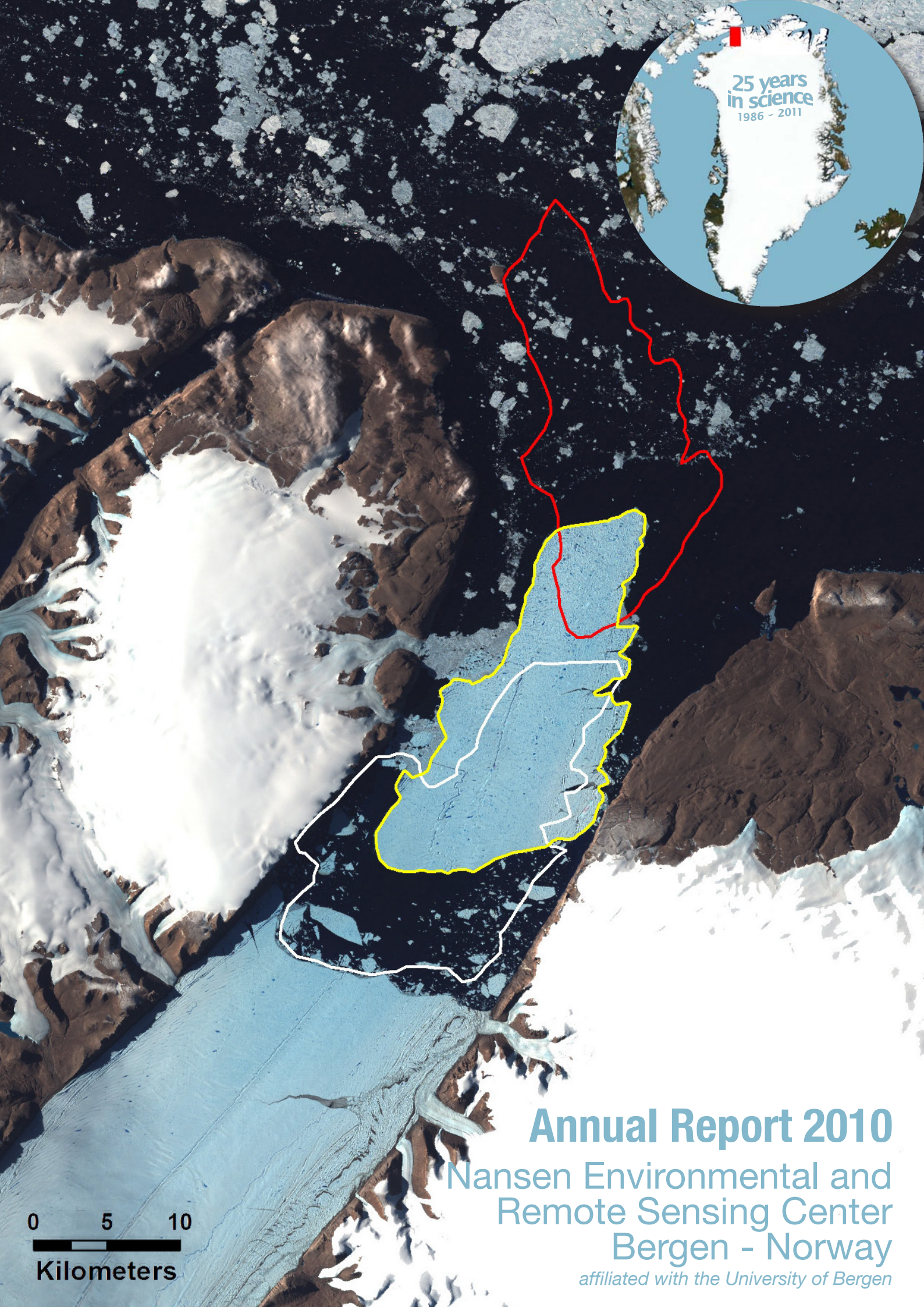


Annual Report 2010

Nansen Environmental and Remote Sensing Center
Bergen - Norway

affiliated with the University of Bergen

2010-report from the board

Vision

The vision of the Nansen Center is to serve the society through advancing knowledge on the marine environment and climate system in the spirit of Fridtjof Nansen.

Main research areas are:

- Climate processes, variability and change
- Arctic and Marine remote sensing
- Ocean modelling, data assimilation and forecasting
- Socioeconomic impact of global change

Organization

The Nansen Center is an independent non-profit research foundation affiliated with the University of Bergen, Norway. The Nansen Center conducts climate and environmental research projects funded by the research councils, space agencies, EU, national and international government agencies, industry and private donations. The Nansen Center has, after 24 years of research on the national and international level, still no basic funding from the Government of Norway, despite recommendations from the Research Council of Norway.

Staff

By the end of 2010 the Nansen Center employed 57 persons from 15 nations, including six in adjunct positions. The staff includes seven Post Docs and eight Ph.D. and one Master student. Foreign students and scientists from UK, Finland, France, India, China, The Netherlands, New Zealand, Russia and South Africa, have been visiting the Nansen Center for periods from weeks to several months during 2010.

The Nansen Center's goal is to be an equal opportunity employer. 40% of the employees were female in 2010.

Office and Environment

The premises and working environment is very satisfactory – both in Bergen and in our office in Svalbard Research Park in Longyearbyen. The board concludes that the Center does not pollute or in other ways harm the environment.

Cover page: On August 8th 2010 (white line) an approximately 270 km² large ice floe broke off from the Peterman Glacier at northern Greenland. The drifting floe was monitored daily, here shown in the Landsat image from 15th (yellow/floe) and sketch from 31st (red). The floes broke in two pieces between 8th and 11th September and drifted southward towards the Baffin Bay. Courtesy: Mohamed Babiker.

Scientific Production

During 2010 40 articles were published in international referee journals, including one in Nature Geoscience, one book, two book articles, 36 articles in conference proceedings, 20 technical and other reports, as well as seven popular science articles – totally 106 publications.

After completing their studies at and with supervision from the Nansen Center, four PhD students and two Master students defended their thesis at the University of Bergen. Another three doctoral candidates at the Center defended their thesis at foreign universities in 2010;

