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PU	Public	X
PP	Restricted to other programme participants (including the Commission Services)	
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. 3
June 2012

ACCESS Highlights

Team photo from the 2nd ACCESS General Assembly, which was convened at the Swedish Royal Academy in Stockholm, Sweden, from 8-10 March 2012.

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

The first year of ACCESS activities

This third edition of the ACCESS newsletter is an opportunity to reflect on progress made during the first year of the ACCESS project. It just follows the submission of the ACCESS annual periodic report. The editorial address of the ACCESS newsletter N°3 is twofold. First it contains some elements of the executive summary publishable report that was submitted to the EU commission as part of the ACCESS annual periodic report. Second it provides a short introduction to some highlighted results obtained during the first year of the ACCESS project as presented in this third edition of the ACCESS newsletter.

Executive summary from the publishable annual periodic report

The Arctic has experienced substantial changes in recent years. These are most likely caused by a combination of natural variability of the high-latitude climate system and anthropogenic changes. They encompass changes in the radiation balance, in atmospheric and oceanic heat transports and in feedbacks of the air-sea-ice-ocean coupled system linked to a thinning and shrinking Arctic sea-ice cover. While many of the current climate models reproduce a general reduction of ice extent and thickness, results still show a large spread in terms of patterns and pace of the ice retreat. For ACCESS to be able to make use of climate model projections for the Arctic, careful inspection and interpretation is required. Thus our activities encompass an assessment of climate models results for the last 30 years regarding their representation of sea-ice, ocean and atmospheric parameters, their seasonal and inter-annual variability and their trends. ACCESS will then evaluate relevant aspects of a carefully chosen subset of Coupled Model Intercomparison Project (CMIP3 and CMIP5) scenario simulations for the next 30 years (until 2040). Results from these coupled climate model projections and downscaling simulations using regional ocean sea-ice modeled will allow us to provide a range of potential sea-ice and ocean developments for the environmental, economic and societal impacts of climate change which are dealt with in ACCESS in further work packages.

For long time, mariners have dreamt of an Arctic shortcut that would allow them to increase the efficiency of trade between Asia and the West. With the reduction of ice cover ahead, a strong increase in ship traffic in the Arctic can be expected. ACCESS considers economical implications, safety issues and environmental problems related to these ship traffic activities and to also growing interest of the tourism industry in Arctic waters. Taking into account the changes in the climate system ACCESS evaluates necessary scientific, technical and operational information needed for such activities. ACCESS will also dedicate important effort to the potential impacts shipping activities might have on the sensitive marine environment including air pollution and long range transport of pollutants by the atmospheric circulation, soot and black carbon deposition on sea-ice, oil spill and ballasting ships tanks in subarctic seas. By this ACCESS strives to provide a base for a beneficial development of increased shipping and tourism in changing Arctic ice conditions, considering the risks and the opportunities.

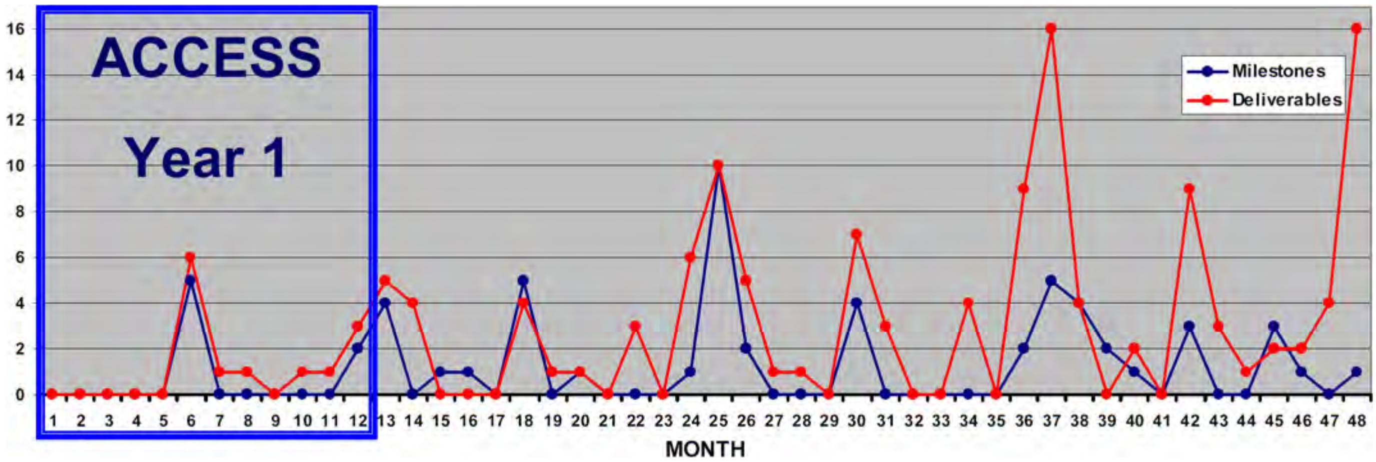
The Barents Sea is one of the most active fishing area in the world. It is also one of the most dynamic areas in terms of oceanic and atmospheric circulation connecting the North Atlantic and Europe with the Arctic regions. The analysis of the socio-economic aspects of fisheries industry in the context of climate change in the Arctic is a major task of ACCESS. Climate change in the Arctic is likely going to change the properties of ecosystems in the Arctic Ocean. ACCESS will focus on enhancing knowledge related to bioeconomic and socioeconomic aspects of fish resources and aquaculture in the context of climate change in the Arctic. ACCESS contributions aim at improving the understanding of both biological responses to climate change and the corresponding human responses. In the northern Barents Sea, which is influenced by Arctic currents, sea-ice and icebergs, marine mammals are very abundant. In ACCESS research is forwarded on the threats to this environment by the increasing human activities which create noise and other pollution.

A further aspect of the reducing sea-ice cover is an increase of the accessibility of offshore oil and gas deposits. However the special conditions in the Arctic, in particular low temperatures, extensive dark periods in winter, the presence of icebergs, sea-ice and associated environmental risks, make the extraction of energy resources more dangerous and expensive. It is the aim of ACCESS to assess the opportunities and multiple risks related to oil and gas extraction in the Arctic Ocean, to highlight potential environmental pressures, provide pathways for technological, legal and institutional solutions and to analyze the socio-economic impacts of resource extraction activity on European, world markets and societies. To better assess the opportunities and risks of resource extraction in the Arctic Ocean, information is needed with respect to the present and predicted meteorological and oceanographic conditions in this region. It is ACCESS' objective to respond to these challenges by proposing solutions that eventually would lead to new concepts for offshore platforms and other equipments. To be able to provide a foundation for the sustainable development of resource extraction in the Arctic Ocean, with a minimal impact on the sensitive Arctic environment, research on quantification of climate change effects on the economy, has to be combined with research on risks and consequences, air and ocean pollution, oil spill under sea-ice, black carbon deposition on snow and ice, noise effects on marine mammals at a technical, environmental and governance level.

A key objective of ACCESS is to point out governance options in the context of the climate system changes and the envisioned increase of human activities in the economic sectors mentioned above. The approach of ACCESS to tackle this issue is cross-sectoral. The wide range of existing legislative instruments, agreements, conventions at national and international level provide a complex often overlapping and in some areas, conflicting system of regulation in an area requiring special integrated overview. ACCESS is uniquely positioned to provide this reflection process, to identify lacunae in the system and to offer strategic policy options for the medium and long-term future in the context of climate change. ACCESS will build on scientific and socio-economic research to identify how the governance system can be made more effective and coherent. The identification of policy options enhancing governance, will be facilitated by the development of marine spatial planning and ecosystem based management tools. These can directly help public authorities and stakeholders to coordinate their action and optimize the use of marine space to benefit economic development while preserving the marine environment. Recognizing the particular vulnerability of the Arctic region and its crucial importance to the world climate system, ACCESS will point out governance options for the Arctic taking into account respect for its uniqueness, the sensitivity of ecosystems as well as needs and rights of Arctic residents, including indigenous peoples. ACCESS will promote a permanent dialogue with NGOs on the state of the environment in the Arctic. ACCESS will heavily rely on intense cooperation with other Arctic projects. The interaction of ACCESS with the stakeholders in the stakeholders/end-users forum, will be a major undertaking of the ACCESS project.

Introduction to ACCESS first year highlighted results

ACCESS is an interdisciplinary project that bridges the natural and social sciences with a main objective to integrate observations, interpretations and predictions in a manner that has policy relevance. Such integration is a big challenge as reflected by the WP reporting of this newsletter – especially in view of deliverables and milestones defined in the ACCESS Description of Work (Gantt Chart).



Gantt Chart of deliverables and milestones throughout the 48-month ACCESS project. Deliverables and milestones around Year 1 are elaborated under Work Package 6 (Dissemination and Communication) of this annual synthesis newsletter.

WP1 "Climate changes in the Arctic" highlighted results based on observations and modeling activities.

Regarding observations, it concerns

1) Sea-ice extent based on satellite AMSR-E observations showing the advance of the melt onset and sea-ice break up during early Spring as well as the freeze up delayed during late Fall over the past 10 years and

2) more recent in situ sea-ice observations gained during a 2011 cruise in the Chukchi Sea on board the South Korean icebreaker R/V Aaron comparing temporal variation of cumulative solar input versus the heat required for the observed melting rate along ice floes trajectories.

3) Oceanographic observations obtained during the past 10 years in the northern Laptev Sea showing the increasing temperature of the Atlantic core penetrating into the Arctic Ocean.

Regarding modeling, it concerns

1) Applications from the Earth system Model (ESM) by Met.no (the so-called NorESM model) showing the effect of increasing resolution for precipitation over the Nordic Seas, Scandinavia and the Barents sea.

2) Applications from the AWI model NAOSIM investigating short time forecasting capabilities for sea-ice concentration pointing the essential role of initial sea-ice thickness distributions

WP2 "Marine transportation" highlighted results mainly based on two Deliverables (D2.11 and D2.14)

1) D2.11. Historical sea-ice conditions and its influence on navigation along the Northern Sea Route from 1949 until

1979 and during a more recent period (1971-2011). These data are essential for ACCESS partners studying navigation efficiency along NSR and identification of infrastructure needed for Arctic shipping along the NSR.
2) D2.14. An assessment of current monitoring and forecasting requirements from users and international providers. 24 experts from international shipping companies, oil & gas industry and Arctic Research Institutes provided information requirements that relate to their activities in the Arctic Ocean such as meteorological, ocean currents, and daily sea-ice information.

WP3 "living resources" highlighted two main results concerning two distinct areas

1) Aquaculture. Perception of the risks and benefits of aquaculture farmed fish and ethno-political dimensions of fish farming with regard to indigenous Sami groups.
2) primary (phytoplankton)and secondary (zooplankton) productivity modeling that underlies the fisheries industry in the Barents Sea until the end of this century.

WP4 "mineral resources" highlighted the socio-economic and environmental impacts of extended production of hydrocarbons in the Arctic Ocean.

That concerned

1) Existing technologies for offshore production of hydrocarbons including fixed and floating structures as well as sub-sea systems. Identification of gaps that prevent adoption of existing technologies for exploration, production and transport of hydrocarbons under Arctic conditions
2) Better understanding and parameterization of oil spill in ice covered seas using controllable tank experiments. Providing an objective assessment of the strengths and weaknesses of the present oil spill response capabilities and technologies used in ice covered waters.
3) Test flights in plumes of oil and gas platform emissions of the concentration of hydrocarbons, sulfur dioxide, volatile aerosols and other parameters clearly detected in the vicinity of oil & gas extraction facilities
4) Noise pollution impacting marine mammals in the vicinity of oil & gas offshore platforms involving in situ measurements and observations as well as modeling.
5) Monitoring activities using modern technology for surveying the ocean environment in sensitive regions of the European Arctic.

WP5 "Arctic governance" highlighted results mainly based on the production of D5.11 "Analysis and synthesis of extant and developing regulatory frameworks"

This deliverable highlighted the complex and diverse range of instruments in play for regulating man's activities in the Arctic Ocean and the great variety of approaches in place in the different ACCESS sectors. D5.11 was then used as the basis to start identifying governance gaps within the existing frameworks. The timeline of hard-law binding agreements and soft-law guidelines to manage human activities and impacts in the Arctic Ocean tends to follow an impressive exponential progression. The synthesis work of WP5 during year 1 of the ACCESS project consisted in preparatory and organizational activities and development of methodologies for the Marine Spatial Planning tool (MSP) and the framework for integrated Ecosystem Based Management (EBM). In contrast to MSP which focuses on the spatial aspects of interactions, the focus of the EBM will be on the nature and dynamics of the interactions between different sectors.

WP6 "Dissemination and Communication" highlighted three different aspects concerning outreach activities

1) The timeline (Gantt chart) of deliverables and milestones achieved during the first year of the ACCESS project
2) The interactions between the ACCESS consortium and the ACCESS Advisory Board that first met during the ACCESS General Assembly in Stockholm on March 9, 2012.
3) The international cooperation specially with the Arctic Council working groups and task forces
4) The dedicated communication with EU commissions that culminated during a special meeting organized in Brussels on February 20, 2012.
5) All the meetings (workshops, international conferences etc..) involving ACCESS partners occurring during the first year of ACCESS.

Work Package Progress

(Acronyms of ACCESS partners mentioned below are found at the back of this newsletter and on http://access-eu.org/en/partners.html)
All other acronyms are either spelled out in the text or in footnotes

This Annual Synthesis Newsletter is Adapted from the ACCESS Annual Report for 2011-12

Work Package 1 – Climate Change and the Arctic Environment

The main objective of WP1 is to inform the other WPs about changing ice properties and other physical environmental parameters. Arctic climate projections for the next decades will be improved by better assessments of anthropogenic and natural sources of pollution.

