXVII/3 (IceArc, 02 August – 08 October 2012) of the German icebreaker RV Polarstern was a highly interdisciplinary cruise to the Arctic Ocean (Fig. 15). Main focus of the cruise was the consequences of the retreating sea-ice cover for the Arctic Ocean and its ecosystems.

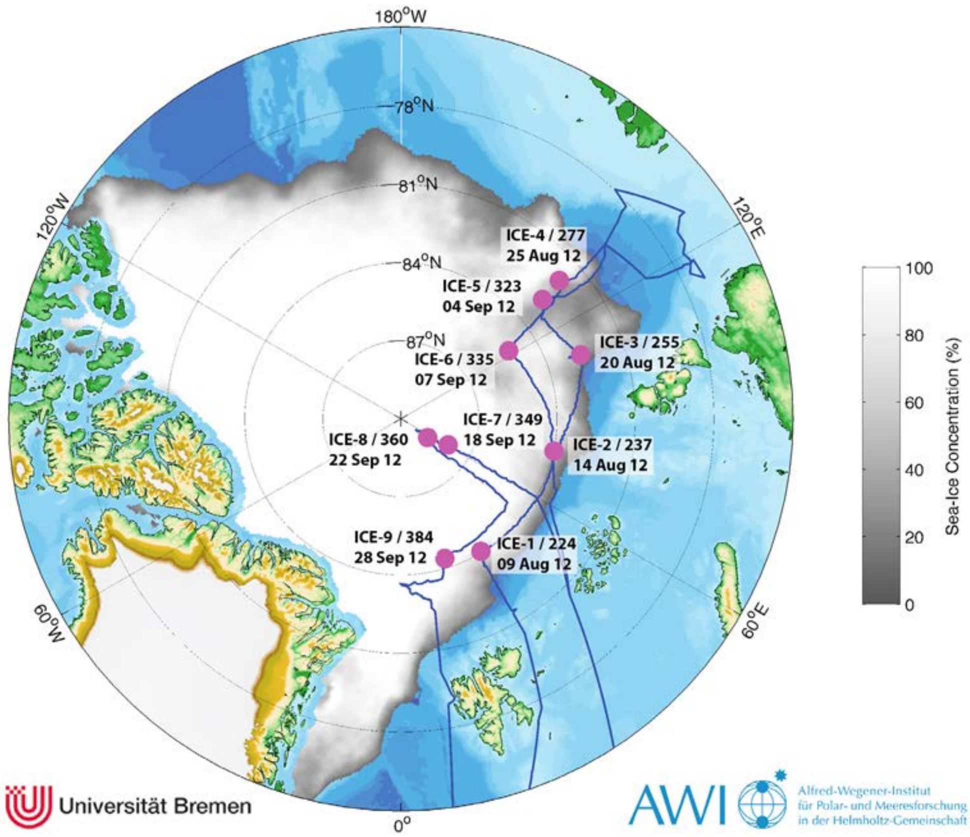

Figure 15 - Station map of the Polarstern cruise ARK-XXVII/3 in 2012

Sea-ice thickness was measured with airborne electromagnetic induction sounding (EM-bird) during flights with more than 3500 km of profile data. These data show similar sea-ice thickness distributions than during a similar cruise in 2011, but significantly thinner sea ice than a decade ago. More large-scale sea-ice observations were obtained from regular bridge observations during the entire voyage through the sea ice, following an international standard protocol. Sea-ice sampling by means of ice cores was conducted during all 9 sea-ice stations in close cooperation with all groups on board. In total 385 cores were drilled to be analyzed for a large variety of physical, biological, and geo-chemical parameters at each ice station. Station time was between 30 and 72 hours. The first ice station was re-visited after 7 weeks of free drift, covering the transition from summer melt to autumn freeze-up. Autonomous stations recorded successfully different components of the sea-ice energy- and mass balance and meteorological conditions. In order to obtain more time-series data of sea-ice and oceanographic conditions, also beyond the cruise, a variety of buoys was deployed in cooperation with different partners of the International Arctic Buoy Program. Studies of the ice-underside and the uppermost ocean under the sea ice were performed with a remotely operated vehicle (ROV). The ROV was launched from the sea ice and for 38 dives, in particular, light conditions under sea ice were mapped (Fig. 16). These data show significant differences between different ice types as well as the spatial variability of organisms and biomass under sea ice.

The objective of the PAMARCMiP (Polar Airborne Measurements and Arctic Regional Climate Model Simulation Project) and TIFAX (Thick Ice Feeding Arctic Export) campaigns was to monitor ice conditions during spring and summer, especially in the main export pathway of the Arctic Ocean. The major aim of both campaigns is the large-scale measurement of sea ice thickness in key Arctic areas. During the flights of PAMARCMIP and TIFAX, the EM-bird is towed by the research aircraft Polar 5 (Fig. 17). The instrument is pulled under the hull of the aircraft by means of a winch for takeoff and landing. For ice thickness surveys, the probe is towed on an 80 m long rope twenty meters above the ice surface.