- Dr. Björn Backeberg: *Modelling the mesoscale variability in the Greater Agulhas Current System Using a Hybrid Coordinate Ocean Model*, Doctoral Thesis # 83, Department of Oceanography, University of Cape Town, South Africa. Supervisors at the Nansen Center: J.A. Johannessen and L. Bertino.
- Dr. Ling Ling Chen: *Greenland Ice Sheet Surface Elevation Change and Influence of Atmospheric Teleconnections in the Northern Hemisphere*, Doctoral Thesis # 90, Institute of Atmospheric Sciences, Chinese Academy of Sciences, Beijing, China. The supervisor at the Nansen Center: O.M. Johannessen.
- Dr. Florian Geyer: *Overflow and topographically induced mixing on the Svalbard shelf*, Doctoral Thesis # 82, University of Bergen, Geophysical institute. Supervisor at the Nansen Center: T. Eldevik.
- Dr. Intissar Keghouche: *Modeling the dynamics and operation of Iceberg in the Barents Sea*, Doctoral Thesis # 85, University of Bergen, Geophysical institute. Supervisors at the Nansen Center: O.M. Johannessen and L. Bertino.
- Dr. Gisle Nondal: *A study of the high and mid latitude biogeochemistry in the Atlantic Ocean: The Influence of surface process*, Doctoral Thesis # 88, University of Bergen, Geophysical institute. Supervisor at the Nansen Center: O.M. Johannessen
- Dr. Irina Sakova: *Low-frequency modes of variability of the Indian Ocean and the Connection with the Indian Ocean dipole*, Doctoral Thesis # 89, University of Tasmania, Australia.
- Dr. Alexandra Seiler: *Reservoir structural model updating using the Ensemble Kalman Filter*, Doctoral Thesis # 87, University of Bergen, Department of Mathematics. Supervisor at the Nansen Center: G. Evensen.
- Katherine K.B. Duarte: *An Inconvenient Truth on Norwegian climate coverage: whose voices and opinions are represented in the Norwegian press coverage of climate change*, Master Thesis # 84, Department of Information and Media Studies, University of Bergen. Supervisor at the Nansen Center: O.M. Johannessen.
- Sven Arild Haugen: *Acoustic tomography in the Fram Strait: - Predicted and Measured travel time*, Master Thesis # 86. University of Bergen, Dept. of Physics and Technology. Supervisors at the Nansen Center: S. Sandven and H. Sagen.

Outreach is done through the press, television and popular science lectures.

Awards

Professor Ola M. Johannessen was awarded the "*Visiting Professor of International Senior Scientists of the Chinese Academy of Sciences for 2010*" by Prof. Yongxian Dr. Ing Lu, President, Chinese Academy of Sciences. He was also elected as Honorary Member of the Norwegian Academy of Technological Sciences and received the "*Certificate*" from the Director-General of the European Space Agency for his contribution to the "*High-Level Science Policy Advisory Committee from 2007-2010*".

Professors Stein Sandven and Johnny A. Johannessen were elected as members of the Norwegian Academy of Technological Sciences.

National Cooperation

The Nansen Center is a partner of the Bjerknes Centre for Climate Research (BCCR) - a Norwegian centre of excellence, the Center for Climate Dynamics, established in 2010 as well as a member of Norwegian Climate Center and Bergen Marine Research Cluster. Furthermore, the Center has a memorandum of understanding with Institute of Marine Research and met.no in operational oceanography. The Nansen Center has extensive cooperation with the University of Bergen, UNIS and other Norwegian research institutions within our fields of expertise.

International Activities

By the end of 2010 the Nansen Center participated in 13 EU funded projects and co-ordinated four of them.

The Nansen-Tutu Centre for Marine Research at the University of Cape Town was officially opened by Archbishop Desmond Tutu in May and had its opening scientific conference in Cape Town in December 2010. The Nansen Tutu Center is founded on the initiative of the Nansen Center in Bergen, along with the Marine Research Institute (MARE/Department of Oceanography - University of Cape Town, the African Centre for Climate and Earth System Studies (ACCESS) and the Council for Scientific and Industrial Research (CSIR) in South Africa, the Geophysical Institute at the University of Bergen and the Institute of Marine Research in Norway and Princeton University, USA. Prof. Johnny A. Johannessen and Prof. Frank Shillington are the co-directors of the Nansen Tutu Center. Prof. John Field is the chairman of the board,

where Prof. Ola M. Johannessen and Einar A. Svendsen from Institute of Marine Research are co-chairmen.

The Nansen Center in Bergen has expanded the collaboration with the Nansen-Zhu Centre at the Institute of Atmospheric Physics (IAP) at the Chinese Academy of Sciences (CAS), Beijing with mutual exchange of scientists and Ph.D. candidates. 69 persons are now employed at the Nansen-Zhu Centre, including 48 Ph.D. and Master students. Prof. Hui-Jun Wang, Director General of IAP, is also the Director for the Nansen-Zhu Centre. Ola M. Johannessen and Hui-Jun Wang are co-chairmen of the Board. Ola M. Johannessen is "Visiting Professor" at the Institute of Atmospheric Physics, CAS and "Guest Professor" at the Peking University, and co-chief editor of the journal Atmospheric and Oceanic Sciences of the Chinese Academy of Sciences.

The Nansen International Center in St. Petersburg is focusing on satellite Earth observation of sea ice, wind, waves, polar lows, climate, marine ecosystems and water quality. It has furthermore started studies of socio-economic impacts of global change. Jean-Pierre Contzen is the President, Lasse H. Pettersson is the Co-vice-president. The Centre, led by Director Dr. Leonid Bobylev, now has 29 employees, including 12 Ph.D. candidates. Prof. Ola M. Johannessen is the Chairman of the Guardian Board.

The co-operation with the Nansen Center in Cochin is expanding with several new young scientists and Ph.D. candidates, focusing their studies on the Indian Ocean. Dr. K. Ajith Joseph is the Director of the Centre. The Nansen Center in Bergen co-operates with Cochin University of Science and Technology, Anna University in Chennai and Indian National Centre for Ocean Information Services (INCOIS), which is the national centre for operational oceanography in India located in Hyderabad. Prof. Ola M. Johannessen is the Chairman of the Board.

International Committees

Johnny A. Johannessen resigned in May 2010 as chairman of ESA's Earth Science Advisory Committee (ESAC). He is also member of "the ESA GOCE Mission Advisory Group" and "the ESA Sentinel-1 Science Advisory Group".

The Nansen Center is a major partner in EuroGOOS, which is an international organization with members from the major European meteorological and oceanographic institutions. The aim of EuroGOOS is to develop and coordinate ocean monitoring and forecasting in European and Arctic waters, as part of the "Global Ocean Observing System (GOOS)" program. Stein Sandven is the chairman of the "Arctic Task Team" and leads the international sea ice information system ArcticROOS http://arctic-roos.org/ established at the Nansen Center. S. Sandven is also a member of "ESA Cryosat-2 Science Advisory Groups" and J.A. Johannessen is a member of EuroGOOS Board.

Johnny A. Johannessen is a member of "GCOS Ocean Observing Panel for Climate (OOPC)" and Management Group in "Joint Technical Commission for Oceanography and Marine Meteorology (JCOMM)". L. Bertino is a member of the "Expert Team in Operational Ocean Forecasting" under JCOMM. J.A. Johannessen is also a member of "EUMETSAT Advisory Expert Group for Ocean Topography and Ocean Imaging Satellite Missions.

The Nansen Center is one of the founders of the "European Climate Forum" (ECF) and Ola M. Johannessen is a member of the Council. ECF is a multi-disciplinary forum gathering research, industry, governmental authorities, NGOs and stakeholders to meetings and projects dealing with climate change issues.

Ola M. Johannessen is also a member of the "Scientific Advisory Committee of the Euromediterranean Centre for Climate Change" in Italy and President of the Norwegian Scientific Academy for Polar Research and elected member of five other academies.

The G.C. Rieber Climate Institute

The G.C. Rieber Climate Institute is a department at the Nansen Center, and is led by Dr. Igor Esau. The department has a staff of 9 employees. The main activity of the department is devoted to the variability and the dynamic properties of the North Atlantic and Arctic climate system, including boundary layer studies between atmosphere, ice and ocean.