A key parameter for all human activities performed in the Arctic as well as for the development of the Arctic climate system itself is the Arctic sea ice. The first year of ACCESS for WP1 has seen a large number of observations of the current developments in Arctic sea ice and their analysis. The observational parameters encompass the sea ice concentration, the sea ice type, its drift, as well as its snow cover and the sea ice thermodynamics. Figure 1 provides an example for the seasonal cycle of sea-ice area as it changed from 2003 to 2010, most significantly increasing the period of summer diminished sea ice by 1 month (Fig. 1).

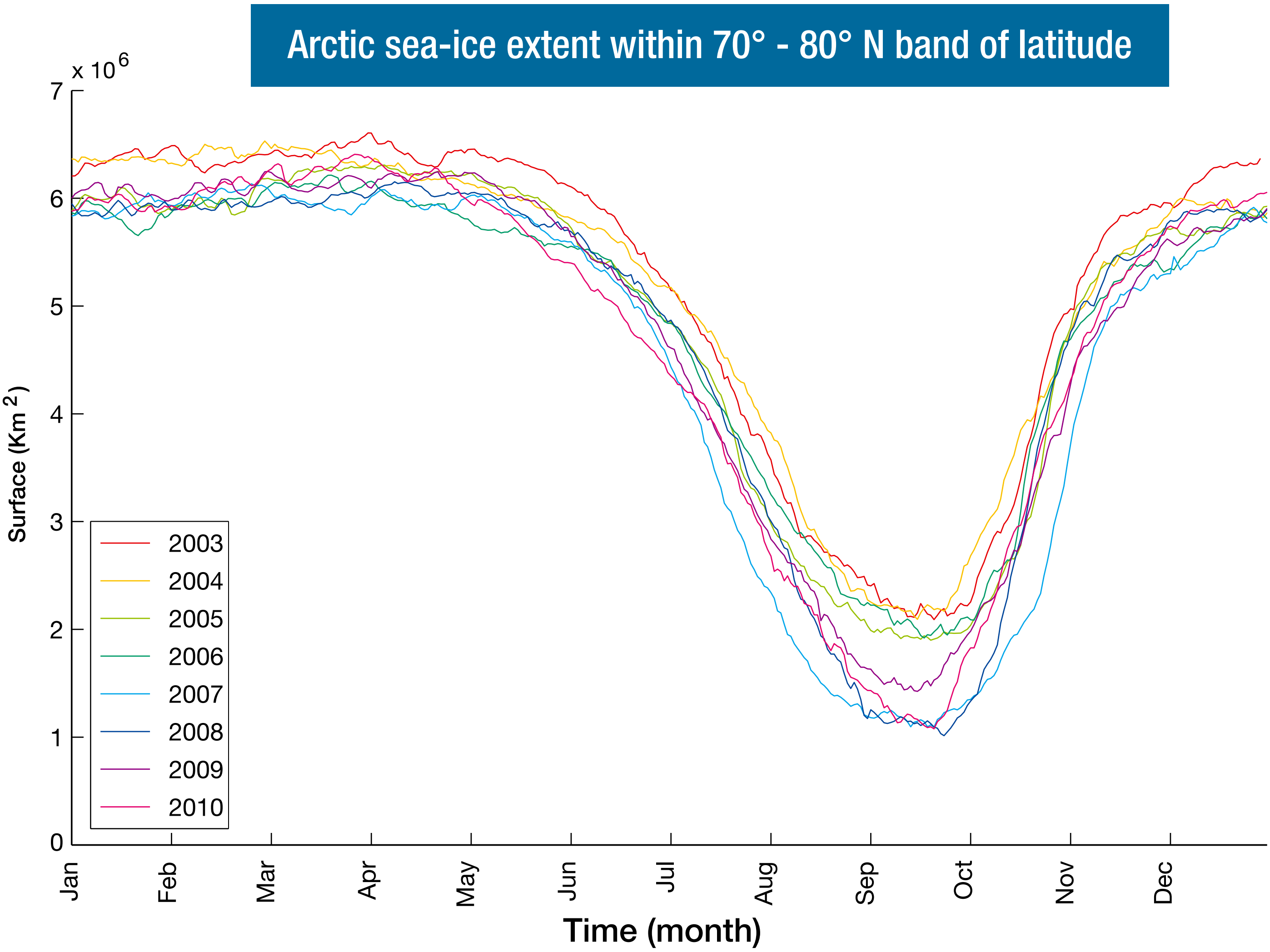


Figure 1: Yearly evolution of Arctic sea-ice extent (million km^2) in a latitudinal band from 70°N to 80°N during the period 2003 to 2010. Minimum sea-ice extent at the end of each summer along with earlier melt-onset, earlier ice break-up and later freeze-up has been developing in more recent years. Melt onset and sea-ice break up have advanced by almost two weeks during this period (i.e. 1 to 2 days per year) while freeze-up as been delayed by the same amount of time, influencing a sea-ice deficit of nearly 1 million km^2 during this decade. ACCESS is focusing on the future evolution of the Arctic sea-ice and the consequences for marine transportation, oil and gas exploitation, and fisheries utilization in the Arctic Ocean. With permission Jean Claude Gascard.

Work Package 1

To better understand the energy balance for the seasonal cycle changes SAMS has deployed several mass balance buoys in the northern Chukchi Sea in August 2011 from board of R/V Araon (Korean Polar Research Institute) revealing unexpectedly large differences in bottom melt rates. Melt rates following individual buoy trajectories are roughly consistent with the accumulative solar energy input into the ocean mixed layer as estimated from meteorological analyses (Fig. 2).

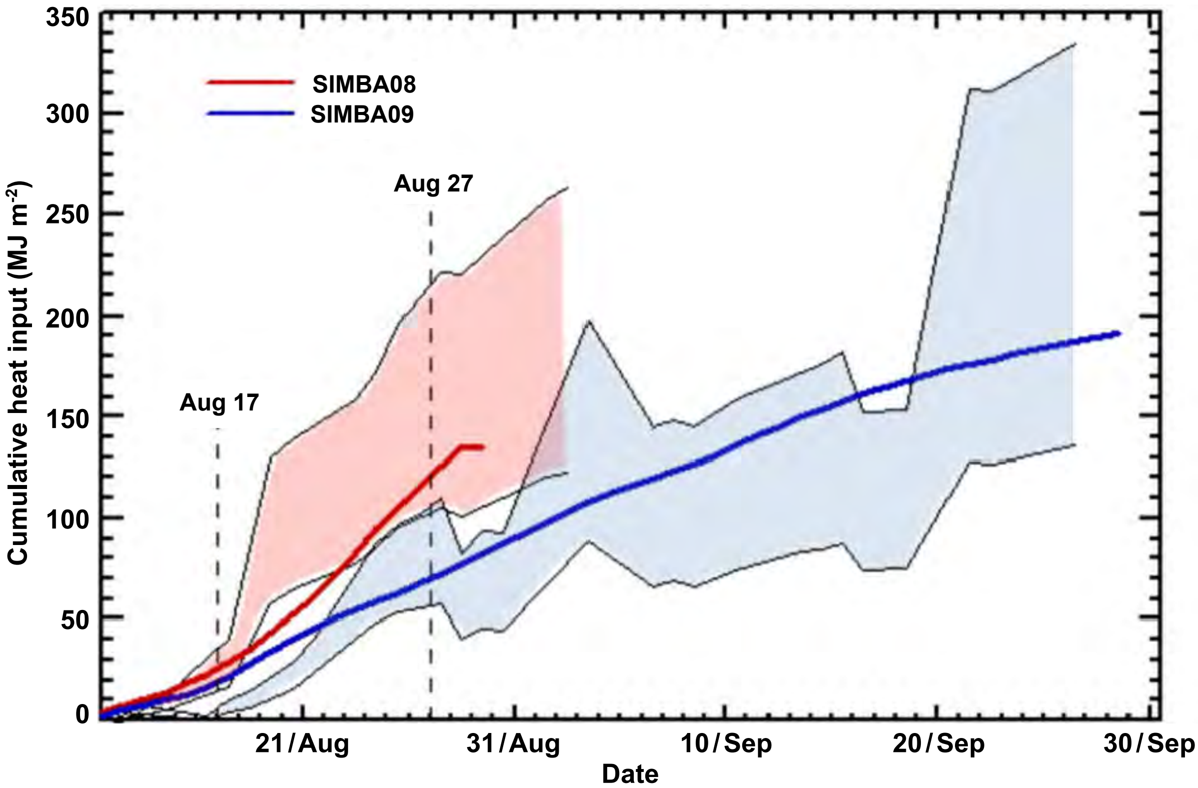


Figure 2: Temporal variation of cumulative solar input as estimated from NCEP a(National Centers for Environmental Prediction's reanalysis) and ERA interim (latest ECMWF, European Centre for Medium-Range Weather Forecasts, global atmospheric reanalysis) versus the required heat input for the observed melt rate along the trajectories of SAMS ice mass balance buoys (blue and red solid lines). The upper and lower borders of the shaded area are the values calculated from NCEP2 (Global atmospheric reanalysis performed by NCEP) and ERA-I (data respectively. From Hwang et al., 2012 (submitted). With permission Jeremy Wilkinson.

The energy balance of the sea ice is also the target for an observational system developed at NPI. A helicopter-borne camera system is used for high resolution mapping of the sea ice properties and its surface topography. The major focus is on melt pond characteristics, their spatial distribution, depth and temporal evolution. The camera system will be used in parallel with an "EM-bird" (electromagnetic sounding) instrument that measures sea ice thickness while carried by the helicopter. The sea ice thickness indeed is the key parameter to the future development of sea ice in the Arctic. One method to measure it, not from the air but from below the ice, is to combine a laser altimeter and an upward looking sonar data on a subsurface platform. Such an approach has been forwarded by UCAM and UPMC-LOV who related the topography of the upper sea ice surface to that seen underneath by sonar mounted on an Automated Underwater Vehicle (AUV).

The analysis of an earlier experiment that took place in the Beaufort Sea was done. There, a multi-beam equipped Gavia AUV was operated under the ice while a scanning laser profilometer was flown in an aircraft over the same area. This was complemented by a comprehensive ground-based survey. Deformed ice is the most challenging ice class for the Cryosat-2 satellite measurements, which form a backbone of Arctic-wide observational opportunities regarding sea ice thickness in the future. Work in WP1 of ACCESS has been done in year one to evaluate the extent and distribution of deformed ice. At UCAM multibeam sonar data from the 2007 Arctic Ocean cruise of the U.K. submarine H.M.S Tireless, have been processed. Based on this work a classification system has been developed to automatically extract areas of deformed ice. Results will be used to model the return signals of Cryosat-2 in three critical regions of the Arctic: Fram Strait, north of Greenland, and the thin first-year ice region of the Beaufort Sea.

Quality of projections of the Arctic climate system's future development critically depends on our ability to understand the past development of the Arctic Ocean. An important part of the ACCESS WP1 activities therefore is devoted to the investigation of past and present conditions of the ocean. The relatively warm period in the Arctic which occurred between 1920 and 1940 is of special interest as a possible analogue to the recent warm period and as a measure of natural variability in the Arctic climate system. SIO extracted oceanographic information out of 67 original books, papers and reports published in Russia during 1925-1965, previously difficult to obtain for western scientists. These reports describe the temperature and salinity characteristics in the northern part of the Barents Sea and in the northern part of the Kara Sea. Data from nearly 130 observed stations were digitized for analysis.

Due to its high heat capacity the ocean's condition has a large impact on the sea ice. On the other hand the sea ice influences the surface processes in the ocean. This interaction needs to be monitored and better understood. Thus, AARI is investigating the impact of Atlantic Water heat content changes on sea ice conditions in the Arctic. While many regions in the Arctic are too well stratified to allow the warm water stemming from the Atlantic to reach the sea ice, there might be specific areas where the upward heat flux from the Atlantic Water layer could reach the surface mixed layer. One of those areas may be near the shelf break of the Laptev Sea, where temperature sections reveal a heat loss from the Atlantic Water layer while the overlying water gains heat, probably due to enhanced vertical mixing over the steeply sloping bottom topography (Fig. 3).