Figure 16 - R/V Polarstern in the background with a remotely operated vehicle (ROV) in the foreground. Courtesy of Marcel Nicolaus (AWI)

Figure 17 - Polar 5 and Danish Twin Otter at Alert. Courtesy of L. Schmidt (AWI)

The PAMARCMiP project is organized around the capacity of the Polar 5 aircraft to provide unique data of aerosol, meteorological conditions, as well as sea ice thickness in the high Arctic. The strategy is to obtain snapshots of critical parameters in order to close gaps in our understanding of Arctic conditions and processes. The PAMARCMiP 2012 campaign started from Longyearbyen, Svalbard, eastbound to Resolute Bay, Nunavut. The PAMARCMiP campaign has been performed from 17th of March to 9th of April 2012, whereby 15 research flights were done (Fig 18). The research flights commence out of Longyearbyen (Svalbard), Station Nord (Greenland), Alert (Nunavut), Eureka (Nunavut) and Resolute Bay (Nunavut).

One of the highlights was the concomitant flight with a Danish Twin Otter from Alert to validate the CryoSat 2 sea ice retrievals (Fig 17). Similar sea ice conditions as in April 2009 and April 2011 were found, characterized by reduced occurrence of multiyear ice.

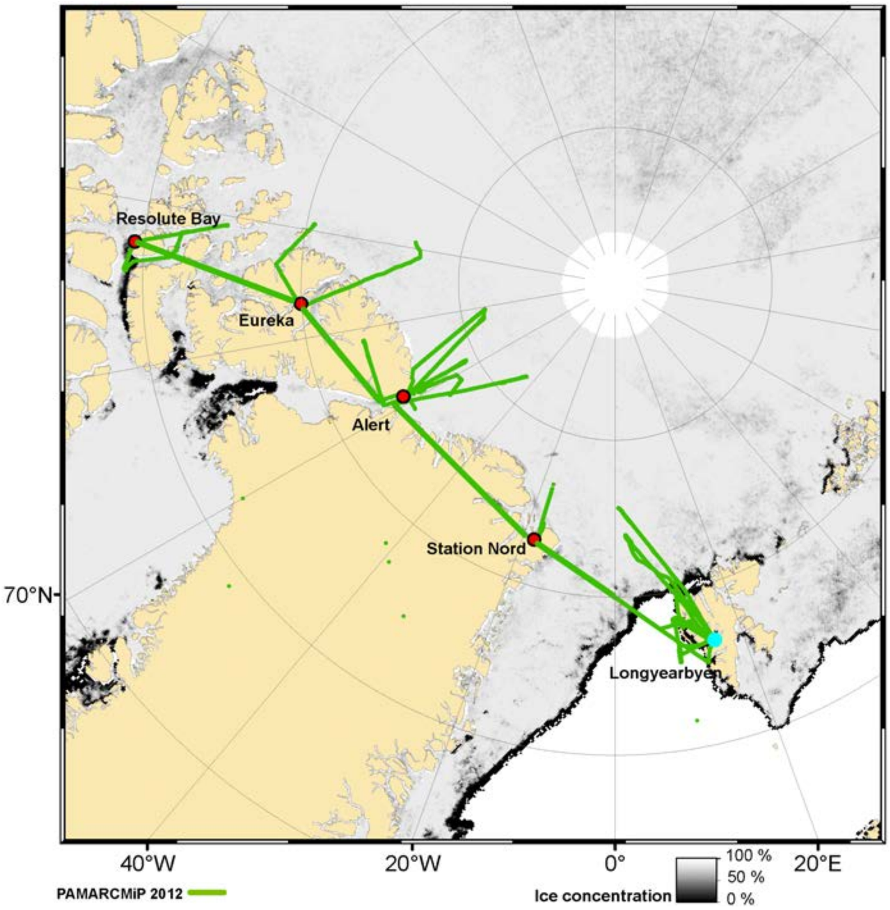

Figure 18 - Flight map during the PAMARCMiP campaign in 2012

The TIFAX campaign took place in summer 2012, following TIFAX campaigns in 2010 and 2011. In total 3 flights were performed between 19th and 21st of July 2012 north of Greenland and across the Fram Strait. The ice thickness measurements confirm findings made on the basis of satellite imagery: The summer of 2012 was characterized by increased advection of thick multi year ice out of the Fram Strait. However, the first year ice was relatively thin compared to earlier summers. In 2013 are similar airborne measurements in the Arctic are planned, like PAMARMIP 2013 in April 2013 and TIFAX 2013 in August 2013.

Environmental Impacts on Fish Populations

Exploring Behavioural Responses to Potential Abrupt Changes in Fish Availability

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Finding ways to secure the provision of marine ecosystem goods and services in the Arctic, like the availability of fish, will not only come from a better understanding of ecosystem functioning, but also from better understanding of human behaviour, in relation to natural resource use. Traditional economic models of resource exploitation often rely on individual rationality. If behavioural deviations from the rationality assumption are present and not accounted for, they may lead to inefficient policies.