The Nansen Center is a partner in the Bjerknes Centre for Climate Research (BCCR) established in Bergen between the University of Bergen, the Nansen Center, the Institute of Marine Research and UniResearch AS. The department contributes to the development of the Norwegian Earth System Model (NorESM) and new research expertise is established within the turbulent small scale boundary layer modelling, which is used for studies of spreading of air pollution in cities and changes of climate in the cities.

The department also published in 2010 one study in Nature Geoscience on the thermohaline processes and interactions between the Atlantic and the Nordic Seas (Otterå et al., 2010).

The G.C. Rieber Funds support the department with NOK 0.7 mill. per year. The board sincerely thanks the G.C. Rieber Funds for this important support through many years.

The Board

Executive Chairman

Professor Ola M. Johannessen, Founding Director, Nansen Center

Vice Chairman

Dr. Anton Kjelaas, representative for UNIFOB Foundation

Members

Bjart Nygaard, Director, Rieber Eiendom AS

Professor Dag Rune Olsen, Dean, Faculty of Mathematics and Natural Sciences, University of Bergen

Mette Krohn-Hansen, Managing Director, StormGeo AS, Bergen

Lasse H. Pettersson, Representative of the employees

The Leader Team

Executive Chairman of the Board

Professor Ola M. Johannessen, also Professor Emeritus at Geophysical Institute, University of Bergen

Director

Stein Sandven, also Professor II at UNIS, Svalbard

Vice Director

Johnny A. Johannessen, also Prof. II at Geophysical Institute, University of Bergen

Mohn-Sverdrup Center for Global Ocean Studies and Operational Oceanography

Research Director Johnny A. Johannessen

Research Director Dr. Laurent Bertino, Deputy leader

Polar & Environmental Remote Sensing

Research Director Stein Sandven

Deputy leader Dr. Torill Hamre

G.C. Rieber Climate Institute

Research Director Dr. Igor Esau

Nansen-Bjerknes Center Group

Research Director Prof. Yongqi Gao

International Cooperation & Marketing

Director Lasse H. Pettersson

Administration

Director Bente E. Johannessen

Economy

Director Lars Gunnar Veland

IT

IT Leader Lars-Gunnar Persson

The Scientific Council

Chairman

Professor Lennart Bengtsson, Max Planck Institute for Meteorology, Hamburg

Members

Bo Anderssen, Director General, Norwegian Space Centre

Ghassem Asrar, Director, World Climate Research programme, WMO, Geneva

Lars Ingolf Eide, Independent consultant

John Erik Hagen, District Director, Norwegian National Coastal Directorate

Professor Peter Mosby Haugan, Institute leader, Geophysical Institute, University of Bergen

Professor Einar Hope, Norwegian School of Economics and Business Administration

Professor Øystein Hov, Research Director, met.no

Jan Petter Myklebust, Director International Division, University of Bergen

Pål Selvik, Chief finance officer, G.C. Rieber AS

Dr. Robert A. Shuchman, Senior Vice President, Michigan Tech Research Institute, Ann Arbor, U.S.A.

Einar Svendsen, Research Director, Institute of Marine Research

The Mohn-Sverdrup Center

The Mohn-Sverdrup Center for Global Ocean Studies and Operational Oceanography (MSC), a department at the Nansen Center, had 20 employees by the end of 2010. Johnny A. Johannessen, who also is Prof. II at the Geophysical Institute, University of Bergen, leads the MSC with Dr. Laurent Bertino as deputy leader. Its main research focus is to develop remote sensing methods for coastal and ocean areas, ocean and marine ecosystem models and data assimilation techniques. These are applied world-wide, but with focus on the Norwegian Sea, the Barents Sea and the Arctic Ocean Region (http://topaz.nersc.no).

Furthermore, ocean colour and infrared satellite data are used in real time monitoring of algae blooms and water quality conditions for the North Sea and Norwegian coastal water (http://HAB.nersc.no) and this activity is led by Lasse H. Pettersson.

The Mohn-Sverdrup Center, with Drs. Geir Evensen and Laurent Bertino, coordinates a large multidisciplinary project under the eVITA program of the Research Council of Norway for applications of the Ensemble Kalman Filter including development of new data assimilation methods in various fields such as oceanography, weather forecasting, oil reservoir modelling, health and bioeconomic management. The TOPAZ ocean forecasting model system is also implemented for the Indian and Southern Oceans in cooperation with the Nansen Center in Cochin and INCOIS, which is the national, centre for operational oceanography in India, as well as at University of Cape Town, South Africa.

Trond Mohn through Frank Mohn ASA supports the Mohn-Sverdrup Center with NOK 5 mill. per year. The board sincerely thanks Trond Mohn for his important support of 50 million NOK that we have received since 2004 and that will last until 2014.

Polar Remote Sensing

The polar remote sensing research activities are led by Stein Sandven, who is also a Professor II at the University Centre in Svalbard – UNIS. The Group has a scientific staff of 13 persons. The main research focus is development and validation of algorithms for retrieval of ocean and sea ice parameters, including detection of icebergs and their drift – from satellite Earth observation data. The information from the satellites is further used in studies of oceanographic processes and climate change. The department has started an acoustic tomography experiment in the Fram Strait, lasting until 2012. The experiment is a part of the EU projects ACOBAR and will measure the ocean temperature by acoustic signals.

Sea Ice information from satellite data is also used in hind-cast as well as in near real time to support navigation and operation in ice covered waters. Particularly, in the Northern Sea Route, monitoring is done in co-operation with Russian scientists from the Nansen International Centre and the Arctic and Antarctic Research Institute, both in St. Petersburg.

The research work aims to develop an integrated ocean and ice monitoring and forecasting system for the Arctic Ocean by using satellite and in situ data, in combination with modelling and data assimilation. The results are disseminated by ArcticROOS, http://arctic-roos.org/, which provides daily updated Arctic sea ice information.

The department also develops web-based geographical information systems (GIS) for integration of different types of satellite, in situ and model data.

The Svalbard office

The Nansen Center´s office in the Svalbard Research Park, Longyearbyen, contributes to building up Arctic research at the Center. The office is useful and supports several of the Center´s projects within oceanography and ice research in the Svalbard region as well as the cooperation with UNIS. The office is also used in connection with major cruise activities starting from Svalbard. Several students and young scientists from the Nansen Center in Bergen and St. Petersburg have stayed at the office during ongoing projects. The Nansen Center is planning to increase its activity at the Svalbard office, including our participation in the project "Svalbard Integrated Observing System (SIOS)". This is in support of the government's priorities on Arctic research.

Terra Orbit AS and CoTo AS

The Nansen Center is the owner of the companies Terra Orbit AS and COTO AS. The goal of these companies is to offer services for monitoring and forecasting of the environment and oceans. The potential revenue of these activities will in turn contribute to the scientific development in the areas where the Nansen Center concentrates its main research and development activities.

In 2010, Terra Orbit has produced a 3D test reanalysis of the South China Sea currents using a nested configuration of the NERSC HYCOM model to support offshore activities.