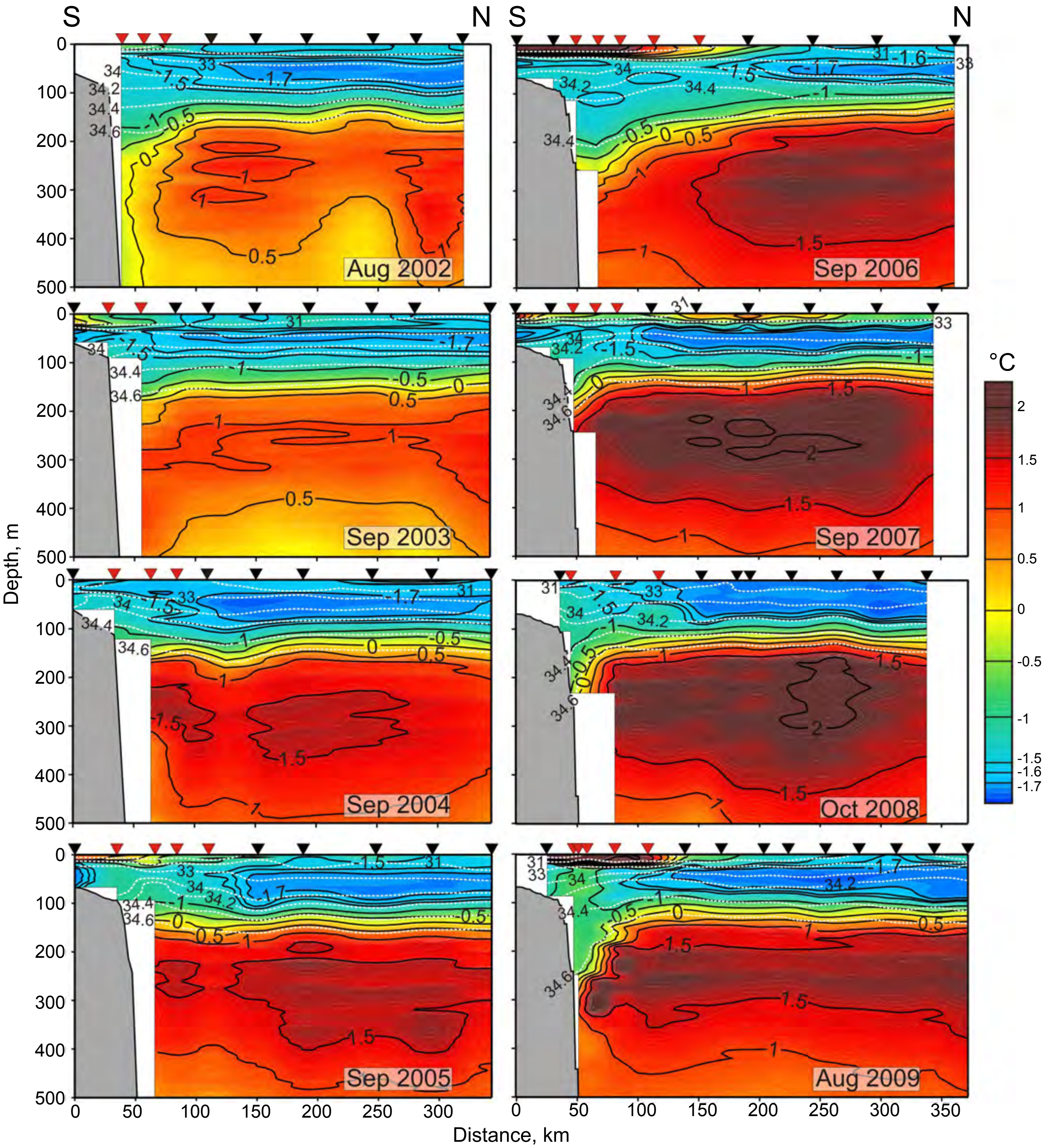


Figure 3: Vertical temperature distribution at 126oE (north of the Laptev Sea) for the summer2002 – summer 2009. Dmitrenko, I. A., V. V. Ivanov, S. A. Kirillov, E. L. Vinogradova, S. Torres-Valdes, and D. Bauch, 2011, Properties of the Atlantic derived halocline waters over the Laptev Sea continental margin: Evidence from 2002 to 2009, Journ. Geophys. Res., doi:10.1029/2011JC007269. With permission Vladimir Ivanov

Work Package 1

To further investigate the strong coupling between ocean, sea ice and atmosphere, UPMC-LOCEAN has been working to deploy IAOOS (Ice Atmosphere Arctic Ocean Observing System) ice-tethered profilers in the central Arctic. These systems are designed to collect simultaneous information about the state of the upper ocean, the lower atmosphere and the sea ice and transmit the observations in near real-time. Work in WP1 of ACCESS is also devoted to the atmospheric conditions in the Arctic. In year one atmospheric data collected by weather stations and data buoys as well as atmospheric reanalysis were analysed. Several activities have been initialized by Met.No to make data available to the project members. For example, data from weather stations and data buoys over the Arctic, which needed to be quality controlled, archives of weather station data from Norwegian territory, including Svalbard are reprocessed to the standard data format suitable to be used in the ACCESS databank and combined with records obtained from Russia, Denmark, Canada and the USA. Buoy data were obtained from the International Arctic Buoy Programme (IABP). Some of these data will also be used in an assessment of Arctic atmospheric forecasting capabilities. Clarification is sought on what temporal range and resolution is required for the modelling tasks within the project. LOCEAN (UPMC) will continue the work initiated during the EU DAMOCLES project and take advantage of the atmospheric data reanalysis (ERA Interim) for estimating the Arctic winter index based on the Freezing Degrees Days (FDD) concept.

Coupled climate models are indispensable tools to develop projections of the state of the climate system components into the future. However, results of such projections for the Arctic e.g. by the IPCC (Intergovernmental Panel on Climate Change) class of models show large range of results, requiring careful evaluation on which information to use for the ACCESS project. This is another task of WP1. Model based climate scenario results as they are described in the scientific literature were summarized regarding the expected changes of the Arctic climate by AWI and distributed within the project. The summary focused on five key aspects of the Arctic climate: shrinking sea ice area, sea ice thickness reduction, increased sea-ice mobility, ocean temperature rise and extreme weather events. A new generation of models and climate simulations are increasingly made available via the Program for Climate Model Diagnosis and Intercomparison (PCMDI, http://pcmdi3.llnl.gov/). AWI has started downloading and processing results to assess climate model simulations of the last 30 – 40 years (1971 – 2010) regarding the representation of sea ice, ocean, and atmospheric parameters, their seasonal and inter-annual variability, and their trends. Furthermore, AWI has begun to obtain sea ice results for selected scenario simulations. Analysis of the results will also help regarding the selection of climate model results for downscaling simulations. This work is tightly linked to the scenario calculations and the assessment of process impacts in the earth system model (ESM) of met.no, named NorESM (Norwegian Earth System Model), in task 6. NorESM is based on the Community Climate System Model version 4 (CCSM4) but differs in the ocean component, in the treatment of the ocean carbon cycle and the atmospheric chemistry, aerosols, and clouds. NorESM is participating in the CMIP5 experiments, which will be completed in the first part of 2012. Work has begun to select multi-decadal time-slices for simulations with higher spatial resolution in the atmospheric component of the model. The effect of increasing the resolution can be seen in the preliminary results for precipitation over the Nordic Seas, Scandinavia and the Barents Sea in Figure 4

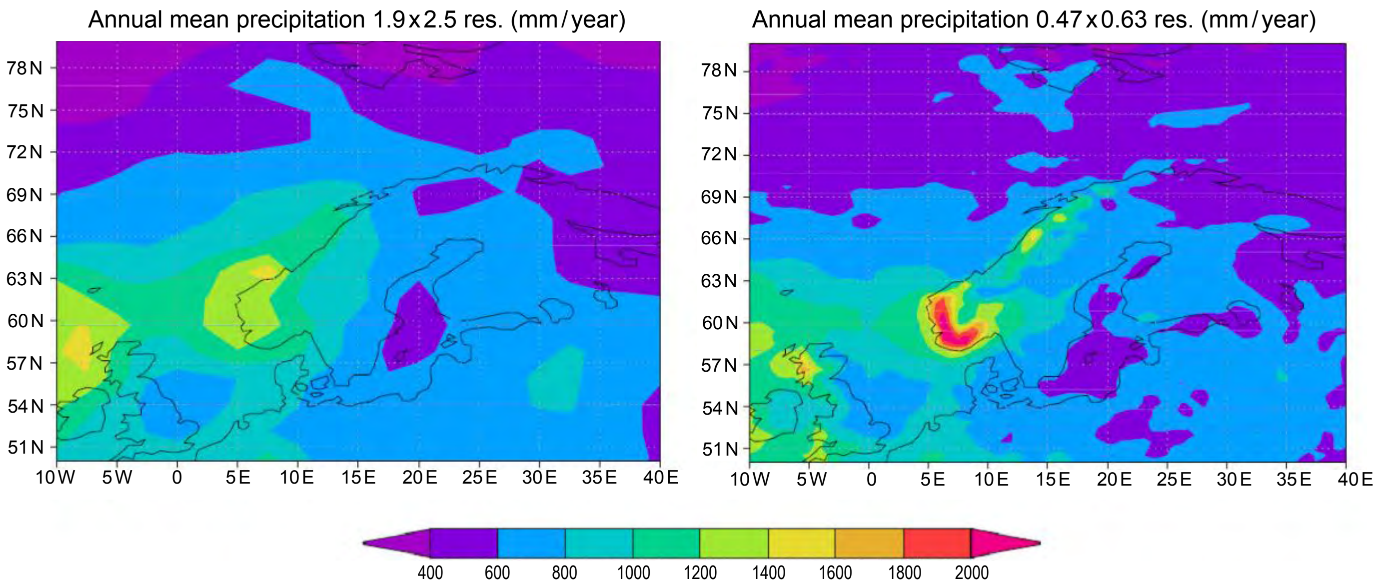


Figure 4 : Annual mean precipitation in NorESM at 1.9o x 2.5o resolution (left) and at 0.5o x 0.6o horizontal resolution. With permission Jens Debernard.

Black carbon is one of the substances that requires special attention in the Arctic context, since it is likely to be increasingly emitted locally in the Arctic with increasing commercial activities. Preliminary experiments with NorESM were conducted to isolate the effects of black carbon from those of other aerosols. In present day climate only small changes result from black carbon alone, the corresponding temperature response is very modest in NorESM. The impact of trace gases and aerosols on Arctic climate and long-range transport of pollution from anthropogenic and fire emissions to the Arctic has been investigated with the Weather Research and Forecasting (WRF) model coupled with Chemistry (WRF-chem). Significant ozone production occurs in the plumes. The global chemical transport model (OsloCTM2) model was used in studies quantifying the radiative forcing from soot and other components in the Arctic. Current impacts from petroleum activity and shipping in the Arctic have been started to be calculated as well as impacts of future global and Arctic shipping, a particular focus being on different scenarios for soot emissions. Distribution of soot in the atmosphere and the deposition of soot on snow surfaces from pre-industrial time until present have been simulated and will be compared with observations including recent measurements of soot in snow in the Arctic.

ACCESS WP1 also investigates short time forecasting capabilities for sea ice and related requirements. Collaboratively partners AWI, FastOpt and OASys participate in seasonal sea ice extent prediction activities as part of the Sea Ice Outlook undertaken by several groups worldwide. Results point to the essential role of initial sea ice thickness distributions. To improve initial conditions for the outlook, assimilation of various data streams has been incorporated into the model NAOSIM (regional coupled sea ice-ocean model of the Arctic). On the technical level different algorithms to improve the reduction of the cost function and to avoid local minima were tested. Significant improvement of the resulting sea ice concentration using additional constraints due to the assimilation are achieved (Fig. 5).

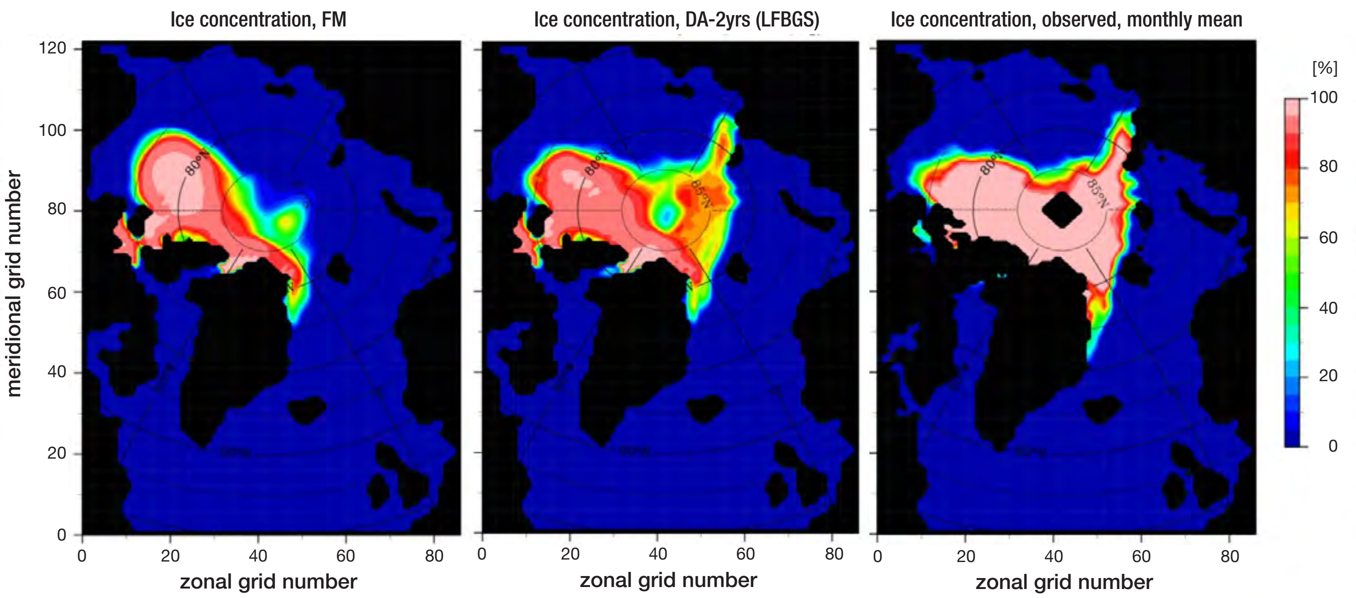


Figure 5: Sea ice concentration in September 2007 for the free model run (left), from an experiment with data assimilation (middle), and the corresponding satellite data. With permission Rüdiger Gerdes

The optimization of observational efforts with respect to minimize financial costs and maximize impact is an important issue for future Arctic observing. For this purpose a quantitative network design (QND) system is developed around the data assimilation system NAOSIMDAS (4-dimensional Variational Assimilation System around NAOSIM). Results will feed into a planned Arctic Observational Network Design system (AOND) that will provide model-based assistance to the design of the Arctic observing system. It will be adapted to the specific needs of marine transport and fixed structures in the Arctic.

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Work Package 2 – Marine Transportation and Tourism

The main objective of WP2 is to evaluate the effects of climate change on increased Arctic shipping and tourism, using the results of WP1 and providing recommendations for WP5. We will consider rules and regulations, infrastructure needs, pollution, safety, and socio-economic costs and benefits.

AARI has analyzed sea ice conditions in the Russian Arctic along the Northern Sea Route (NSR) between 1949 and 1979 (Fig. 6) with regard to:

- Ice concentration
- Fast ice
- Ice thickness
- Ice age
- Hummocks concentration
- Stage of melting

The results are being documented in Deliverable 2.11 ("Historical ice conditions and its influence on navigation on the Northern Sea Route"). Additional investigations have been focusing on sea ice conditions since 1971 until 2011. All these data have been provided required information by ACCESS partners like HSVA and NBC for their WP2-studies on navigation efficiency along the NSR.