Eliciting behavioural responses to resource changes from relevant user groups is a way to assess whether one can expect such deviations and try to quantify their effects. In the past months, we have been evaluating an experimental design that will be used to collect data on how Arctic fishermen respond to potential abrupt changes in the availability of fish. This is important since Arctic marine ecosystems might undergo dramatic changes (due to e.g. climate change) in the near future that will most likely also affect the provision of ecosystem goods, like fish. For this first and crucial step we have used students (so-called laboratory experiments), mainly from Stockholm University.

In the laboratory experiments, which we performed during the calendar year 2011/ 2012, we tested how a potential abrupt drop in the renewal rate of the fish stock, and how various forms of uncertainty related to such a change, influenced behavioural strategies for exploitation and cooperation in situations where the fishing ground was shared by a group of users (3-4 students), representing a so-called common pool dilemma. In all our experiments communication was allowed. Overall, we performed 72 experimental sessions in which in total 266 people participated (Fig. 19).

Figure 19 - Experimental session at the Beijer Institute. Courtesy of Agneta Sundin (Beijer Institute)

We found that when there was no potential abrupt change in the renewal rate of the resource, the usual tragedy of the commons emerged in 62% of the cases. Groups that faced a resource renewal rate with a known critical threshold (where an abrupt drop in the renewal rate occurred), however, were more careful and more successful in their management and the usual tragedy of the commons emerged in only 10% of the cases. We argue that the threat of reaching a critical threshold triggered more effective communication within the group which enabled not only commitment for cooperation, but also knowledge sharing about the resource dynamics, which together can explain why these groups performed better. When there was a 50 percent risk of reaching a threshold, subjects responded to the uncertainty, and in a precautionary manner. There were significantly fewer tragedies observed than in the treatment without a potential abrupt change and significantly more tragedies observed than in the treatment with a critical threshold. These results suggest that it is not only the threat of reaching a critical threshold that triggers cooperative behaviour, but that subjects are also responding to the certainty of the threat.

These experiments have definitely resulted in some insights on potential behaviour and responses in relation to abrupt changes in the availability of the natural resource on which the user group depends. After having thoroughly evaluated the experimental design in the laboratory with students, the next step, which is ongoing, is to bring it to the field in order to test how Arctic fishermen respond (in this experimental setting) to potential abrupt changes in the resource they depend on and if their behaviour differs significantly from the students' behaviour. Moreover, we will to expand the experimental design by introducing various forms of policy interventions and price changes.

Coastal Fishery Activities

Changing Barents Sea and Coastal Communities: Expedition to the High Arctic

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My solo expeditions (January 22 – February 2 and May 28 – June 17) in 2012 started from 66.33oN latitude (Rovaniemi, Finland) and ended to 71.2.28oN latitude (Finmark, Norway) on the northernmost point of the European mainland, in the small village of Gamvik at the Arctic Ocean (Fig. 20).

Figure 20 - Map of expedition route

Purpose:

The aim of the expeditions was to investigate the current state of the coastal economies in the Barents region under the changing environmental, economic and political conditions. I was particularly interested in a perceptual view on seawater in societal perspective and among different decision-frames that may mandate, encourage and inform adaptive actions.

First, my purpose was to identify factors that are in interplay across a dynamic seascape of the Barents Sea. Further, I have been concerned with the question how these changes are experienced and reflected in the people's interpretation. Moreover, it was important to make my investigation in the context of the practical involvement of people in their environment, who negotiate changes as a mode of engagement with seawater.

The format of my fieldwork was focused on multiple sites and different economic activities going on in this Arctic region. Therefore, I visited places in a particular setting, whether that is a rural declining or flourishing fishermen community, emerging tourist village, regional/local centre of power or coastal large/small-scale economic enterprise.

Fieldwork is scholarly work that requires firsthand observation. It seeks to understand the underlying meaning of 'contemporary' societal realities that cannot be captured, for example, by structured survey methods or statistics. It encompasses as much as possible of an 'insider's' perspective. The classic fieldwork technique of 'participant observation' requires the researcher to reside in the community under study for a prolonged period and, as far as possible, to participate in its activities. This fieldwork gave me the possibility to get key insights into issues that the local communities are dealing with. Some of the activities I participated in were helping with the veterinary inspection of 14 pens of the salmon farm located in the middle of the fiord, eating the Arctic Char from my visit at the land based farm and discussing the advantages and disadvantages of sea and land based fish farming. I made my first trip into the open ocean on the small fishing boat for 10 hours, where I was almost 'disabled' being sea sick. I learned a lot about hard work of fishermen, environmental and social sensitivities connected to aquaculture, crab fishing and crab farming, processing and storing of fish, recreational and small-/large scale commercial fishing.