Nansen Scientific Society

The Nansen Scientific Society, established in 2006, is "the parent organization" for all the Nansen Centres in Norway, Russia, India, China, South Africa – and possible new centres in other parts of the world. It´s President is Prof. Ola M. Johannessen. Its main goal is to expand the existing "Nansen Fellowship Program" to support young scientists in environmental and climate studies. Furthermore, it contributes to the scientific coordination and funding of activities at the Nansen Centres – as well as public outreach. The vision is that research and education in environmental and climate issues performed by young people from different countries and cultures will help build a foundation for a better understanding and co-existence between people in the world - in the spirit of Fridtjof Nansen. The founders of the Society are the Nansen Center, Trond Mohn, G.C. Rieber Funds and Sparebanken Vest. The foundation started with an equity capital of NOK 10,8 millions.

In 2010 the Society has funded several Nansen Fellowships and exchange visits for students from China, India, Russia and South Africa as well as a summer school in Cochin, India for 46 Indian students. Furthermore it also funded an oceanographic expedition to the East coast of Greenland, organized by the Nansen Centre in Bergen.

Financial Situation

The Nansen Center is an independent non-profit research institute without any basic Governmental funding. The total income in 2010 was 42.39 MNOK. 1.792 MNOK is transferred to the equity capital, which now amounts to 38.835 MNOK.

The 2010 project income has mainly come from The Research Council of Norway, the European Commission (EU), European Space Agency, oil companies, the Norwegian Space Center and a small part from industrial projects. The Nansen Center has received substantial financial support (14%) from G.C. Rieber Funds and Frank Mohn ASA by Trond Mohn.

Prospects for 2011

We expect an expansion of our research activities in 2011, primarily due to increased activities in the Northern areas – where the Nansen Center has a major expertise and experience developed over the last 24 years. Additionally, increased funding for climate research is expected. The Nansen Center has an urgent demand for basic funding from the Government in order to further develop the expertise needed to meet the future needs within environmental and climate research.

Bergen, April 15th 2011

Ola M. Johannessen, Executive Chairman
Anton Kjelaas, Vice Chairman
Mette Krohn-Hansen
Bjart Nygaard
Dag Rune Olsen
Lasse H. Pettersson, Repr. of employees

science
report for 2010

Studies of Glaciers in Greenland Using Satellite and Oceanographic Data

Ola M. Johannessen, Mohamed Babiker, Victoria Miles & Alexander Korablev

The Greenland Ice Sheet is drained by outlet glaciers that terminate on land or in the sea, and by runoff from summer melting. Mass losses from the marine-terminating glaciers occur through calving of icebergs. The Nansen Center has over the last few years studied and monitored the calving from the Petermann Glacier in North-West Greenland and the Helheim Glacier in South-west Greenland by use of high-resolution radar (SAR) and optical satellite images over the last decades.

The Petermann Glacier extends out in the Petermann Fjord as a 70 km floating ice shelf. Petermann ice shelf is the longest floating ice shelf on the Northern hemisphere. In the last 50 years there have been several massive calving events where more than 100 km^2 of the ice shelf has been released and drifted as icebergs into the Nares Strait and the Baffin Bay. In August 2010 a record large calving event was observed in a series of images, where a 270 km^2 large part of the ice tongue was detached and started to drift out in the fjord (see Cover page).

The Helheim glacier front position in the Sermilikfjord has been studied systematically with satellite images from 1980 to 2010, showing the largest retreat of the front in 2005 (Figure 1). The reason for the variability in the calving events is not well understood, and several mechanisms can contribute to the events. It is hypothesized that the glaciers have recently become vulnerable to calving due to extensive fracturing and subsurface melting, where Atlantic warm water in the fjords can play an important role. In order to investigate the role of the ocean in melting of the outlet glaciers, the Nansen Center has conducted several field expeditions to the Sermilikfjord in East Greenland. Oceanographic measurements have been obtained in the fjord, showing that subsurface warm Atlantic Water up to 4.5^{0}C is present and represents a mechanism for melting of the outlet glacier. The studies will continue in the coming years to improve the knowledge of the effects of ocean and atmospheric forcing on the variability of the outlet glacier.

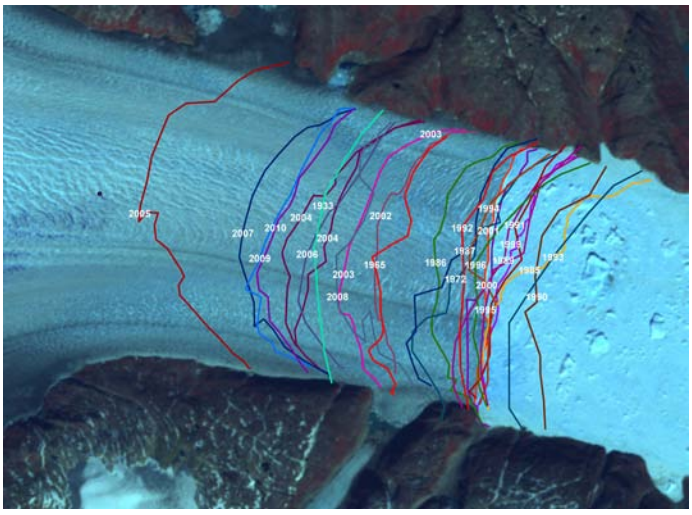


Figure 1. The Helheim glacier front location, derived from satellite images during 1980 to 2010 (Courtesy; Victoria Miles).

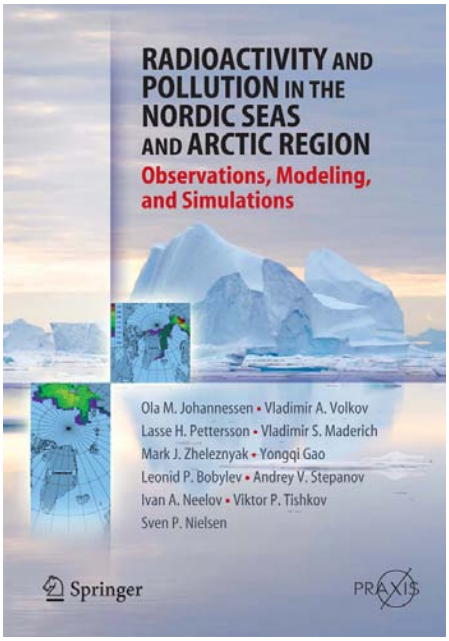
Radioactivity in The Nordic Seas

Ola M. Johannessen, Lasse H. Pettersson & Yongqi Gao

Radioactivity in the Nordic Seas and the Arctic is a matter of concern because it can persist for long periods and spread over large distances, primarily through the rivers and seas, but also the atmosphere. In terrestrial environments it may also lead to high exposure in organisms and humans. Therefore, the ability to understand and predict the spread of radioactivity and other contaminants (eg. persistent organic environmental toxins) through the environment, is important, complex and challenging. This requires a multi-scale multi-model system that can handle flows in rivers, including sediments, continental shelves, the deep Arctic and the Nordic Seas. "The generic Model System (GMS)" developed in the book "Radio Activity and Pollution in the Nordic Seas and Arctic region observation, Modelling and Simulations, Johannessen et al. 2010" represents a means to accomplish this – the GMS is thus one of the most important results from the decade of studies this book is based on.