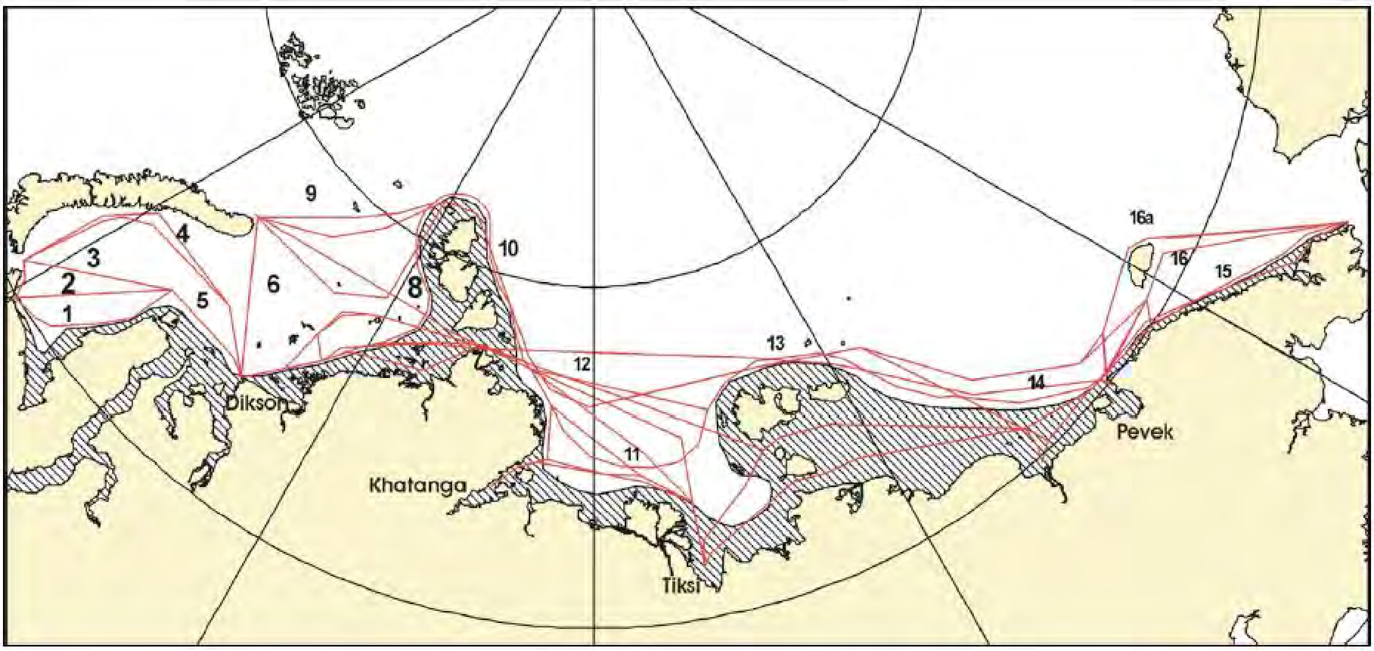

Figure 6: Locations of sea-ice measurements along the Northern Sea Route during February, May, June, Jule, August, September and October periods from 1949 to 1979. With permission Sergey Frolov.

The identification of infra-structure needs for Arctic shipping is performed by UCAM. A review of Arctic literature indicates few documents addressing the important issue of marine infrastructure that is required to support even today's levels of Arctic marine use. One of the key studies from the Arctic Council, the Arctic Marine Shipping Assessment (AMSA) presents a fundamental review of the infrastructure deficit today in the Arctic. AMSA results have been used as a baseline in initiating a comprehensive ACCESS survey on current and future marine infrastructure requirements. Planning is ongoing for two important Arctic Port Workshops, one in 2012 in Arkhangelsk and one in Norway.

Growing shipping activities in the Arctic can cause air and noise pollution, which could be harmful for the environment. In order to predict the possible effects of both pollutants theoretical analyses as well as full scale measurements are done. DLR and LATMOS are preparing measurements of ship emissions by using a DLR Falcon aircraft. The instrumentation for trace gas and aerosol has been newly certified and air control permissions for low level air flights have been obtained. The campaign will take place in July 2012 with its base in Andoya in the North-West part of Norway. Coordination of the measurements in the exhaust plumes of dedicated ships has been started with partner NBC. The effect of noise from ship engines is being addressed by UPC by modeling the propagation of this noise and the analysis of the effect of different noise sources and identification/ranking of the most critical ones. Also models have been developed for noise exposure and sound dosage of mammals. Preparations are underway to develop full scale testing equipment for recording under water noise from ice going ships in the Arctic.

The decreasing ice thickness and coverage in the Arctic have already caused an increase of Arctic Shipping. According to a report by the Russian Government the transport volume on the NSR (Fig. 6) in 2011 was 5.8-times higher than in 2010. This development requires also special attention with regard to the improvement of safety, as well as economic considerations. One issue in this respect is a better handle on lateral sea ice pressure. This horizontal pressure can create damage to the ship and can cause ships to get stuck in the ice. HSVA and SAMS will measure the lateral ice pressure as a function of ice thickness, ice temperature and wind and current velocities and directions. HSVA has started to design a stress sensor buoy, which will be frozen in large Arctic ice covers. The design of this instrument has caused problems regarding the necessary rigidity of the cylindrical structure of the buoy and hereby a postponement of the stress measurements to 2013, which will be organized by SAMS in connection a WP1 Arctic Expedition. This postponement provides the possibility to carry out pretests with the stress sensor buoy in the Northern Baltic Sea before using it in the High Arctic.

ESRI has studied the impact of precipitation and temperature on the tourist demand and has analyzed determinants for cruise tourism focusing on the Caribbean and Norwegian markets. NBC (Fig. 7, page 11) has started to calculate transport time and costs for using the NSR instead the Suez-Route for shipping cargo. For this calculation NBC has used results of HSVA and own experience by shipping ore from Europe to China in 2010 and 2011 via NSR, where the transport time and fuel saving was more than 50 %.

Governance issues of marine transport have been addressed at WP2-meetings with regard to WP2 inputs to the WP5-Workshops in Southampton and Stockholm. Special attention was given to the regulations of Arctic Shipping by the Arctic Council (AMSA-Report) and by International Maritime Organization (IMO) in view of its emerging polar shipping code. Since the Polar Code is still under development it is recommended to establish contact to IMO in order to open the potential for ACCESS research results being considered in the Polar Code.

An important outcome from WP2 was the survey of 24 experts from international shipping companies, oil/gas industry and Arctic research institutes with regard to information requirements that relate to their activities in the Arctic Ocean. The results of this survey are described in Deliverable 2.14 ("Assessment of current monitoring and forecasting requirements from users and international providers") conducted by Met.No. An example result from this survey is presented in Table 1.

Parameter	Number of users	%	Level of detail
Concentration	21	100	Percentage
Sea Ice Drift	18	85	High resolution
Sea Ice Thickness	18	85	Actual values
Sea Ice Type	17	80	WMO ice classes
Ice Edge Mapping	16	76	Detailed
Other	16	76	Surface temperature
Ice Deformation	15	71	Leads and polynyas
Icebergs	14	67	Occurrence/Drift

Table 1 : Survey of importance of ice-measurement requirements in the Arctic Ocean

Nearly all respondents (20 or 95 %) required meteorological information. Of these, all wanted information on winds whilst 48 % also wanted information on atmospheric air pressure and 19% identified other parameters of interest, including air temperature, visibility, and surface fluxes. Nearly all respondents (19 or 90 %) required oceanographic information with greatest interest in current data (80 %) while other oceanographic parameters were less important with 38.1 % wanting sea surface temperature, 24 % bathymetry, 19 % chlorophyll data and 14 % identified other parameters including surface fluxes, salinity, tides, and waves. Ocean and tidal currents was the clear wish of the shipping community, with all 7 respondent organisations requesting it. In addition, the respondents were asked how often they required ice information to be updated. "As often as possible" and "on request" represented the largest group, with 90 % of respondents. Daily was next most requested with 57 %. There were no requests for annually updated products.

The overall conclusion that can be reached from the results of the questionnaire are that the users of sea ice charts require as much information on different parameters as possible with the best detail available, and this made available to them as often as possible. Most of the need is for tactical information, with only some requiring operational and strategic forecasting for their activities.

There is a strong demand for all the different parameters of sea ice information. Some of these, particularly sea ice thickness, require more work to be done by the scientific community before

Work Package 2

Figure 7: Operations icebreaker Magadan and tanker Primorsk in sea ice. With permission Nordic Bulk Carriers.

that information can be made available in a reliable way to the operational organisations producing sea ice maps. New ways of presenting information on some sea ice parameters, that go beyond the standard World Meteorological Organization (WMO) and Ice Services symbologies, will have to be developed. The requirement for as much detail in the mapping as possible, with frequent updates, suggests that:

- more work be done on the assimilation of high resolution data products derived from satellite sensors such as synthetic aperture radar and optical into forecast models; and
- outputs of these models are made available more frequently, or in a way that users can plot ice information based on a combination of assimilated data and model forecast for a particular time that they require.

Under half of the responding organisations required strategic forecasts. This is partly because only some user sectors require planning of their investment that far ahead, and also due to some lack of awareness of how long-term changes to conditions may affect their operations. The follow-up questionnaire should aim to include the results of long-term forecasting done under WP1 with examples of scenarios of how future changes might affect user sector operations.

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Work Package 3 – Fisheries

The main objective of WP3 is to estimate and quantify how climate changes impact Arctic fisheries and aquaculture, and the livelihood of communities and economic actors depending of these industries.

SINTEF provides NOFIMA with two series of spatially distributed simulation data on temperatures and zooplankton biomasses, representing the current climate conditions and the A1B scenario. Data has been provided and will be used to parameterise a cellular automata model representing possible ecosystem dynamics of the Barents Sea associated with bioeconomic performance of the system under different management conditions.

BEIJER and NOFIMA have mapped the aquaculture production volumes farmed within the Arctic, with respect to species and geographic location (Fig. 8). The aquaculture production in the Arctic region, defined as north of the polar circle (blue circle), is mainly carried out in Northern Norway together with small shared in North of Russia, Sweden and Finland. Norway is the main Actor in its salmon and rainbow trout farming. Also legal and guiding policy documents for this sector were produced for use in WP 5. On the onset of the ACCESS' second year industry actors will be addressed in a questionnaire survey to gain further insight in factors limiting production in the Arctic.

One of the WP3 objectives is to substantiate the impact of cost increases and demand changes on the fishing fleet, from governmental regulations and/or consumer behaviour respectively, from mitigation attempts to climate change. In this first year, data on fuel costs have been gathered and a model developed, to carry out a sensitivity analysis on vessel groups from the effect of fuel price increases. Based on the price of oil, especially the price shock in 2008, and the profitability study for the fishing fleet, a sensitivity analysis is being conducted, generating information on which fleet groups that will be rendered unprofitable under sufficient fuel price increases. Similarly, price effects are being analysed in the same model.

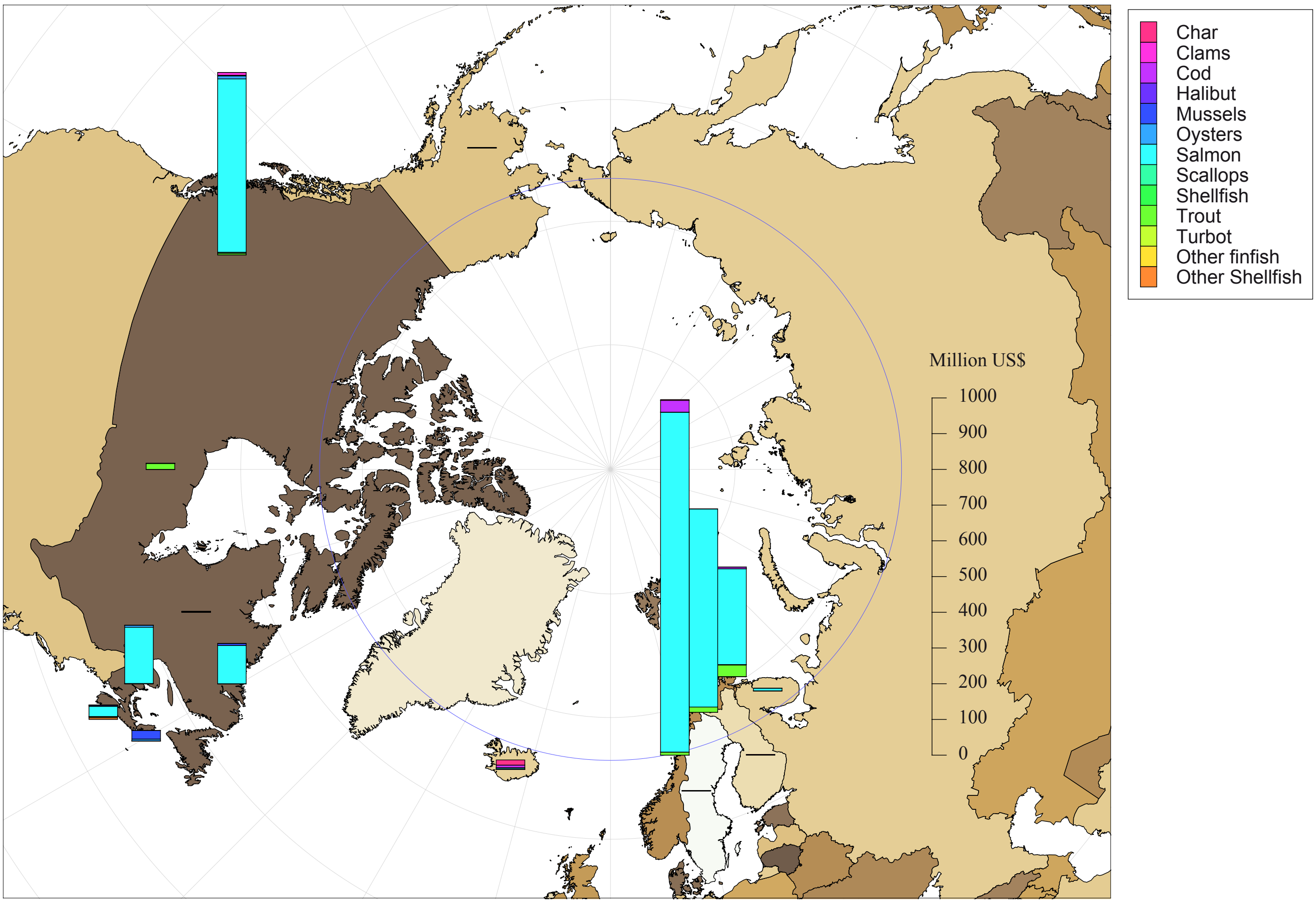

Figure 8: Value ($USD) of aquaculture production in the Arctic and surrounding area in Canada and Alaska in 2010, reflected by the height of the charts, in relation to various resource groups (different colours). With permission Øystein Hermansen and Max Troell.