Seawater as a 'theory machine' in the context of empirical work turned up in the form of sets of questions that relate water, marine resources and coastal communities. These relations are embedded into multiple meanings of seawater. Once it is a part of everyday practices, a social construction or a field of political struggle. It may possess different properties like taking and giving at the same time. In the emerging tourist activities in the coastal area people may refer to the imaginary qualities of water as space. My investigation included a diversity of actors: from Norwegian or Russian fishermen, resource managers or farm/factories workers to tourist agents, local journalists or indigenous members of community. All these aspects are intertwined and they form diverse entity.

Preliminary results:

The picture of the coastal Barents area, drawn from local and spatial context demonstrates importance of physical changes of water for the coastal economies, but also significant altering values of the Barents Sea. Coastal space is also a limited resource and different economic activities may compete over its use. Seascape is becoming a space, where power may be exercised. The fieldwork materials also demonstrate how seawater becomes more a 'global' substance and a national view of water resources becomes more transnational.

Identifying of changes, their causes and impacts in their perceptual perspective points on diversity and possible differences in interpretation and acting towards these changes. It may vary between different sectors (e.g., between production of farmed fish and recreational salmon fishing, small and large-scale fishery).

Coastal Fishery Activities

Salmon farming started as a government-supported activity to save the wild salmon and create jobs (Fig. 21). This approach is still applied, but nowadays mass production of fish has to deal with the increasing concern of the local salmon fishery. Industrial activities on the Norwegian coast bring on the local and domestic agenda new questions: Does the aquaculture sector support the maintenance of biodiversity? Or escapees from the farms are threatening the viability of wild species? Local communities and recreational salmon fishing in the Tana River try to attract more attention to the activities in the sea when introducing regulations on limitations for the river fishing.

Among the indigenous Sami people, the coastal seascape is increasingly conceived as a 'contested' space. In this way, the fish farming industry becomes an issue of particular indigenous concern in the context of increased production of farmed fish and expanding aquaculture activities in the northern coastal area. Sea rise temperature in the southern areas that may cause more intensive aquaculture activities in the northern fjords, where water temperature is lower is among other perceived threats for small northern settlements along the Barents Sea coast. The intention of the Norwegian Research Council to allocate more money to research on cod farming meets a strong resistance among local fishers.

Figure 21 - Salmon aquaculture in Norway.
Courtesy of Anna Stammler-Gossmann (University of Lapland)

Indigenous fishing rights and access to the resources are addressed in new emerging activities related to the sea water – like mapping of traditional indigenous fishing grounds, revitalization of Sami place names in the fjords, research on toponyms for sea bottom features, trans-boundary cooperation and lobbying efforts with another indigenous groups.

Small scale Norwegian fishery seems to be more sensitive to the fluctuations in the sea. Changing fish locations may increase working hours of fishermen, fuel consumption and longer stay in the sea. Russian deep-sea fishermen, who land fish in Norwegian harbors, are more oriented on the market prices.

Some changes may be perceived differently even within the same sector. Alien species of the Barents Sea like King Crab may be considered among fishery sector as burden for one group and as asset for another one. On the one hand, it may contribute to the community viability or even may rescue declining community from 'dying out' and bring new opportunities for tourist activities (King Crab safari) and become an economic force as a global commodity (King Crab fishing and farming). On the other hand, it may be considered as invasive species that has negative impact on native fish and on the coastal ecosystem.

Growing consumers' and environmental concern about the seafood brings new challenges for the coastal economies. US Green House Seafood Guide suggests to avoid imported Atlantic Cod, Red King Crab and farmed salmon. Different recommendations programs indicate to consider the sustainability issues of fishing: are species overfished and/or fished or farmed in ways that harm other marine life or environment? Is buying seafood encouraging an invasive species?

The ethnographic accounts collected during the fieldwork also demonstrate how diversity of actors may respond to the changes and mobilize in order to better govern their own future. Local inhabitants are convinced in the crucial role of local initiative in keeping local economies viable. As observed in different settlements for example 'oceanization' may bring a great economic force for one community thanks this initiative, for another one, where it is missing, involvement into translocally connected processes may accelerate declining tendency.

Impact of climate driven changes is not always easy to link directly as far as change is considered as natural attribute of the water. Possible effect is multi-layered and is interrelated with other factors. In the local perception there is no direct linkage between cause-and-effect towards climate driven changes in the Barents Sea. Understanding the interactions of coastal communities and climate bring us to focus more on role of perceptions, different form of knowledge, and values as elements of these interactions that inform adaptive responses.

The results of the expeditions can be integrated into the research issues proposed in Work Package 4, Tasks 4.6 and 4.7 in relation to the regulatory framework (e.g. ban on the seal hunting in the coastal area and its impact on the coastal fishery; quota regulations, etc.) and to the identification of sustainability indicators for sectors. On the basis of my materials from the first expedition that was particularly focused on aquaculture, I produced a documentary film – Domesticated fish: Farmed and Monitored. (Field Notes from the Expedition to the High North). These video materials may be used as dissemination activities and for the educational purpose.