As described, there are many potential sources of radioactive pollution both in terrestrial and marine environments. In parts of the Arctic, there is a high density of sources of radionuclides. The risk of accidents combined with the vulnerability of the Arctic environment from radioactive contamination increases the need for continuous efforts to understand and reduce the risks of spreading.

But there has been significant progress in recent years in regard to what can be done to reduce the risk of radioactive contamination



from any of the potential sources, mainly as a result of national and international measures (AMAP, 2009). Many of these potential sources are located in northern and northwestern Russia, including obsolete nuclear icebreakers and atomic submarines from the Russian Northern Fleet, most of which are now properly being condemned.

In the Arctic marine environment, discharge to the sea from reprocessing of spent nuclear fuel at Sellafield (UK) and Cap de la Hague (France) has been a major source of radioactive contamination, mainly ^{137}Cs but also other radionuclides. As presented here and in other studies, these pollutants are transported over long distances, they follow the Atlantic Current to the Norwegian Sea and along the Norwegian coast into the Barents Sea on a journey that takes 4-5 years, and finally reaches the Arctic Ocean.

Emissions of radionuclides and radiation levels - as well as persistent organic pollutants - observed in the Arctic and the Nordic Seas has gone down over the last century. However there remains much to do to reduce, predict and manage the risk of radiation. As we describe and model, the potential for the spread of radionuclides from discharges from sources that the Russian nuclear complex, especially those located along the rivers Ob and Yenisei, Sellafield and Cap de la Hague power plants, can be extensive and prolonged. Moreover, there are new potential sources of radioactive contamination, such as the Russian plans for a building floating nuclear power plants in the Russian Arctic ocean areas, and non-radioactive pollution from increased hydrocarbon exploitation and marine transportation in the Arctic, as expected from the estimates of further reductions in sea ice during summer.

Anthropogenic climate change will probably affect the transport of con-

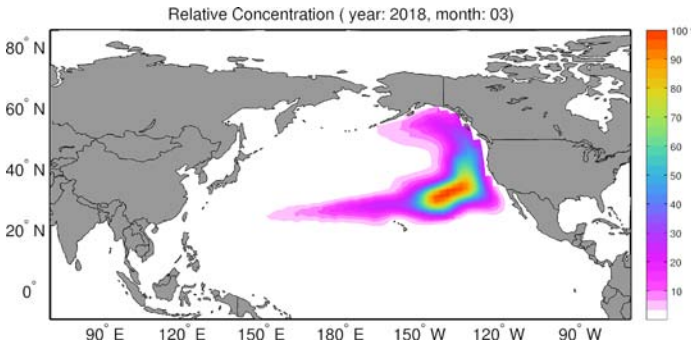


Figure 2. Location of center with maximum concentration in March of 2018 showing the release signal reached the eastern North Pacific with one branch towards the west and the other towards the Bering Strait.

taminants in the marine environment in the 21st century. Changes in the atmosphere and ocean circulation are expected to change routes and accumulation of pollutants in the marine environment. A new discovery is the potential change in the large-scale circulation of the Nordic and Arctic seas. Here we show that the modelled circulation patterns under a doubling of CO_2 in the atmosphere are very different from today, namely that the Baufort Gyre in the Arctic Ocean will dramatically weaken and that the Transpolar current disappears. This will cause the pollution that enters the Arctic marine environment to remain in the Arctic for much longer periods than today.

What about the risk for future releases of radioactive pollution and its transport to the Arctic and Nordic Seas? In the past, the resulting exposure of contaminants to biota and humans in the Arctic has been relatively low (AMAP, 2009) owing to the dilution of these pollutants in water. We have considered that the risk of release of radionuclides from point sources close to the rivers Ob and Yenisei, and find that in general the effects should be moderate, except during a severe accident. Model tools developed in this book can be very useful to predict the spread and effects of such pollution scenarios in the future - a future where climate change can play an important role in the spread of contamination.

Propagation of Radioactive Leakage from the Fukushima Nuclear Reactor

Yongqi Gao & Ola M. Johannessen

Anthropogenic environmental pollution with radionuclides is a global problem arising from the nuclear weapon tests in 1950s and 1960s. It is still an important environmental problem because radioactive discharges to atmosphere, land and sea have occurred during nuclear weapon testing and accidents at reactors of nuclear-power stations. The Chernobyl accident in Ukraine in 1986 is a well-known example. Furthermore, storage of radioactive materials from old nuclear reactors also represents a potential risk for radioactive leakage.

Since potential radioactive sources often are located in the coastal regions, contamination of the world oceans is a problem because it can have severe impact on the marine environment, and in particular the marine food chains. The temporal and spatial distribution of radionuclides in the ocean can be modelled by combining precise source functions of the radionuclides, available in-situ observations, and 3-dimensional Ocean General Circulation Models (OGCMs). It has been demonstrated that the OGCMs can be a powerful tool to simulate the temporal and spatial distributions of man-made radionuclides. Supported by European Commission and Norwegian Research Council, Nansen Center created the "Generic Modelling System" and has been working with numerical simulations on spreading of man-made radionuclides in the ocean for more than 10 years focusing on radioactive contamination in North Atlantic and Arctic regions under the present day and global warming scenario (Gao et al., 2004, J. Environ. Radioact., 2005, Tellus B; 2009, J. Environ. Radioact.; Johannessen et al., Praxis-Springer, 2010).

An extraordinary earthquake hit Japan on March 11, 2011, which generated a huge tsunami, which led to a severe accident at the Fukushima nuclear power plant on the east coast of Japan. The accident resulted in uncontrolled leakage of radionuclides to the ocean. In order to study the spreading of the radioactive pollution, the Nansen Center used it´s "Generic Modelling System" to simulate the propagation of radioactive elements over many years. In the simulation, a constant and continuous leakage from the Fukushima nuclear reactor for 1 year starting from March 2011 was assumed. The atmospheric forcing was provided by the NCEP/NCAR daily fields in 2010 and simulation were performed for a period of 20 years.

The results showed that the maximum concentration of radionuclides propagated eastward in the Pacific Ocean (Figure 2), while the total concentration decreased to 1 - 2% of the source concentration (100%) after 5 years. The radioactive material from Fukushima was fully confined to the North Pacific during the first 10 year simulation.

CryoSat Studies of Ice Thickness

Stein Sandven

European Space Agency launched the CryoSat-2 April 2010 and one of the major objective of the satellite is to measure sea ice thickness with Synthetic Aperture Interferometric Radar Altimeter (SIRAL). The Nansen Center has conducted CryoSat-2 pre-launch studies of sea ice using airborne altimeter data. A part of the pre-launch studies is the analysis of sea ice physics data from previous and new field expeditions in order to establish the relationship between freeboard, snow cover, snow & ice density and snow & ice thickness. This relationship is the basis for the ice thickness retrieval algorithm for CryoSat-2.