Work Package 3

Research also is being conducted to analyze past, recent and possible responses in the fishery sector to climate change, including indirect, multiple order and cumulative impacts for the purpose of:

- Gaining a greater general understanding of local economies in the Barents region as well as familiarity with local sensitivities and circumstances;
- Identifying the principal risks and uncertainties that may impact the fishery and aquaculture sectors and to compare their magnitudes;
- Identifying an inverse relationship between coastal economies and environment as well as between natural factors influenced by non-natural factors of political decisions, economic developments and cultural values.

The starting point of this study was to estimate the potential implications of climate variability on economic activities related to the fishery and aquaculture sector of the Barents region. The analysis of economic activities is being conducted in the context of social, political and economic changes in human-environmental interactions that go beyond the resources, analyzing the intersection between society and environmental systems with concern over the ways in which biophysical changes have been perceived and negotiated in the economic sectors. The assessment has been performed at multiple levels: the international, national and regional / local.

The main fieldwork of WP3 was conducted in Northern Norway: Tromsø – Kirkenes – Hesseng - Sør Varanger fjords (October 2011 and January-February 2012), including boat trip to the salmon farm and offshore feeding platform, visiting of salmon processing plant, and land-based fish farm. The research was carried out using methods of interviewing, participant observation, and comparison and analysis of the combined data. This research focused on the aquaculture industry and mass production of fish in open net pens and land based farming with regard to:

- Perception of the risk and benefits of aquaculture farmed fish and farmed fish consumption (in depth interviews in Finnmark with managers and the public);
- Double exposure for the local fishing communities to aquaculture and king crab invasion (adaptive practices in the coastal villages);
- Challenges to Norwegian politics regarding, environmental, economic and human health issues;
- Ethno-political dimensions of fish farming with regard to indigenous Sami groups.

There also were complementary interviews with Russian fishermen in the Kirkenes harbor, municipal Seamen's club, harbor custom office, local enterprises related to delivery services for Russian vessels, researchers of the Barents Institute and of the local museum (eight semi-structured in-depth interviews). This work was particularly valuable for gaining a greater view into community viability issues and current situation in the Russian fishery sector. Addressing issues of the coastal community of Kirkenes, which has an economy that has been heavily dependent on the landing of Russian vessels, deals with the current situation when landing patterns have changed and are less present in this Norwegian harbour. Data also are being compiled and mapped with regard to economic parameters associated with: cod harvesting in the Barents Sea by the Murmansk fleet in 2010-2011; number of operating harvesting vessels of the Murmansk region in 2006-2011; catch dynamic of the Murmansk enterprises in 1995-2011; fish export in the Murmansk region in 2002-2011; King Crab catches in 2000-2011; aquaculture of the Murmansk region in 2005-2011; cod and haddock distribution in the Barents Sea 2009-2011; and areas and periods of most active fishing in the Barents Sea from 2006-2010.

Additional research is being conducted to model the primary productivity and zooplankton production that underlies the fisheries that exist in the Barents Sea region (Fig. 9, page14). A coupled 3-D, hydrodynamic-ice-chemistry-biology model system (SINMOD) was used to simulate the zooplankton production and distribution that will be used as input to the fisheries models. SINMOD uses atmospheric forcing from various sources depending on the area and time period to be simulated. In the Arctic Tipping Points (ATP) project supported by the EU, high-resolution atmospheric data were generated by Max Planck Institute's Regional atmospheric Model (REMO) model using the IPCC Special Report on Emissions Scenarios (RES) scenario A1B. The simulation period was from 2001 to 2100.

WP3 is devoted to the socio-economic impacts Arctic climate change might have on the fisheries and aquaculture industries. A warmer climate will definitely change the distribution of warm Atlantic water and seasonal ice cover in the European Arctic. This will again affect the primary (phytoplankton) and secondary (zooplankton) production – the basic energy source for the fish populations.

In the present climate, highest primary production is found in the Atlantic nutrients are easily mixed into the euphotic zone during the early summer. In the northern Barents Sea ice and in the Arctic Ocean the growth rate is reduced in spring due to reduce light into the water column by the ice cover. When the ice melts, a strong thermocline is formed that inhibits the nutrients to be mixed into the euphotic zone. Towards the end of the century a strong increase in primary production is found in the western Kara Sea and in the Atlantic water that flows along the northern slope of the Barents Sea (Fig. 9b, page 14). Secondary production seems to increase in the Southern Barents Sea, but decrease in the Northern Barents Sea and on the East Greenland shelf as the Northern areas warm (Fig. 9d, page 14). The substantial decrease in zooplankton production in the northern areas is due to increased temperature that is unfavourable for Arctic zooplankton species, but not high enough to enable production by Atlantic species in the Arctic Ocean.

It is recognized that greater understanding of current conditions is required, especially in view of the recent discovery of unexpectedly high phytoplankton production under the Arctic sea ice in the Beaufort Sea and Chuckchi Sea. Possible local and regional climate change effects are investigated by University of Lapland, with special emphasis on fisheries and aquaculture and related environmental issues. The task is carried out by applying anthropological methods during field works in the Russian-Norwegian Arctic.

Behavioural responses of stakeholders are investigated as well, by setting up a number of laboratory experiments to mimic decision behaviour in fisheries. Several experiments have been carried out and a first draft report is under preparation and results have been presented by different occasions. More experiments are planned, also including field experiments. This task is carried out by BEIJER.

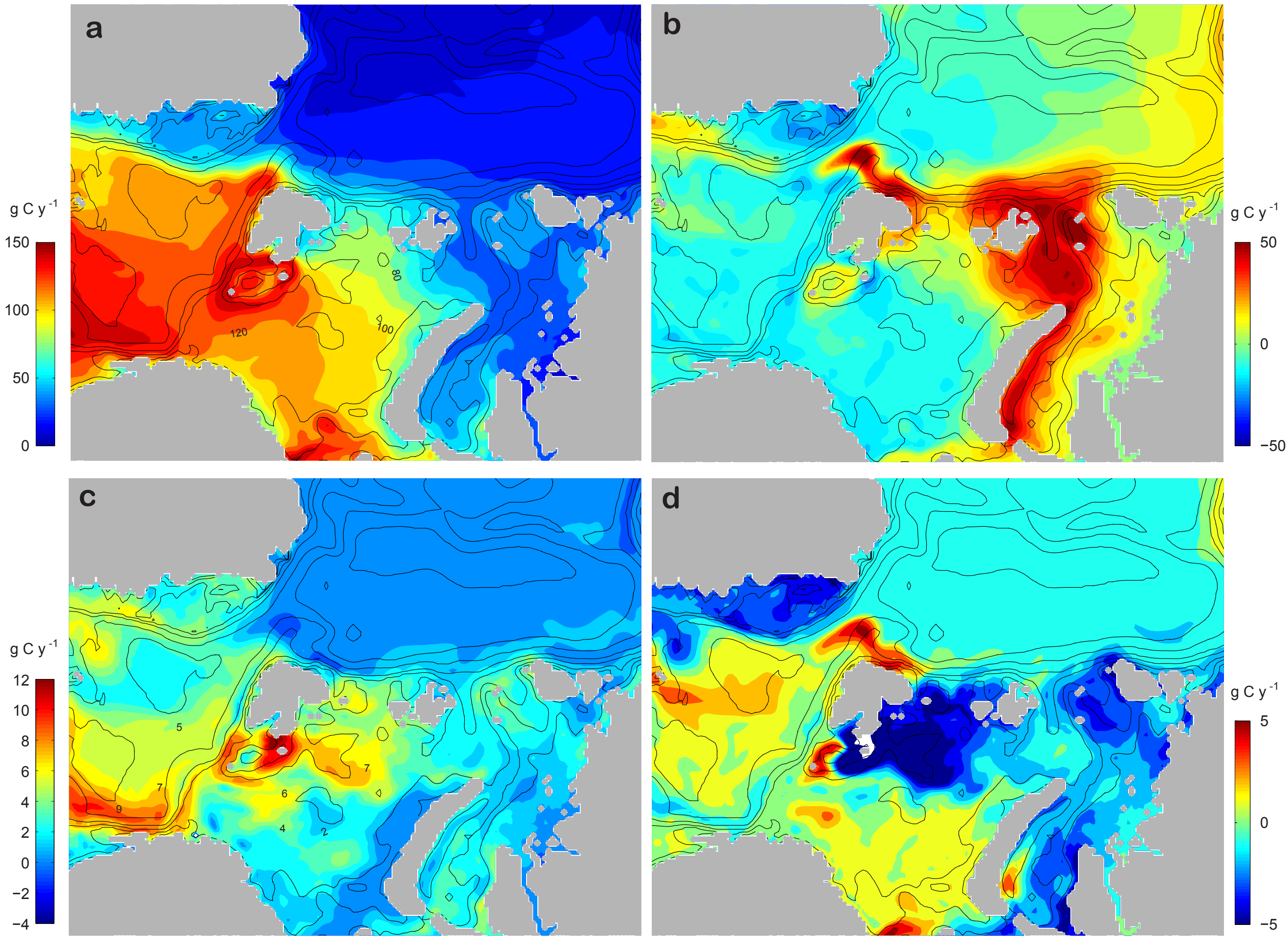

Figure 9: Simulated production levels (colour chart in grams carbon per square-meter per year) across latitudes and longitudes in the Barents Sea, Arctic Ocean. Present annual mean primary (a) and secondary (c) production for the years 2001 to 2020. Difference between present and future annual mean primary (b) and secondary (d) production for the years 2080 to 2099. With permission Dag Slagstad and Ingrid Ellingsen.

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Work Package 4 – Resource Extraction

The main objective of WP4 is to assess the risks and opportunities associated with the extraction of hydrocarbons from the Arctic Ocean. These assessments will be further considered in view of socio-economic impacts on European and world markets.

Work Package 4 (WP4) covers a diverse range of topics that encompass many different disciplines and sectors. From the socio-economic impacts of resource extraction on European and world markets, to the technologies and risks involved in the safe extraction of hydrocarbons, through to the environmental pressures on the marine environment due of these developments. Because of this the first year of ACCESS has been a year for integration, consolidation and understanding within WP4. Even so much work has been performed in the tasks that make up this WP. Below is a breakdown of the tasks performed with the WP over this first 12 months.

Socio-economic impacts of resource extraction

One goal of this mulit-sectorial activity is to analyse the socio-economic impacts of extended production of hydrocarbons in the Arctic region using a two-step modelling approach. The basis for these efforts and one of the key innovations are good estimates of production costs of off-shore oil and gas production under (uncertain) Arctic conditions. The partners, IfW, EWI and IMPaC, agreed on a scenario-based approach to cope with the inherent uncertainty about the production environment and economic conditions. These scenarios as well as their key determinants have been discussed and drafted. Technically relevant information for exploration, production and transport of hydrocarbons has been gathered and summarized in a report and first cost estimates for possible exemplary extraction scenarios have been made (IMPaC) in preparation for the modeling work to come, They await final partner approval along with WP1 input on environmental information.

EWI's gas market model MAGELAN was extended and refined to better display real-world behavior of agents. It now allows for an analysis of strategic behaviour of different players in the global gas market. Due to the far-reaching improvements and extensions of the gas market model, the model has been renamed and is now called COLUMBUS.

Assessment of technological issues

HSVA and IMPaC assessed existing technologies for the off-shore production of hydrocarbons, including fixed and floating structures as well as sub-sea systems, and identified technological gaps that prevent technology adoption under Arctic conditions (Fig. 10). HSVA concentrated on the winterization problem of vessels operating under Arctic climate. Rules, guidelines and recommendations of classification societies as well as international organisations and national authorities were reviewed. HSVA also worked on the influence of ship geometry and on environmental impacts on ice accruement and measures to prevent ice accretion. IMPaC started to analyse the existing technology for exploration, production and transportation of hydrocarbons in terms of its feasibility to work in harsh environments and even in ice conditions. As a first result of this work IMPaC modified its available and patented LNG (liquefied natural gas) transfer system concept.