My upcoming fieldwork in the coastal areas of Northern Norway will focus on the collecting data for the in-depth analysis of community adaptive practices in dealing with the invasive species (in Bugoyness, Varangerfjord), 'oceanization' processes (in Mehamn and Gamvik, Norkyn Peninsula), with changes in legal regulations in Russia (among Russian fishermen in Kirkenes), and on community viability (in Longyearbyen and Barentsburg, Svalbard).

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Shipping Along the Northern Sea Route

Nordic Bulk Carriers Along the Northern Sea Route

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2012 was a great year for the Northern Sea Route (NSR) with increased volume of seaborne cargo, reaching more than 1 million tons.

One of Nordic Bulk Carriers (NBC) tasks in ACCESS is to follow economic aspects of the NSR (Work Package 2, Task 2.6) and 2012 was a good opportunity to do so. The result speaks for itself with 10 completed transits in 2012 (Figs. 22-23) compared to 1 in 2011.

2012 was a breakthrough in all aspect for NBC and their position as a world leading ice ship-owner with special focus on Arctic was one again high lighted. The transits began in early July in 2012 (compared to starting in August in 2011) and only ended at the end of November, a record 5 month window. During this period, NBC carried about 370,000 mts cargo or about 30% of the total NSR cargo volume and almost 80% of the total dry cargo volume in 2012.

Figure 22 - Nordic Bulk Carrier shipping along the Northern Sea Route. Courtesy of Christian Bonfils (NBC)

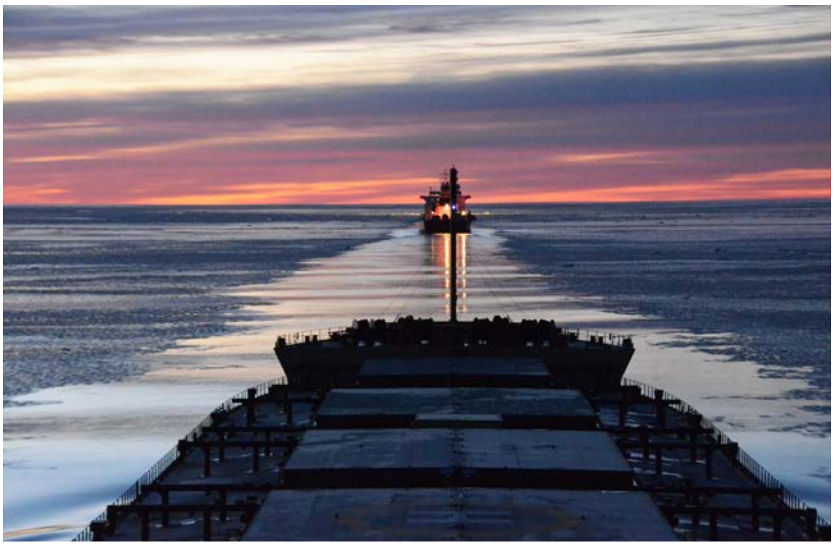

Figure 23- Nordic Bulk Carrier shipping along the Northern Sea Route accompanied by Atomflot ship from Russia. Courtesy of Christian Bonfils (NBC)

NBC almost used their full vessel capacity, including the latest investments of two 75,000 dwt Japanese build vessels that are the most modern and biggest ice classed vessels to fulfill the safety requirement for the NSR. Success in 2012 along with NSR was a combination of two features. First, there was increased transparency in the rules and regulation from the Russian Authorities for transit along the NSR. Second, their was investment in more vessels to provide flexibility that wasn't possible with chartered vessels. Even with the success of 2012 along the NSR, there still is room for improvements and continued focus on rules and regulations is a key to future successes with Arctic cargo shipping.

Air Pollution Over the Arctic Ocean

Airborne Measurements of Local and Imported Air Pollution in the Arctic

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ACCESS WP 4

The expected future increase of transpolar shipping and hydrocarbon resource extraction in the Arctic will have a significant impact on the atmospheric composition in the northern polar region. At present, the distribution of chemical species and aerosols is mainly affected by a few Arctic pollution sources and the import of anthropogenic and boreal biomass burning emissions from northern mid-latitudes. In the frame of ACCESS these local pollution sources, e.g. ships and oil/gas platforms, and the imported pollution are investigated by the DLR Institute of Atmospheric Physics using airborne in-situ measurements.

The DLR research aircraft "Falcon" was deployed from 9-27 July 2012 from the airport in Andoya, northern Norway (Fig. 24). The Falcon 20, a modified twin-engine jet, was equipped with a comprehensive set of trace gas and aerosol instruments for measurements of nitrogen oxides, carbon dioxide, methane and other hydrocarbons, sulfur dioxide, and particulate matter including black carbon. A total of 13 flights were conducted in the Arctic covering altitudes from 50 m up to the maximum cruise altitude of 12.8 km. Figure 25 shows all flight paths covering latitudes from 63°N to 82°N and longitudes from 5°E to 30°E (Fig. 25).