This algorithm needs to be adjusted and validated for different regions and seasons of the year using available data from in situ field experiments and airborne campaigns. One aspect of validating the algorithm is to analyse the accuracy of the ice thickness retrieval from freeboard data using documented variability in ice and snow parameters and assumed errors in ice freeboard measurements. This has been done based on various in situ data from Arctic expeditions and the results were published by Alexandrov et al., (2010) (Figure 3). For first year ice (FY), retrieval of ≈ 1.0 m thickness has an uncertainty of 50%. When the thickness increases the uncertainty is reduced. For multi-year (MY) ice the main uncertainty is ice density error, since the freeboard error is relatively smaller than for FY ice. Retrieval of 3.0 m thick MY ice has an error of 18 %. There are also other errors associated with the freeboard measurements, especially snow thickness and density . Studies of CryoSat sea ice thickness will continue and be extended with a PhD study starting in 2011.

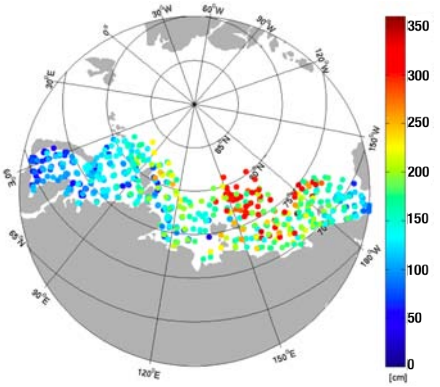


Figure 3. Observations of ice thickness, freeboard, and snow depth measurements during aircraft landings on Arctic sea ice in 1980s. The aircraft data were obtained during the Sever expeditions and are available at http://nsidc.org. The colour indicates mean ice thickness at each landing site.

Acoustic Tomography in the Fram Strait

Hanne Sagen & Stein Sandven

A multipurpose acoustic system was deployed in a Marginal Ice Zone (MIZ) in August 2010 in order to observe ocean temperature and currents in the Fram Strait using acoustic tomography method. The goal is to com-

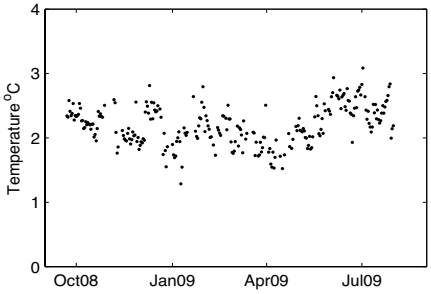


Figure 4. One year of acoustic travel time data inverted to sea water temperature in the West Spitzbergen Current.

bine observations from acoustic tomography, gliders and oceanographic moorings with ice-ocean models through data assimilation. This integrated system can be used to determine the volume and heat fluxes with better accuracy and more cost-effective than the present stand-alone mooring array. The system provides acoustic travel time measurements along 6 sections for direct assimilation into ocean models and for tomographic inversions. Gliders, equipped with acoustic receivers and software for acoustic navigation, will use the acoustic signals to perform under-ice surveys in 2011. Furthermore, ambient noise measurements from 5 vertical arrays will be used for detection and study of sounds from marine mammals and sea ice dynamics.

A one-year long series of travel-time data from the vertical receiving array, obtained from the pilot experiment 2008 – 2009, has been analysed to recover temperature variations along the 130 km section located in the West Spitzbergen Current (Figure 4).

After recovery of the moorings, the acoustic data has been carefully quality-checked, corrected for clock drift and mooring motion. Finally, the travel time data has been inverted to temperature representing an average estimate over the 130 km long section for different depth intervals between 150 and 500 m.

The travel time data have also been used to validate the Fram Strait ice-ocean model based on modelled travel time and observed sound velocity profiles from CTD data. The comparison shows that observed acoustic arrivals were 100 ms later than the calculated arrivals from the Fram Strait model. This leads to the conclusion that the temperature from Fram Strait model was less than 0.5° too warm for the selected case study. This is an innovative method to validate an ocean model using acoustic travel time data.

This research is done in cooperation with Scripps Institution of Oceanography, Woods Hole Oceanographic Institution, Alfred Wegener Institution for Polar Research and Greek Foundation for Research and Technology.

Marine Remote Sensing

Johnny A. Johannessen

The European Space Agency (ESA) Gravity Field and Steady-State Ocean Circulation Explorer (GOCE) mission was successfully launched in March 2009. The first GOCE gravity field and geoid model was presented at ESA's Living Planet Symposium in Bergen, Norway, in June 2010. Towards the end of 2010 the ambitious goal of mapping the Earth's gravity with unprecedented precision (gravity: ~1-2 mgal; geoid: ~1-2 cm) at a spatial resolution of ~100 km has almost been achieved. (Recently ESA obtained approval from its members states to extend the mission to the end of 2012.)

The mean dynamic topography (MDT) is derived from the difference between this GOCE based geoid height and the sea-surface height measured from altimetry (see Figure 5). This topographic surface is revealing insight into the global current regimes whereby the most intense currents are co-located with the steepest topographic reliefs. The Gulf Stream, the North Atlantic Current, the Norwegian Atlantic Current, the Kuroshio in the north Pacific, the Agulhas Current and the Antarctic Circumpolar Current in the Southern Ocean are clearly evident.

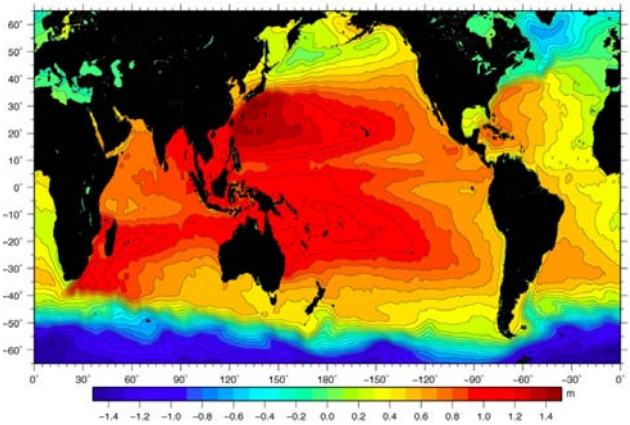


Figure 5. The mean dynamic topography of the world oceans derived from an altimetric mean sea-surface model combined with a model of the geoid based on just two months of GOCE data. The colour bar is in units of meter and reveals the main current regimes directed along the isolines of constant topography (Courtesy ESA).

At NERSC the regular use of this MDT in combination with the range Doppler velocity retrievals from satellite SAR (Johannessen et al., 2008), sea level anomalies from satellite altimetry and in-situ data is now emerging. Studies are particularly undertaken to advance the understanding of the relationship between the MDT and the temporal and spatial variations of the ocean circulation. The focus areas are the inflow of Atlantic Water to the Norwegian Sea between Island and Shetland Island (Hansen et al., 2011) and the greater Agulhas Current regime (Rouault et al, 2010). These current regimes with their corresponding transport of mass, heat and salt are highly important in the context of climate change. Improved accuracies in the estimation of these transports is also strengthening the capability to validate simulated products from the two ocean models run at NERSC.

NORMAP Database

Knut-Frode Dagestad and Johnny A. Johannessen

The Norwegian satellite Earth Observation database for marine and polar research (NORMAP) is a new infrastructure project funded by the Research Council of Norway for 6-years. NERSC is coordinating the project, with met.no and Kongsberg Satellite Services as partners, and with CERSAT (Ifremer, France) as international support. The kickoff meeting was in September 2010. The main objective is to simplify the access to satellite data for scientists and students, and stimulate multidisciplinary Earth System research, applications and education in marine, polar and climate sciences. NORMAP is creating and maintaining a repository of satellite data following international standards and protocols with particular cover of the high latitude and Arctic regions. The satellite data will reside at the production centres (the consortium partners and other external servers), whereas metadata will be collected and made available through a single server or interface. Hence the users will be able to discover and download data without needing to know where the actual data are stored.