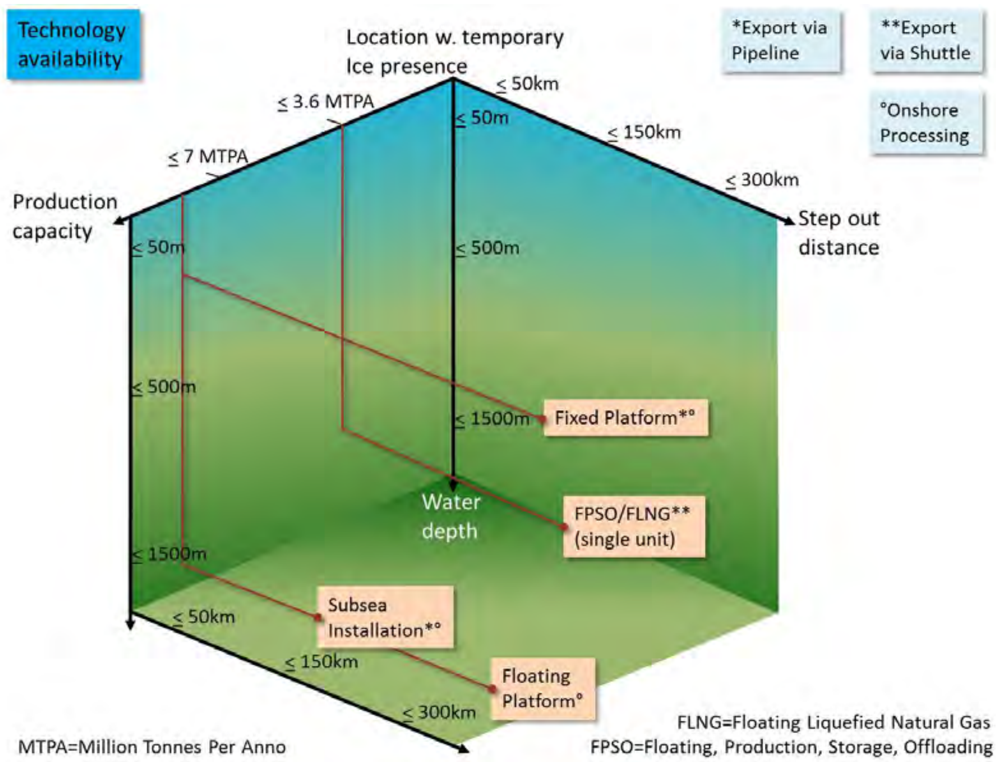

Figure 10: Production technology 3D-matrix: Types of technology (fixed, floating structures etc.) that are suitable to exploit gas and oil under different conditions (water depths, step out distance, production capacity) in the Arctic Ocean. With permission Sven Hoog.

Assessment of environmental risks related to resource exploration, extraction, and transportation, and contingency planning for mitigation of risk

Oil spill contingency and response strategies vary considerably between open water and areas with a sea ice cover. The temporal and spatial variability of the Arctic sea ice means that we need strategies that are tuned to the appropriate ice and weather conditions at the time of a spill. Partners SAMS, SINTEF, HSVA, UCAM, and Met.no are providing an objective assessment of the strengths and weaknesses of the present oil spill response capabilities and technologies in ice-covered waters by performing a simultaneous up-to-date assessment of the main areas:

- oil detection;
- oil fate, behaviour and weathering;
- oil modeling; and
- oil response techniques / countermeasures.

Within each of the four above mentioned areas we are 'boiling down' the knowledge that has been amassed over many decades, including the significant review papers that have been prepared, as well as drawing on information from the recently conducted reviews by the Joint Industry Project (JIP). Our review is further subdivided in a number of realistic scenarios, which are link together with possible sea ice conditions. These scenarios are displayed in Figure 11.

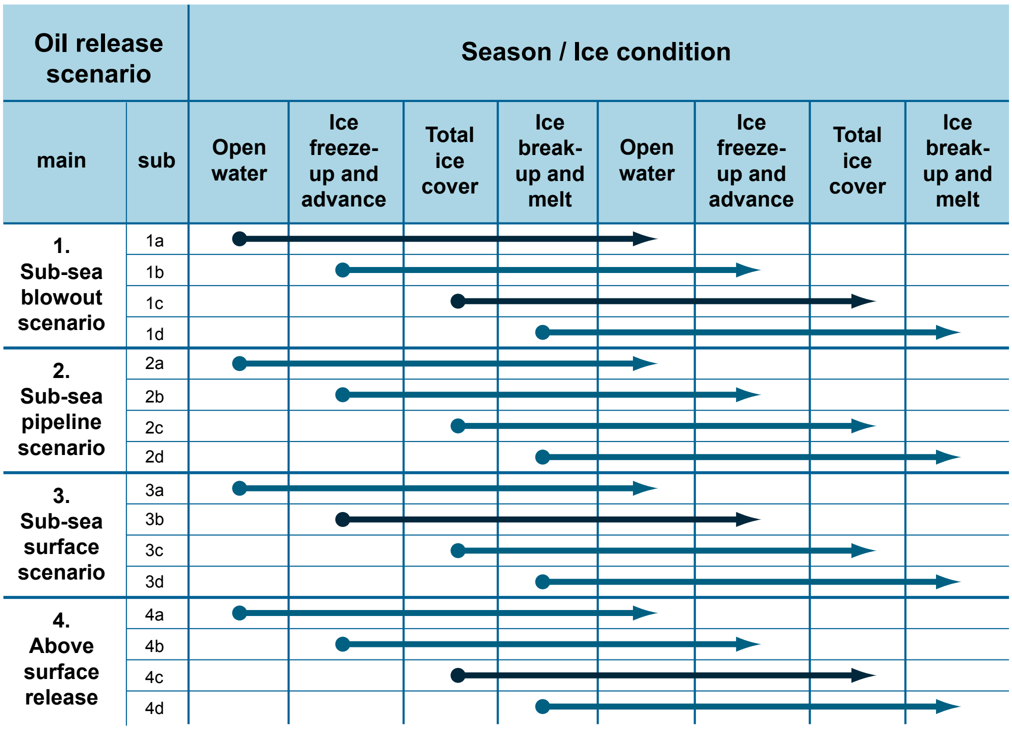

Figure 11: Suggested scenarios for oil spill response in ice-covered waters. With permission Jeremy Wilkinson.

Along with the report on the oil spill response capabilities and technologies in ice-covered waters SAMS, SINTEF, UCAM, and Met.no jointly aim to provide a better understanding and parameterisations of oil behaviour in ice covered seas. This is to be achieved through a series of repeatable and controllable tank experiments. Work within this Task only commenced during the final months of Year 1 and thus we are only in the early stages. In early 2012 we participated with US colleagues in separately funded oil spill tank experiments that were carried out at the US Army Cold Regions Research and Engineering Laboratory (Fig. 12, page 17). Data from these experiments are presently being analysed and results will be used to tune the tank experiments being performed in the Year 2.

A better understanding of oil behaviour in ice covered seas will lead to more accurate oil spill models. It is generally accepted that open-ocean oil spill models are well established and perform well in open-ocean conditions, however modelling of oil flow in the presence of sea ice is more uncertain. We are developing an under ice oil trajectory model based around a high-resolution 3-D dataset of the ice bottom, thus overcoming the inadequacies of previous under-ice oil spill models. This powerful combination enabled under-ice oil spill modelling to go significantly beyond the state-of-the-art and allowed for the first time an accurate appraisal of the potential oil holding capacity of sea ice. We have found that the modelling the flow of oil under sea ice is challenging because our analysis has revealed that the under ice topography of sea ice is very heterogeneous in nature. As a result there will always be different stages in the movement of oil that are dependent on a combination of the changing nature of the under ice topography and the absolute amount of oil spilled. We look forward to incorporating results from the upcoming Autonomous Underwater Vehicle (AUV) runs in WP1 along with the parameterisation of oil flow under ice that are being performed. Taken together these activities will reduce the uncertainty within the model.

Assessment of other environmental pressures

Existing data on oil and gas emissions is very limited and mainly from reports prepared by AMAP and OSPAR. On this background, CICERO recently developed a dataset together with other partners within the Norwegian Arcact project, which will be accessible to ACCESS. In addition, new data will be collected by ACCESS partners. CNRS-LATMOS is working, in collaboration with DLR, on an aircraft campaign to study oil and emissions in the Arctic region that will take place in Andoya, northern Norway in July 2012. Contacts are being made with oil companies in order to make flights close to operational oil platforms during the campaign. DLR performed

Work Package 4

Figure 12 : Oil spill experiments at the United States Army Cold Regions Research and Engineering Laboratory in Hanover, USA. Oil was injected under the ice from above (left), and a suite of instruments, including cameras, sonar, and a laser system, were placed on a trolley beneath the slick (right). This work was partly funded by the Oil Spill Recovery Institute (http://www.pws-osri.org/). With permission Jeremy Wilkinson.

test flights in plumes of oil and gas platform emissions along the coast of Italy and Borneo in the frame of other aircraft campaigns. Large enhancements of the concentrations of hydrocarbons, sulfur dioxide, volatile aerosols and other parameters were clearly detected in the vicinity of the oil and gas extraction facilities.

Furthermore UPMC-LOCEAN established a baseline set of parameters that are needed to monitor the health of the ocean environment before oil and gas extraction at any given site in the Arctic Ocean. Historically the Ocean environment was monitored expensively from ships (icebreakers) using CTD (Conductivity Temperature and Depth sensors) to sample vertical profiles of temperature and salinity from surface to bottom. Recently however a shift did occur towards the monitoring of the Ocean environment using autonomous platforms (ITP Ice Tethered platforms for example). Thanks to a large cooperation among Arctic scientists from many countries, more than 18000 CTD vertical profiles have been collected in the central and deep part of the Arctic Ocean, including data from icebreaker campaigns, drifting buoys (ITP), as well as from aerial survey and submarine cruises. They cover the period 1997-2009 and are distributed across the central Arctic basin. UPMC-LOCEAN already developed the physical oceanographic part of the data set, and a complementary data set containing the biological infrormation could readily be added in particular with respect to icebreaker campaigns.

Along with development of resource extraction facilities in the Arctic will be an increase in noise within the water column itself. This acoustic noise can cause problems to marine mammals. UPC provided noise measurements in collaboration with WP2 (shipping noise), WP3 (mapping of marine mammal populations, whaling and climate change) and WP5 (best practices). Corresponding modelling work of the seismic source has been performed by SIO, linking closely with WP1. Other activities include a simulator of noise contribution from seismic operations, real-time acoustic monitoring architecture development and the implementation of a passive acoustic monitoring system on site.

To model and manage the relationship between oil and gas exploration and production (E&P) noise and marine mammals, the partners adhere to the following process: First, measurements will be made on site under different environmental scenarios. The measurements of particular ships of interest around the activities will also be taken into account, allowing the most precise recordings. Second, to estimate the noise contribution to an area where E&P activities take place, the source level has to be estimated. This was preliminary done through simulations using the global ocean model (ORCA), computing the propagation loss and subsequently the source levels using simulated measured levels. The focus here is on the frequencies that were defined in the protocol. Third, the sources were placed in a different environment and using their estimated source the background noise levels in the environment were computed. For this different methods available in the ocean acoustic library were used. Finally, the data was entered into SONS-3D, which is an acoustic analysis system coordinated by the University of Cataluyna, to combine the noise produced by E&P activity with cetacean presence and to assess also the influence of the ships on the nearby area.

Provide legal and institutional solutions to new challenges

NERC targets at developing legal and institutional solutions to new challenges and elaboration of possible institutional and legal conflicts. A precondition is a critical evaluation of existing regulatory instruments (such as UNCLOS, OSPAR, as well as those dealing with offshore installations, emergency operations and pollution prevention conventions and protocols) relevant to the Arctic Region and to resource extraction, as well as an assessment whether this regulation can sustain the variations and pressures (such as increased iceberg occurrence, extreme weather conditions) brought to bear from climate change on the ocean environment. NERC has started this effort by summarizing and synthesizing relevant regulations related to Arctic oil and gas extraction.

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Work Package 5 – Governance, Sustainable Development and Synthesis

The main objective of WP5 is to integrate results of WP 1-4, revealing international and interdisciplinary policy options that can be considered by decision makers to ensure sustainable development and environmental protection of the Arctic Ocean.

During the first year of ACCESS, WP5 has focused on governance and synthesis (Fig. 13), two important responsibilities that needed to be put in place at an early stage of the project. The highlights of these include for the governance part an overview and assessment of current regulatory instruments (Deliverable 5.11: "Analysis and synthesis of extant and developing regulatory frameworks").