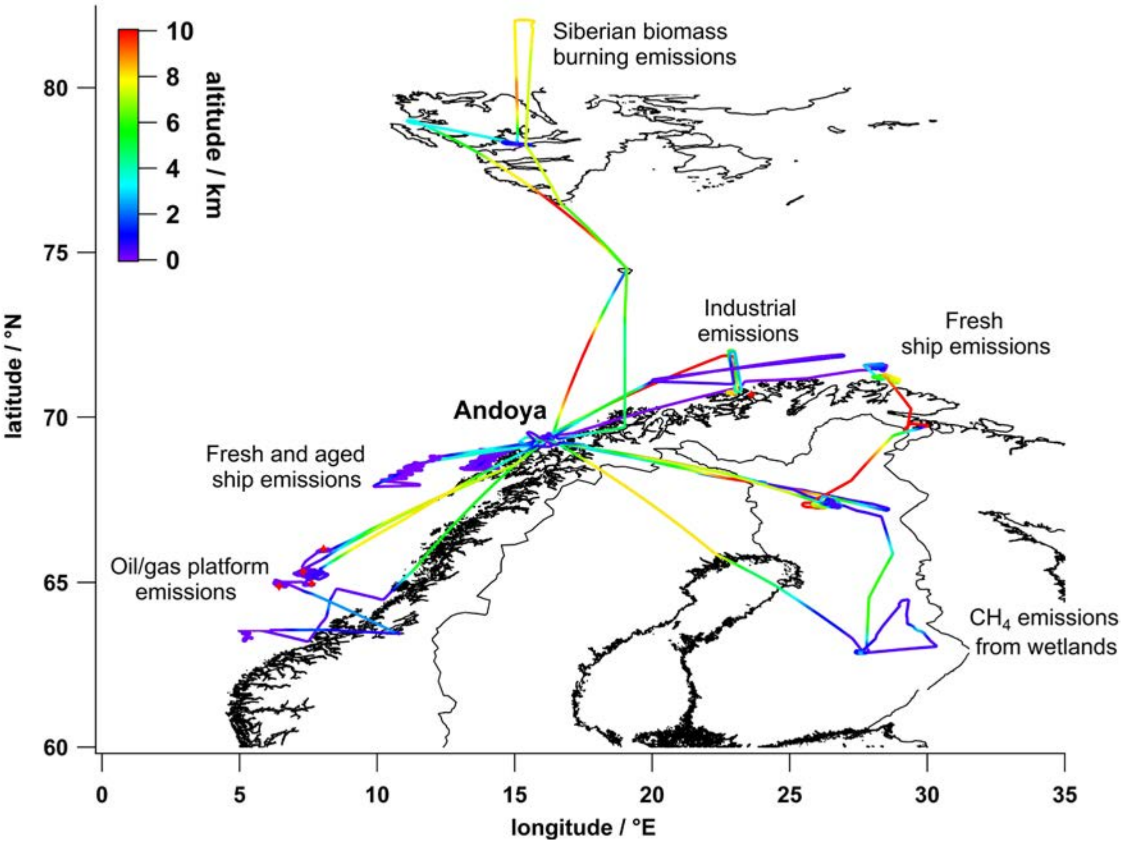

Figure 24- Flight paths of the DLR Falcon of 13 research missions conducted during the ACCESS campaign in July 2012 (flight altitude is color-coded)

Figure 25- Falcon research aircraft at Andoya airport, northern Norway. Courtesy of Bernadett Weinzierl

Several Falcon flights were performed to study the chemical and particle composition of exhaust plumes from dedicated source ships and oil/gas extraction facilities in the Norwegian Sea. Figure 26 shows, as an example, nitrogen oxide measurements in the exhaust trail of the "Heidrun" platform. The Falcon first approached the Heidrun platform as close as possible in order to sample fresh emissions and then meandered away from the emission source. This type of measurement flights allows the analysis of emissions at different plume ages from about 60s to 1-2 hours and help to investigate chemical and aerosol transformations during the dispersion of the pollution plumes. Other Falcon flights were dedicated to the measurements of emissions from various vessel types (passenger, cargo and fishing ships) burning different types of fuel. These measurements help to investigate the emission of soot and the formation of sulfate aerosols from emitted sulfur dioxide in the ship plumes.

Imports of emissions from pollution sources into the Arctic were also studied during the ACCESS campaign. In a mission to Spitzbergen, biomass-burning emissions transported from Siberia into the Arctic were sampled. The intersected pollution plume showed strongly enhanced carbon monoxide and black carbon concentrations. Another pollution plume was probed over the Barents Sea with particularly high sulfur dioxide mixing ratios, originating from the industrial regions of the Kola Peninsula (Russia).

The Falcon measurements will be used to characterize the emissions from the different sources and to validate model simulations using a regional chemical transport model (WRF-Chem) and a global chemical transport model (MOZART-4). This will, in turn, help to improve model predictions of the future development of Arctic pollution and warming.