NERSC and the other consortium partners will in the coming years populate the database with quality-controlled satellite data for marine, polar and climate sciences. A first operating version of the repository and web interface will be available at the end of 2011. This will later in the project be followed up by activities related to training and courses, as well as capacity building and international networking.

Climate Research

Igor Esau

The researchers of the group were able to run 600 years' simulations of the Bergen Climate Model with a realistic proxy forcing. This run (and its consequent variations) has a large scientific potential, of which only a small part has been reported yet in a Nature Geoscience publication (Otterå et al., 2010; Figure 6). In

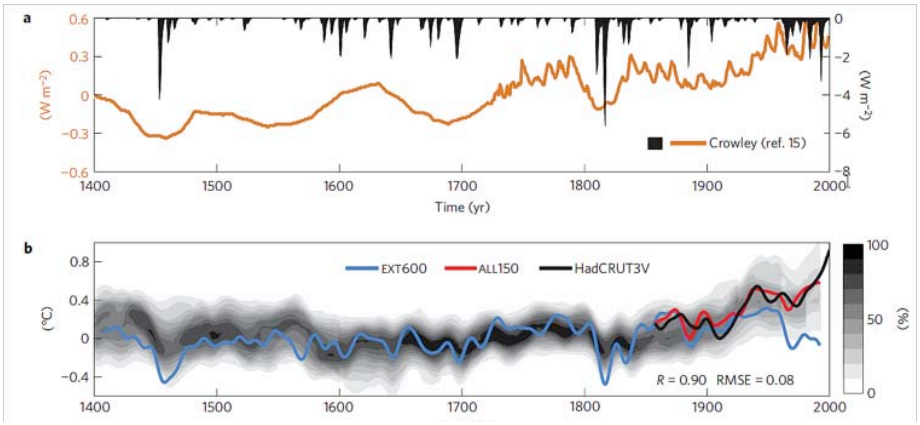


Figure 6. Observed and simulated northern hemisphere (HN) temperature and Atlantic multidecadal oscillation. a, Volcanic (black) and solar (yellow) forcings. b, Observed and simulated NH surface-air-temperature anomalies in the runs EXT600 (blue) and ALL150 (red) together with the concentration of overlapping NH temperature reconstructions (Otterå et al., 2010).

particular, it should be emphasized that this run allows direct studies of the Arctic early warming event from 1910 to 1940.

The group in collaboration with the University of Pretoria (South Africa) has completed the analysis of the African micro-meteorological data collected during 2008-2010 by 10 automatic stations deployed in the Highveld Priority Area. The measurement frequency (10 min.) and density (8 km to 50 km) make the experiment comparable with the fine-resolution numerical climate and weather prediction models. The data contain unique information on the role of the surface heterogeneities in the initiation of tropical convection and on the correlation between the land use type and the amount of rainfall.

The Role of External Forcing in the Arctic Early 20th Century Warming

Lingling Suo & Ola M. Johannessen

The observed early Arctic warming (1910-1940) is comparable with present-day warming in terms of magnitude. Although the present-day warming is widely attributed to the human-induced increase of greenhouse gases, the causes and mechanisms for the early 20th century warming are less clear. A series of coupled atmosphere-ice-ocean model simulations by the Bergen Climate Model covering the last 150 years, indicate that the solar radiation intensification and the lull in volcanic activity during the 1920-1950 periods were the main causes for the early 20th century warming (Figure 7A). The anthropogenic forcing supplied a small warming background in the period and played a role in getting the timing of the peak warming correct (Figure 7A). The reduced emissions of well-mixed greenhouse gases during the 1940s in combination with increased tropospheric sulphate aerosols contributed to a cooling trend from 1940 to late 1950s. The subsequent solar minimum starting in the late 1950s/early 1960s in combination with the strong volcanic eruptions in 1960s further added to the cooling. The results also show that sea ice played a vital role in Arctic early 20th century warming. According to the model experiments the increased radiative forcing caused sea ice to retreat (Figure 7B) and by that more ocean surface was exposed to the atmosphere, which subsequently released more heat into the atmosphere (Figure 7C).

Our results imply that the evolution of natural forcing over the coming decades could potentially play an important role in the future development of the Arctic climate. If the following decades would see a solar trend similar to what occurred in the early 20th century, the loss of Arctic sea ice would likely be more accelerated.

The Nansen TOPAZ4 Pilot Reanalysis

Laurent Bertino, Pavel Sakov & Francois Counillon

The TOPAZ ocean modelling and assimilation system has been used since 2003 for operational forecasting purposes. The same modelling and data assimilation system can also be run in a reanalysis mode, including all observations that are not available in near real-time, in order to compute the best estimate of the past state of the ocean.

The 4th version of the TOPAZ system has been through such an exercise for the 6-years period 2003-2008. TOPAZ4 is running the HYCOM model over the North Atlantic and Arctic Oceans at a resolution of about 12 km, coupled to an elastic-viscous-plastic sea ice model. An ensemble of 100 members is integrated to derive the flow-dependent error statistics and the deterministic version of the Ensemble Kalman Filter (Sakov and Oke, Tellus, 2008) is used to assimilate observations of different types: along-track sea level anomalies, sea surface temperatures, sea ice concentrations, and sea ice drift from satellites and in situ temperature and salinity profiles from the Nansen hydrographic database, including profiles from the Argo buoys and the Ice-Tethered Profilers (ITPs) deployed during the International Polar Year (IPY.)

The total number of observations assimilated per week is typically 400.000 after superobing. A few new innovations have been introduced in the course of the pilot reanalysis, such as an on-line bias estimation procedure and the moderation of observation errors that improved the system performance.

Figure 8 illustrates the sensitivity of the assimilation to observations of all types: the most useful observations in our system are located in