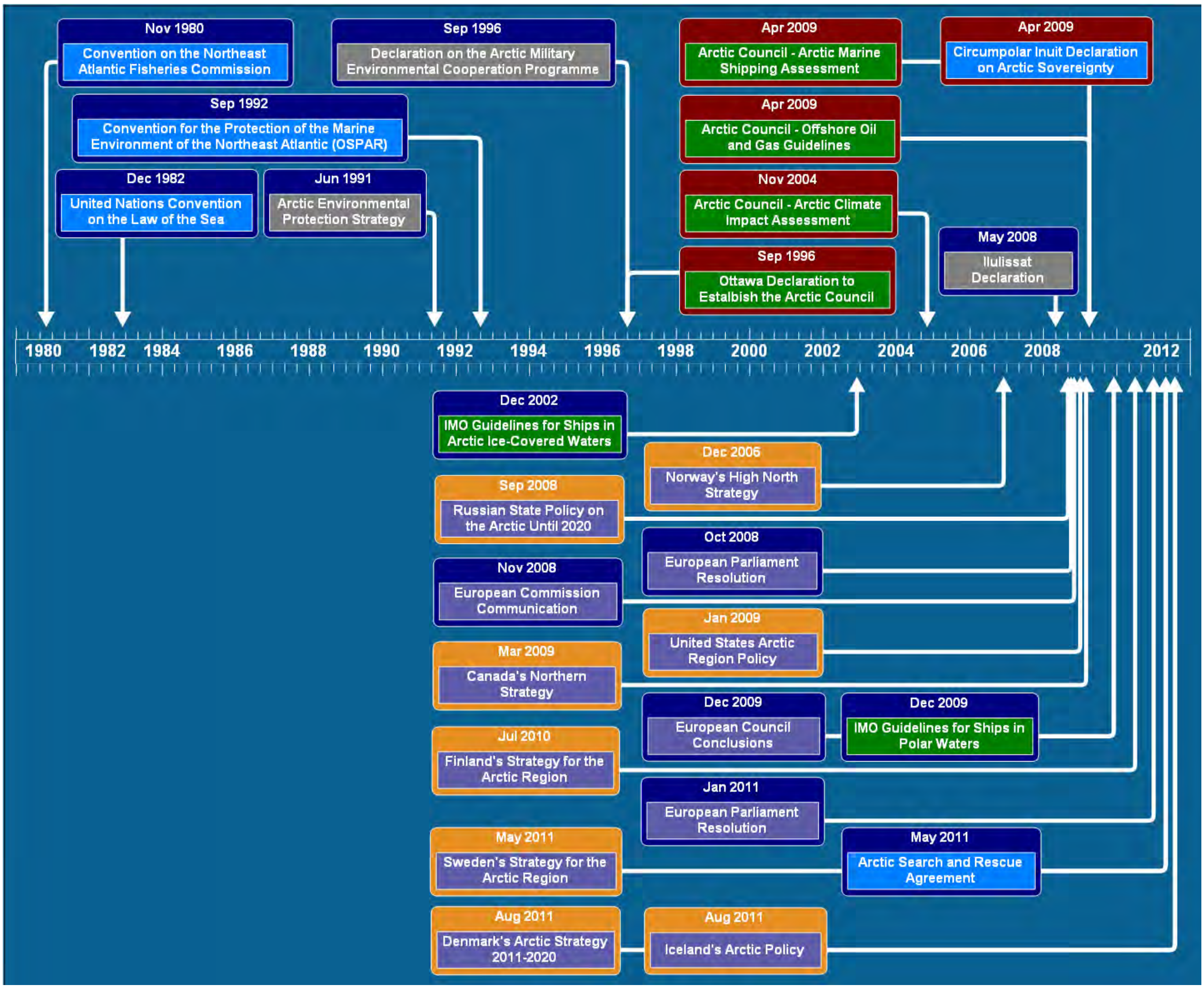

Figure 13: Illustrative timeline of 'hard-law' binding agreements and 'soft-law' guidelines to manage human activities and impacts in the Arctic Ocean. Color schemes are used to represent agreements that are similar in jurisdiction, scope or concept. Production of legal instruments that relate to the Arctic Ocean has markedly increased during the past decade. With permission Paul Arthur Berkman.

The Deliverable 5.11 report summarizes the different hierarchical levels of regulation, from supra-national/international through regional, multilateral and national, and includes assessments of hard and soft law, guidelines and recommendations:

- Within Arctic states;
- Between Arctic states parties;
- Between Arctic states and non-Arctic states parties; and
- Between states and non-states parties.

The Deliverable 5.11 report also highlights the complex and diverse range of instruments in play in regulation of man's activities in the Arctic Ocean and the great variety of approaches in place in the different ACCESS sectors.

The Deliverable 5.11 report then was used as the basis to start identifying governance gaps within the existing framework. The governance gaps that we identified include the lack of regional fisheries management systems in place for the Arctic Ocean, the absence of any provisions in place in the developing IMO Polar Code with respect to climate change effects, and a fragmented approach to regulations for the resource exploitation industry. In particular, it was noted from the vast majority of the texts and instruments examined and studied that there was a widespread shortfall in recognition and/or the addressing of the effects on legislation, agreements and guidelines that extend across diverse jurisdictions with interplay among institutions that has yet to be defined, especially in operational contexts.

Diverse boundaries that have been defined by different international institutions reflecting the complexity of governance and infrastructure development in this region surrounded by states that have sovereign jurisdictions in the marine environment, as reflected by:

- Southern limit based on the astronomical boundary of the Arctic Circle at 66.5o North (white circle);
- Large Marine Ecosystem boundaries revealed by AMSA;
- Potential continental shelf limits of the Arctic coastal states under UNCLOS;
- Exclusive economic zones and high seas under UNCLOS;
- Meteorological / Navigational Areas under the International Hydrographic Organization and International Meteorological Organization; and
- Search and rescue areas of the Arctic coastal states under their 2011 Agreement on Cooperation on Aeronautical and Maritime Search and Rescue.

Current shipping activity in the central Arctic Ocean is low, but with the reduction of sea ice an increase in shipping activity is anticipated. It would seem likely that at least initially (up to 2020) this will be mostly traffic travelling to and from Arctic harbours rather than trans-Arctic between continents. The list of threats, which are likely to develop acutely in relation to the increase in shipping – such as risk of accidents, pollution and spills, black soot, alien species, choke-points and search and rescue issues – is long and complex. Major efforts by the International Maritime Organisation to develop a mandatory Polar Code are beginning to bear fruit, albeit after a long process.

The oil and gas extraction sector overlaps significantly with the shipping and marine transport sectors, and much of the current legislation, as well as soft law and guidelines are intimately integrated with the transportation regulations. However, the fact that oil and gas E&P is one of the fastest growing demand sectors is likely to affect the Arctic in the coming years and decades.

For fisheries, there is a lack of a strong commercial industrial focus in the Arctic Ocean. Transboundary stock distributions, and/or developing management practices present ongoing challenges, but some areas – such as the Barents Sea – enjoy a significant level of fishing activities. Aquaculture is a prominent and growing industry in the region (Fig. 8). Regulation as regard to fisheries is scattered and combined of different national legislations complemented with several bilateral agreements.

WP5 continued its work on regulatory systems relevant to the Artic Ocean in the context of climate change in its preparation of extant governance options that are currently available for the region. These will be examined during the course of the ACCESS project to assess how suitable they would be if they remained in place over a period of long-term climate change. In the event of their potential inoperability, alternatives, or amendments would be suggested. These options are numerous and range between comprehensive re-formulation of regulations and minor modification of existing arrangements – and it is this spectrum of strategies that needs to be examined fully to evaluate its suitability to act in a fully integrated process of ocean governance.

The synthesis work in WP5 during Year 1 consisted of preparatory and organizational activities, and development of methodologies for the Marine Spatial planning tool (MSP) and the Framework for Integrated Ecosystem Based Management (FIEBM). MSP is a tool that incorporates multiple users of the Arctic Ocean to provide support for informed and coordinated decisions about how to use marine resources sustainably. MSP uses maps to create a more comprehensive picture of a marine area – identifying where and how an area is being used and what natural resources and habitat exist. ACCESS WP 5 will use the MSP as a tool to conduct an integrated ocean management assessment, where strategic options for promoting the conservation and sustainable use of the marine environment can be developed. MSP will focus on the regulatory, scientific, socio-economic and environmental parameters associated with, and affected by long-term climate change in the Ocean and directly analyze the impacts of climate change. MSP may, for example, demonstrate the changes in transport pathways, increasing traffic and the pollution effects (WP 2), changes in fish migratory patterns and bio-mass (WP 3) and the socio-economic impacts of increasing hydrocarbon exploitation and its potential effect on the marine environment (WP 4). Incorporating such data into the MSP will provide an efficient way of observing changes in marine space use and recognition of areas of potential conflict of use. During year 1, WP5 worked to produce a planning concept and framework for the development of the MSP element of ACCESS (see ACCESS Newsletter No. 2).

WP 5 has also started working on the synthesis task dedicated to FIEBM as an environmental management approach that recognizes the full array of interactions within an ecosystem, including humans, rather than considering isolated issues, species or services. Hence social interactions, economic activities, their interactions with each other and with underlying ecosystems are at the heart of the FIEBM to be produced. During year 1 we identified which particular aspects in a FIEBM ACCESS should focus on. In contrast to MSP, which focuses on the spatial aspects of interactions, the focus of the FIEBM will be on the nature and dynamics of the interactions between different sectors. FIEBM will also consider links to non-ACCESS sectors like the provision of ecosystem services in the Arctic Ocean and interactions with markets and other major drivers outside the Arctic. Contacts have been made with the Arctic Resilience Report of the Arctic Council to identify synergies.

Preliminary literature studies helped us gather available knowledge of the main ecosystem services related to ACCESS sectors and the location of possible hot spots. We also started to further assess the impacts of ACCESS activities on ecosystem services and how these may affected by climate change. This work relies to a significant extent on communication within the ACCESS consortium (e.g. delivery of information on by WP2 and WP3) as well as gathering of information from the EU FP7 project Arctic Tipping Points and other sources. The focus for the first year has been to find good communication channels to guarantee the flow of information to this synthesis task. In particular we have initiated collaborative exchanges between the people responsible for the MSP and the FIEBM to make sure that the tasks inform and complement rather than duplicate each other. Further we have put in place several channels for communication with other WPs and particular ACCESS participants.

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Work Package 6 – Dissemination and Outreach

The main objective of WP6 is to openly share research results from WP 1-5 with policy makers, industrial and academic stakeholders, and the public-at-large via the ACCESS Website , Flyer and Newsletter as well as through other media.

DELIVERABLES AROUND YEAR 1 OF THE ACCESS PROJECT				
Work Package	ACCESS Partner	DELIVERABLE		
		Number	Date	Title
WP1	Met.no.	D1.24	Month 14	Integrate additional satellite sensors into daily ice draft map production to improve summer melt
WP1	Met.no.	D1.41	Month 14	User guide containing quality assessment of Arctic weather station and buoy data
WP2	AARI	D2.11	Month 12	Historical ice conditions and its influence on navigation on Northern Sea Route
WP2	Met.no.	D2.14	Month 12	Assessment of current monitoring and forecasting requirements from users and international providers o services
WP3	UoL	D3.52	Month 13	Yearly report on ethical issues
WP4	SAMS	D4.41	Month 11	Oil spill response capabilities and technologies in ice free and ice covered water
WP5	NERC	D5.11	Month 13	Analysis and synthesis of extent and developing regulatory frameworks
WP5	NERC	D5.21	Month 14	Production of current governance options for ACCESS sectors / themes
WP5	NERC	D5.81	Month 13	Development of MSP concept and principal framework
WP6	UPMC	D6.11	Month 13	Annual dissemination and exploitation report and plan the report indicates the progress regarding the activities of all partners during the former year
WP6	UPMC	D6.21	Month 6	Creation of the ACCESS web site
WP6	UPMC	D6.211	Month 6	ACCESS Newsletter N°1
WP6	UPMC	D6.212	Month 10	ACCESS Newsletter N°2
WP6	UPMC	D6.213	Month 14	ACCESS Newsletter N°3
WP6	UPMC	D6.22	Month 8	Updated list of ACCESS related interested parties of four targeted groups: (1) Policy makers; (2) Academic stakeholders; (3) Industrial stakeholders; (4) Society, including indigenous people
WP6	UPMC	D6.24	Month 12	ACCESS Policy Brief
WP6	Met.no.	D6.31	Month 6	Creation and updating of a data management system
WP6	NERC	D6.32	Month 6	Creation and updating of a data management system non- climate data. Progress report will be integrated in the exploitation report

MILESTONE AROUND YEAR 1 OF THE ACCESS PROJECT			
Work Package	ACCESS Partner	MILESTONE	
		Date	Title
WP2	Met.no.	Month 6	Solicit user requirements
WP2	UPC	Month 12	Design and manufacture of low cost autonomous buoy for measuring under ice noise from ice going ships
WP4	IMPaC	Month 6	First estimates of oil and gas production costs for different ice scenarios
WP4	NERC	Month 13	Synthesis of regulations, agreements, legislation relating to oil and gas extraction sector, Report
WP5	LCP	Month 12	Level of participation of Arctic indigenous peoples in the present Arctic governance process
WP5	NERC	Month 13	Overview of existing regulatory instruments
WP5	NERC	Month 13	Identification of gaps in governance within this framework
WP5	NERC	Month 13	Development of Marine Spatial Planning (MSP) concept and principal framework – presentation of model, and subsequent versions
WP5	Oasys	Month 6	External Board's engagement
WP6	UPMC	Month 6	ACCESS website
WP6	Met.no.	Month 6	1st summer school on cross-sectoral ACCESS topics in Bremen

Work Package 6

ACCESS Advisory Board Interactions

The following comments and observations are based on the panel discussion among the Advisory Board members at the ACCESS General Assembling meeting in Stockholm, March 2012. Backgrounds of the Advisory Board members are sketched in ACCESS Newsletter No. 2.

Ms. Adele Airoldi pointed out the novelty of ACCESS based on how ACCESS was formed, its cross-sectoral approach and the way the results were going to be used. She mentioned the large number of on-going Arctic related EU projects and actions which were difficult to oversee right now and she pointed out the outcome was unclear yet for many of them. Ms. Airoldi strengthened that ACCESS has a role to fulfill with respect to the EU: The project ACCESS has the opportunity to shape the EU Arctic policy. She also pointed out that the EU commission at large would be very interested to be informed and updated on the progress of the project during its active phase. An unclear situation was mentionned by her with respect to the further development of the EU perspective on indigenous issues, given the difficult heritage derived from the past.

Prof. Hajo Eicken stated that the challenge for the project was big, even more so since it is largely a user-driven research approach, in contrast to academically-driven research. A very important aspect in his view was that this kind of EU Arctic research was perceived as impartial by others. He strongly urged to keep up this kind of neutrality. A challenge will be to bridge the requested level of high specificity and at the same time to keep up a pan-Arctic vision. He suggested to start with the local scale and then to zoom out at the pan-Arctic scale. A last issue he mentioned was the question of accessibility of the ACCESS quality controlled products and how results can and should be best communicated by the project to the outside world.

Ambassador Hannu Halinen pointed out the importance of international cooperation for all Arctic research, and the necessity to involve all players. Furthermore he highlighted the question of how ACCESS should and could convey the acquired knowledge to stakeholders and large public, and he suggested that the Arctic Council's action plan on outreach might be an appropriate example. He mentioned the ambitious program of the Arctic Council for the coming years, including the Arctic Change Assessment (ACA) and the Resilience Project. He welcomed the possibilities for ACCESS to provide an input to the ACA.