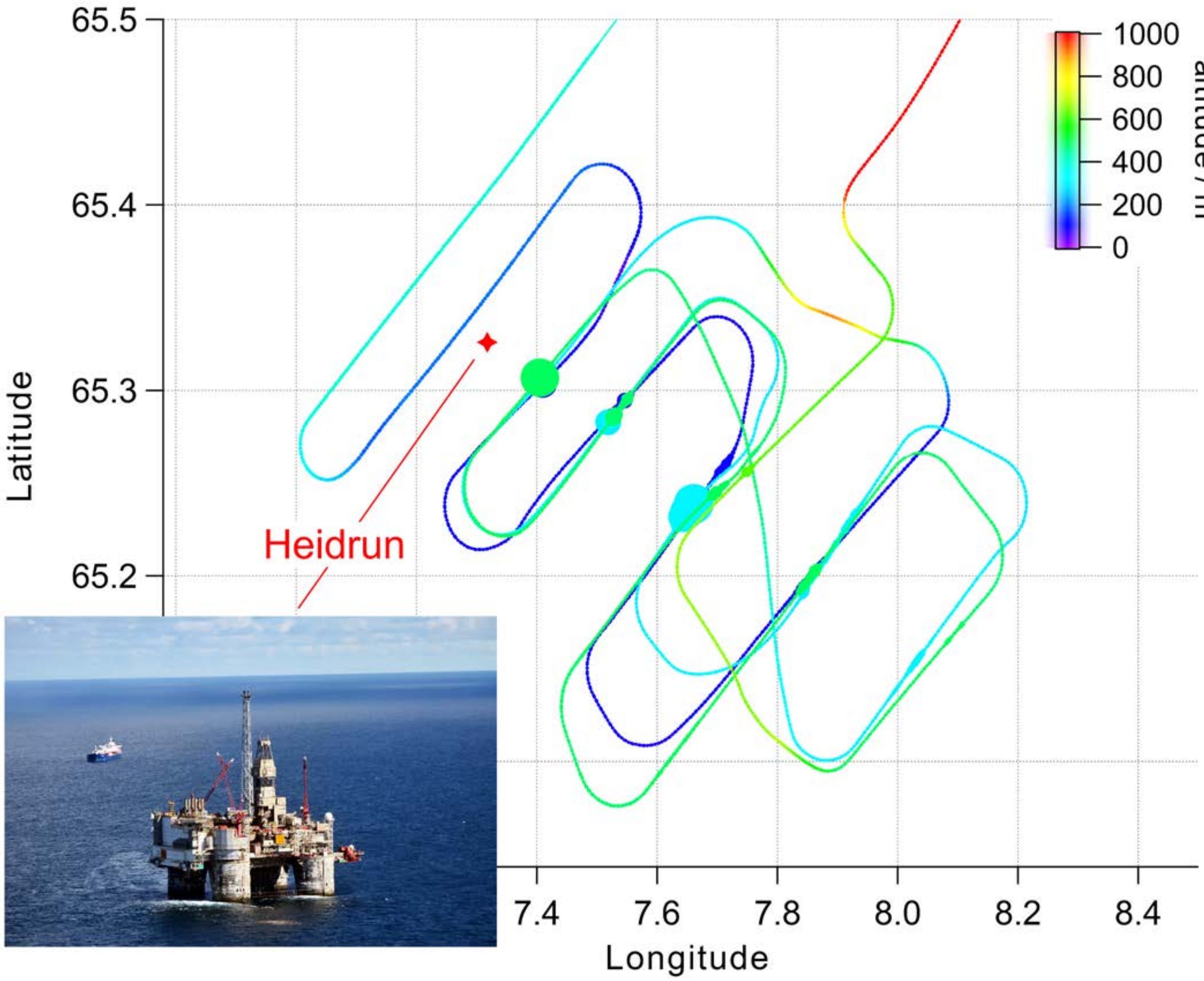

Figure 26- Falcon measurement track of the flight on 20 July 2012, dedicated to the investigation of emissions from the "Heidrun" platform (small inset on the bottom left). The emissions were sampled at different distances from the platforms and at different altitudes. The marker size indicates the measured nitrogen monoxide mixing ratios, decreasing with distance from the source due to dilution.

SNAPSHOTS OF ACCESS FIELDWORK IN 2013

In 2013 there will be four main field work activities

The first one will be similar to last year with a second set of instruments being deployed at the North pole around mid April 2013. These instruments concern profiling in the upper 800m under the ocean surface and throughout the sea-ice during a 6-month period. The instruments will be ice tethered, drifting southward in the direction of the Fram Strait. Hopefully these instruments will be recovered in Fram Strait with ship of opportunities, hovercraft or helicopters. This is a contribution from UPMC/LOCEAN in Paris (France), from SIO in Moscow (Russia) and NPI in Tromso (Norway) to ACCESS WP1 in cooperation with the Polar Center of the University of Washington (PI J. Morison).

A second major field work experiment will be another intensive airborne campaign with the AWI Polar 5 aircraft to measure the evolution of sea-ice thickness over a large region of the Arctic region. Like in 2012, also in 2013 the joint campaigns PAMARCMiP (Polar Airborne Measurements and Arctic Regional Climate Model Simulation Project) and TIFAX (Thick Ice Feeding Arctic Export) based on the POLAR 5 aircraft of partner AWI will provide ACCESS with important data on ice thickness between 65°N and 85°N at the end of winter and in summer. In addition the campaigns will provide data of aerosols and meteorological conditions. For 2013 we will concentrate of the European Arctic (Longyearbyen, Svalbard and Station Nord, Greenland) and the Canadian Forces Station Alert (Ellesmere Island, Nunavut, Canada). Please see above for a description of last year's campaign and the scientific relevance of the obtained data sets.

The PAMARCMIP program will require about three weeks, including ferrying the aircraft from and to Bremerhaven, The total flight time will be approximately 75 hours. The mission will be closely coordinated with satellite (e.g. CRYOSAT II and CALIPSO). The project is being organized under the leadership of the Alfred Wegener Institute Bremerhaven in cooperation with several partners in Germany (Jade HS, FIELAX), Canada (Environment Canada Toronto, University of Alberta, KBAL, LCA) USA (NASA LaRC, NOAA Boulder), and Europe (ESA Nordwijk).

The TIFAX campaign campaign is planned for August 2013 and complements the large-scale sea ice surveys of PAMARCMIP in April with summer data from the same area. Partners involved are Environment Canada and University of Toronto, plus the AWI group in Postdam. Also here the sea ice survey, and measurements of meteorological and aerosol key parameter are planned. The primary goal of this survey is to obtain airborne sea ice thickness data set under Arctic summer conditions. The campaign serves to monitor ice conditions near and in the main export pathway of Arctic sea ice in a situation of possibly decisive developments in the overall Arctic sea ice balance. A second goal of the campaign is the determination of vertical and horizontal aerosol and black Carbon distribution and the feedbacks to the atmospheric radiation field as well as the measurements of the atmospheric conditions, especially in planetary boundary layer by using of aerosol In-Situ systems, drop sounding system, airborne photometer and airborne aerosol Lidar. The time duration is from August 19, 2013 to August 30, 2013 with operation from Longyearbyen, Station Nord as well as Alert.

The third major ACCESS fieldwork activity will be a circumnavigation of the French schooner Tara. Tara became an iconic polar vessel during the previous European research project DAMOCLES during the IPY 2007-2008 completing a fabulous transpolar drift across the Arctic Ocean in about 500 days. Many peer reviewed scientific papers related to the Tara transpolar drift have already been published in outstanding journals and will be gathered in a special issue in 2013. The new Tara Arctic circumnavigation will start in July 2013 and will end in October 2013 (Fig. 27). In fact Tara will leave France (Lorient) in May 2013 and will return to Lorient in December 2013. There will be portcalls in Tromso, Murmansk, Dudinka, Franz Josef Land, Pevek, Tuktoyaktuk, Resolute Bay, Illulisat, Quebec city and Saint Pierre et Miquelon.

The main fieldwork will consist in physical and biological observations. From a biological point of view, Tara will complete a genomic study of phytoplankton initiated during the previous 3 year Tara Ocean expedition covering all the World Ocean except the Arctic Ocean. This has never been attempted before. From a physical and biogeochemical point of view more than 100 CTD stations (including a rosette device for sampling seawater) will be taken in the North East and North West passages + the Beaufort Sea when crossing over the Arctic Ocean from Siberia to Canada. A geodetic GPS coupled to an altimeter (both measuring distances within one cm accuracy) will operate simultaneously in order to evaluate the amount of fresh water circulating around the Arctic Ocean. Three pairs of radiometers (UV, IR and visible) will measure continuously incoming and outgoing solar radiation, albedo and light transmitted through the ocean surface. Water samples will be taken in order to measure 016/018 ratio and to evaluate fresh water origins. Many other biogeochemical parameters will be analysed such as nutrients, chlorophyll and dissolved oxygen. From ACCESS there will be two partners participating to this cruise: SIO (PI Sergey Pisarev) and UPMC/LOCEAN (PIs Diana Ruiz Pino and J-C Gascard)

The fourth major activity will concern iceberg observations and testing of operational models from the Canadian Ice Services installed at the Meteorological Institute in Norway. Icebergs observations will be taken in a West Greenland fjord (Ummannaq) from the UK schooner Gambo which is actually wintering in this Fjord (PI Nolwenn Chauche). This is a cooperation with Aberystwyth University, (PI Dr Alun Hubbard) in Wales, UK. This is a contribution from UPMC/LOCEAN, Paris, France and Met.no, Tromso, Norway to ACCESS WP4.

The research leading to these results has received funding from the European Union Seventh Framework Programme

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Comments and suggestions for the ACCESS Newsletter are most welcome

For further information, please contact Paul Arthur Berkman : berkman@bren.ucsb.edu

Figure 27- Tara Arctic circumnavigation's map: "Tara Oceans Polar Circle". © Tara Expeditions