Minister Inuuteq Holm Olsen stated the willingness of Greenland to use the best practice to make use of the natural resources. He mentioned, the process was developing very fast at the moment, having started about 10 years ago. He pointed out the important question for understanding and anticipating where the forces of change might come from, the outside world, the climate or from the inside. He pointed out that policy makers were looking for solutions and this was one of the questions where science might play a role. He made one further recommendation, i.e. to think about possibilities to produce some outcome from the project not only in English language, but in other languages such as Russian and/or Inuit to reach a larger audience.

Professor Oran Young presented five observations related to ACCESS:

1. He highlighted the importance of linking the ACCESS research with other scientific programs, like the AO review, the Arctic Governance project, and to the debates about Governance and related discussions on EU policy.

2. Further he suggested to 'compare notes' with other programs, such IASC.

3. An important aspect he pointed out was to carefully keep an eye on the policy relevance of the research and to frame questions in a way that is relevant to on-going discussions e.g. in the Acrtic Council's working groups. An example may be the Arctic Human Development report of the Arctic Council from which Governance related researchers could be identified and to which connections could and should be made.

4. Pr Young stressed our attention on the great importance for the ACCESS research to envision and to understand the Arctic in a global context

5. For the next general Assembly he suggested a more interactive approach to better involve all ACCESS participants in the discussions and results of the project.

ACCESS Meeting with European Officials Regarding Arctic Affairs (Brussels, 20 February 2012)

EU representatives: Gaëlle Le Bouler (ACCESS Project Officer – European Commission, Research Technology and Development programme, Transport), Jaime Reynolds (European Commission, Directorate-General, Environment), Zuzanna Bieniuk (European Union, European External Action Service), Ramon Van Barneveld (European Commission, Directorate-General, Marine Affairs and Fisheries), Josep Casanovas (European Commission, Directorate-General, Mobility and Transport), Nikolaj Bock (Eureopean Environmental Agency), Marcus Lippold (European Commission, Directorate-General, Energy), Susanna Calsamiglia-Mendlewicz (European Commission, Directorate-General, Research and Innovation).

ACCESS representatives: Jean-Claude Gascard (ACCESS Scientific Coordinator), Adele Airoldi (ACCESS Advisory Board), Melanie Pellen (ACCESS Project Manager), Michael Karcher (ACCESS Assistant Coordinator), Joachim Schwarz (ACCESS WP2 leader), Wilkinson Jeremy (ACCESS WP4 leader).

This meeting was the second of a kind following a first meeting organized in Brussels on 7 July 2011 (cf minute report on the ACCESS website). The agenda covered four main topics that would be discussed further during the 2012 ACCESS General Assembly in Stockholm.

1. An update of the ACCESS project (one year after the kick-off meeting in Paris, France) before the General Assembly scheduled on 8-10 March 2012 in Stockholm Sweden.

2. Improved communication with European Commission departments involved in Arctic affairs. An update of the Preparatory Action proposed by the European Parliament to be implemented by the European Commission involving the future creation of an European Arctic Information Center.

3. Interaction between ACCESS and the Arctic Council Working groups and Tasks forces.

4. ACCESS and the international cooperation.

The following are highlights from this meeting:

- The European External Action Service requested ACCESS expert input on the value of proposals contained in the European Commission communication COM(2008)763: "*The European Union and the Arctic Region.*" It should be noted that on 26 June 2012, the European Commission issued a *Joint Communication to the European Parliament and the Council* along with accompanying documents on "*Developing a European Union Policy Towards the Arctic Region: Progress Since 2008.*"
- It was confirmed the DG Environment would be leading the implementation of the Preparatory Action proposed by the European Parliament on "*Strategic Impact Assessment of the Development of the Arctic.*" This Preparatory Action involved the creation of a European Arctic Information Center, which was mentioned in the European Parliament resolution from 20 January 2011 on a "*Sustainable EU Policy for the High North.*"
- Contributing to the productivity of the Arctic Council was discussed, especially with regard to engaging ACCESS experts in Arctic Council working group and task forces. Common interests and complementary expertise were identified in many areas, including: risks of oil spill in ice-covered areas; polar code for navigation; socio-economic impacts of climate change, especially on indigenous peoples; environmental impact of human activities, such as black carbon deposition from shipping; spring tropospheric ozone depletion; and sea-ice outlook of melting and freezing.
- There was strong interest to continue ACCESS linkages with Arctic programmes in North America and Asia, particularly through joint workshops, sharing logistics, data exchanges, complementary fieldwork, observing networks, and other forms of research cooperation.

International Collaboration Activities

Collaboration between ACCESS consortium partners and the Arctic Council working groups are being forged. Activity of the Arctic Council's 6 working groups and 6 task forces are structured in a way that could easily and logically trigger positive interactions with the five ACCESS working groups. In particular, five of the Arctic Council tasks force focusing on Short-Lived Climate Forcers (SLCF), oil spill preparedness and response, Arctic change and resilience report, Ecosystem-based management and Sustainable Arctic Observing Network (SAON), could benefit from ACCESS experts knowledge and vice versa.

One of the main activity of ACCESS relies on the development of a Marine Spatial Planning (MSP) and Ecosystem-Based Management (EBM) considered as the most appropriate tools for integrating a wide spectrum of expertise and knowledge linking the Arctic natural environment and human activities in a context of enhanced Arctic climate changes. This activity being also one of the main activity of the Arctic Council working groups and task forces plead legitimately for some mutually beneficial interactions with ACCESS working groups.

Building on the IPY and DAMOCLES (Developing Arctic Modelling and Observing Capabilities for Long-term Environmental Studies) and SEARCH for DAMOCLES, ACCESS also is involved in observing the Arctic Ocean including the atmosphere, sea-ice and ocean interactions, the Sustainable Arctic Observing Network (SAON) is another domain prone to fruitful and powerful interactions between the Arctic Council SAON Task force and the ACCESS consortium. ACCESS participated actively to the SAON Board meeting in Tromso in January 2012.

In addition, ACCESS partners are actively participating to the ACA (Arctic Change Assessment), the Arctic Ocean Review (AOR), the Arctic Resilience report and the Arctic Human Development Report II (AHDR) under the Sustainable Development Working Group (SDWG) following meetings organized by Arctic Council Working groups in Copenhagen (November 2011), in Reykjavik (September 2011) Stockholm and Roskilde (March 2012), respectively. ACCESS is also deeply involved in the Sea-Ice Outlook (SIO) activities leading to a better sea-ice prediction during the next 30 years having strong implications on important issues such as the navigation along the Northern Sea Route (NSR) and the IMO Polar Code.

Work Package 6

Meetings Involving Access Dissemination And Outreach

8-10 March 2011 – **1st ACCESS General Assembly**, Université Pierre et Marie Curie, Paris, France.

17-18 March 2011 – **Arctic Science, International Law and Climate Protection - Legal Aspects of Marine Science in the Arctic Ocean.** German Federal Foreign Office, Berlin, Germany.

28 March-1 April 2011 – **Arctic Science Summit Week 2011 / International Arctic Science Committee: Marine Working Group.** Seoul, South Korea.

23 May 2011 – **WP4 Planing Meeting.** Hamburg, Germany. This initial planning meeting provided an opportunity for WP4 collaborators to become acquainted and to discuss their shared activities throughout the ACCESS project.

31 May 2011 – **WP2 Meeting.** HSVA in Hamburg.

30 May-1 June 2011 – **Regional conferences: The Arctic and the EU: Environmental and Human Challenges.** Rovaniemi, Finland, and Stockholm, Sweden.

8-9 June 2011 – **WP3 Planning Meeting.** Beijer Institute, Stockholm, Sweden.

21-24 June 2011 – **77th Rose-Roth Seminar on Changes in the High North: Implications for NATO and Beyond.** NATO Parliamentary Assembly and Norwegian Parliament, Tromsø, Norway.

29 June-2 July 2011 – **Annual conference of the European Association of Environmental and Resource Economists.** Rome, Italy.

10-14 July 2011 – **21st International Conference on Port and Ocean Engineering under Arctic Conditions.** Montreal, Canada.

10-12 August 2011 – **Joint WP5 and ACCESS Steering Committee meeting to facilitate ACCESS project integration.** National Oceanography Centre, Southampton, United Kingdom.

5-6 September 2011 – **WP1/ACCESS workshop on "Climate Scenarios and Climate Simulations".** Haus de Wissenchaft, Bremen, Germany.

17-19 Sept 2011 – **Food security and aquaculture development in a globalized world - links and tradeoffs between marine and terrestrial production systems.** Askö Sweden.

20-23 September 2011 – **Oil Spill in Sea Ice, Past, Present and Future.** Istituto Geografico Polare "Silvio Zavatti", Fermo, Italy.

21-24 September 2011 – **2nd International Arctic Forum : Territory of Dialogue.** Russian Geographic Society. Archangelsk, Russian Federation.

27-30 September 2011 – **Polar Code Hazard Identification Workshop.** International Maritime Organization, Cambridge, United Kingdom.

5 October 2011 – **WP4 Meeting.** Institut für Weltwirtschaft, Kiel, Germany.

12-14 October 2011 – **Sustainable Shipping Conference.** Petromedia, Vancouver, Canada.

18-19 November 2011 – **Arctic Human Development Report : Regional Processes and Global Linkages (AHDR-II).** Sustainable Development Working Group of the Arctic Council, Copenhagen, Denmark.

23 November 2011 – **Seminar on The spatial dimension - A Step Forward for Fish Management ?** Institute of Marine Research Bergen, Norway

24-25 November 2011 – **ACCESS Fieldwork and Activities Workshop.** Laboratoire d'Océanographie de Villefranche, France.

29 November 2011 – **WP2 Meeting.** Nordic Bulk Carriers, Copenhagen, Denmark,

6 December 2011 – **Workshop on Aquaculture in the Arctic.** Nofima, Tromsø, Norway

7-8 December 2011 – **Anticipating the Future: Risk Management for Long-term Planning.** Centre for Risk Studies, Judge Business School, University of Cambridge, Cambridge, United Kingdom.

19-20 December 2011 – **19th International Congress on Modelling and Simulation.** Modelling and Simulation Society of Australia and New Zealand,

18-19 January 2012 – **WP5 Meeting.** Royal Academy of Sciences / Beijer Institute of Ecological Economics, Stockholm, Sweden.

25-26 January 2012 – **Arctic Tipping Points (ATP) project of the European Commission, Arctic Frontiers Meeting.** Tromsø. Norway.

25-26 January 2012 – **Sustainable Arctic Observing Network (SAON) taskforce of the Arctic Council, Arctic Frontiers Meeting.** Tromsø, Norway.

20 February 2012 – ACCESS Meeting with European Officials Regarding Arctic Affairs, Brussels, Belgium.

30 January - 1 February 2012 – **The "Responding to Change" workshop.** The Queen's University, School of Policy Science, Kingston, Ontario.

8-10 March 2012 – **2nd ACCESS General Assembly.** Royal Academy of Sciences Stockholm, Sweden.

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CONSORTIUM FOR THE ARCTIC CLIMATE CHANGE, ECONOMIC AND SOCIETY (ACCESS) PROJECT

ACCESS CONSORTIUM PARTNERS PARTICIPATION		WORK PACKAGE (WP)					
NO.	PARTNER (COUNTRY)	WP1	WP2	WP3	WP4	WP5	WP6
1	**UPMC –** Université Pierre et Marie Curie (France) - **LOCEAN –** Laboratoire d'Océanographie et du Climat: Expérimentation et Approche Numérique - **LATMOS –** Laboratoire Atmosphères, Milieux, Observations Spatiales - **LOV –** Laboratoire d'Océanographie de Villefranche	●	●		●	●	●
2	**OASys –** Ocean Atmosphere Systems Gmbh (Germany)	●	●		●		●
3	**NERC –** Natural Environment Research Council (United Kingdom)				●	●	●
4	**IfW –** Kiel Institute for the World Economy (Germany)				●	●	
5	**UCAM –** The Chancellor, Masters, and Scholars of the University of Cambridge (United Kingdom)	●	●		●	●	●
6	**AWI –** Alfred Wegener Institute For Polar And Marine Research (Germany)	●				●	
7	**JSC –** Joachim Schwarz Consultant (Germany)		●			●	
8	**NOFIMA –** Nofima marin AS (Norway)			●		●	
9	**HSVA –** The Hamburgische Schiffbau-Versuchsanstalt GmbH (Germany)		●		●		
10	**NPI –** Norwegian Polar Institute (Norway)	●					
11	**METNO –** Meteorologisk Institutt (Norway)	●	●		●	●	●
12	**FASTOPT –** FastOpt GmBH (Germany)	●	●		●		
13	**SAMS –** Scottish Association for Marine Science (United Kingdom)	●	●		●		
14	**RSAS –** The Beijer Institute of Ecological Economics, Royal Swedish Academy of Sciences (Sweden)			●		●	●
15	**SIO –** P.P. Shirshov Institute of Oceanology, Russian Academy of Science (Russian Federation)	●	●		●	●	
16	**IMPaC –** IMPaC Offshore Engineering (Germany)				●		
17	**UPC –** Universitat Politecnica de Catalunya (Spain)		●	●	●	●	●
18	**DLR –** The Deutsches Zentrum für Luft- und Raumfahrt (Germany)		●		●		
19	**AARI –** State Research Center Arctic and Antarctic Research Institute (Russian Federation)	●	●				
20	**ESRI –** The Economic and Social Research Institute (Ireland)		●				
21	**UoL –** Arctic Centre University of Lapland (Finland)			●			
22	**SINTEF F&H –** SINTEF Fiskeri og havbruk (Norway)			●	●		
23	**CICERO –** Center for International and Environmental Research (Norway)	●	●		●		
24	**SINTEF –** Stiftelsen SINTEF (Norway)				●		
25	**EWI –** Energiewirtschaftliches Institut an der Universität zu Köln (Germany)				●		
26	**LCP –** Le Cercle Polaire (France)					●	
27	**NBC –** Nordic Bulk Carriers (Denmark)		●				

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Comments and suggestions for the ACCESS Newsletter are most welcome
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