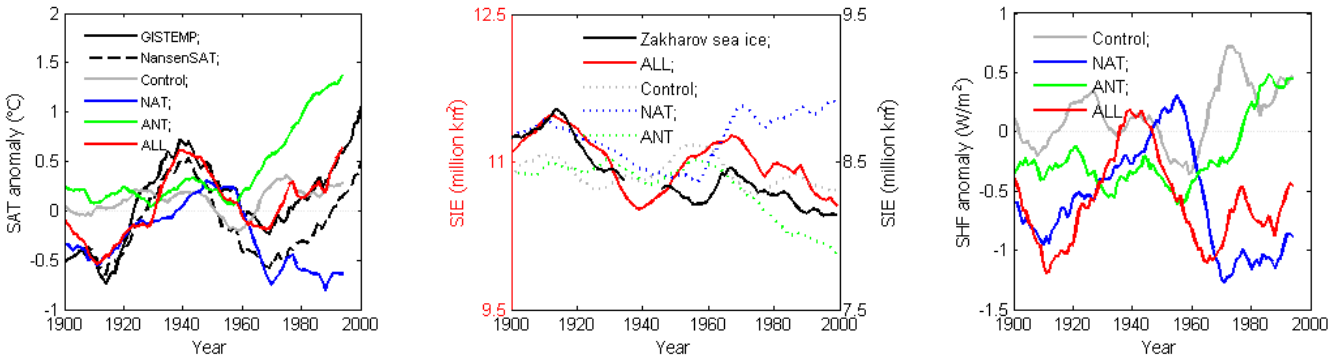


Figure 7. A) 11-year-running-mean variability of surface air temperature (SAT) anomaly in Arctic (north of 60°N); B) sea ice extent (SIE, left ordinate for model experiments and right ordinate for observation) and C) simulated upward surface heat flux (SHF, upward is positive) anomaly. Observed SAT is from GISTEMP (Hansen et al., 2010) and NansenSAT (Kuzmina et al., 2005). The observed sea ice extent is from Zakharov sea ice data, only covering 75% of the Arctic Ocean (see Johannessen et al., 2004). Control is control experiment with no external forcing variations; NAT is natural forcing experiment forced by solar variations and volcanic eruptions; ANT is anthropogenic forcing experiment forced by greenhouse gases and troposphere aerosols; ALL is all forcing experiment forced by all factors mentioned above.

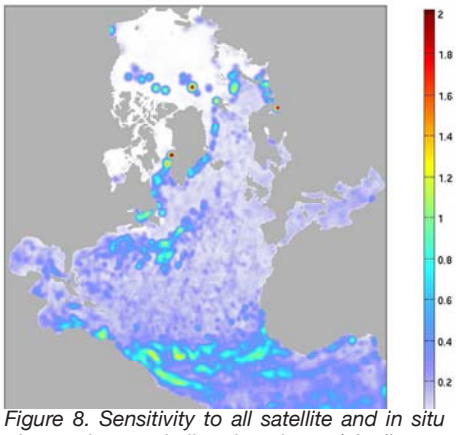


Figure 8. Sensitivity to all satellite and in situ observations assimilated on the 23rd April 2008 measured as ensemble Spread Reduction Factor (SRF) over the whole Atlantic and Arctic oceans TOPAZ4 model domain. An SRF of 0 means no impact and 1 means the ensemble spread has been halved. Note in particular the strong impact of ITP profiles below the sea ice.

frontal zones and close to the ice edge. During the year 2007, the deployment of ITPs and new Argo buoys has helped improving the water mass properties in the Central Arctic and in the Nordic Seas. The general circulation in the Nordic Seas also tends to improve during that period as an apparent consequence.

The overall good performance and stability of the Pilot reanalysis is an important milestone towards the 20-years reanalysis (1990-2010) planned for 2012.

The reanalysis is a part of the service delivery from the MyOcean Arctic Marine Forecasting Center, lead by NERSC. The monthly ensemble means are freely available under OPeNDAP, http://topaz.nersc.no/thredds, and from the MyOcean web portal, http://www.myocean.eu.org. A similar TOPAZ4 system is run in forecast mode in met.no's operational suite in MyOcean.

publications in 2010

Referee Papers in International Journals

Climate Research

Assmann, K M., **Bentsen, M.**, Segschneider, J., Heinze, C.: An isopycnic ocean carbon cycle model, Geoscientific Model Development, Copernicus Publications on behalf of the European Geosciences Union, 2010.

Chen, L., Johannessen, O.M., Wang, H., Ohmura, A.: Accumulation over the Greenland Ice Sheet represented in reanalysis data, Advances in Atmospheric Sciences, Science Press, Institute of Atmospheric Physics, Chinese Academy of Science, Vol. submitted, ISSN 0256-1530, 2010.

Orre, S.S., Smith, J N., Alfimov, J., **Bentsen, M.**: Simulating transport of 129I and idealized tracers in the northern North Atlantic Ocean, Environmental Fluid Mechanics, Springer Science+Business Media B.V., doi: 10.1007/s10652-009-9138-3, 2010.

Otterå, O.H., **Bentsen, M.**, Drange, H., **Suo, L.**: External forcing as a metronome for Atlantic multidecadal variability, Nature Geoscience, Nature Publishing Group, Vol. 3, doi: 10.1038/ngeo955, 2010.

Sandø, A.B., **Nilsen, J.E., Gao, Y.**, Lohmann, K.: Importance of heat transport and local air-sea heat fluxes for Barents Sea climate variability, Journal of Geophysical Research, American Geophysical Union, Vol. 115, pp.11, doi: 10.1029/2009JC005884, 2010.

Tjiputra, J.M., Assmann, KM., **Bentsen, M.**, Bethke, I., Otterå, O.H., Sturm, C., Heinze, C.: Bergen earth system model (BCM-C): model description and regional climate-carbon cycle feedbacks assessment, Geoscientific Model Development, Copernicus Publications on behalf of the European Geosciences Union, Vol. 3, doi: 10.5194/gmd-3-123-2010, ISSN 1991-959X, ISBN 1991-9603, 2010.

Yu, L., **Gao, Y.**, Drange, H., Otterå, O.H.: Diapycnal mixing in transient response of the Atlantic meridional overturning circulation in an enhanced freshwater perturbation experiment, Atmospheric and oceanic science letters, Institute of Atmospheric Physics, Chinese Academy of Science, Science Press, Vol. 3, No. 4, ISSN 16742834, 2010.

Oceanography and Sea Ice

Alexandrov, V., Sandven, S., Wåhlin, J., Johannessen, O.M.: The relation between sea ice thickness and freeboard in the Arctic, The Cryosphere, Copernicus Publications on behalf of the European Geosciences Union, Vol. 4, doi: 10.5194/tc-4-373-2010, ISSN 1994-0416, 2010.

Alpers, W., Ivanov, Y.A., **Dagestad, K.F.**: Observation of local wind fields and cyclonic atmospheric eddies over the Eastern Black Sea using Envisat synthetic aperture radar images, Earth Research from Space, Russian Academy of Science (RAS), pp.13, No. 5, ISSN 0205-9614, 2010.

Backeberg, B., Reason, C J C.: A connection between the South Equatorial Current north of Madagascar and Mozambique Channel Eddies, Geophysical Research Letters, American Geophysical Union, Vol. 37, doi: 10.1029/2009GL041950, 2010.

Dumont, D., Gratton, Y., Arbetter, T.E.: Modeling wind driven circulation and landfast ice-edge processes during polynya events in northern Baffin Bay, Journal of Physical Oceanography, American Meteorological Society, Vol. 40, No. 6, doi: 10.1175/2010JPO4292.1, 2010.

Fer, I., Skogseth, R., **Geyer, F.**: Internal waves and mixing in the Marginal Ice Zone near the Yermak Plateau, Journal of Physical Oceanography, American Meteorological Society, Vol. 40, No. 7, doi: 10.1175/2010JPO4371.1, ISSN 00223670, 2010.

Fujimura, A., Soloviev, A., **Kudryavtsev, V.N.**: Numerical Simulation of the Wind-Stress Effect on SAR Imagery of Far Wakes of Ships, IEEE Geoscience and Remote Sensing Letters, Institute of Electrical and Electronics Engineers (IEEE), Vol. 7, No. 4, doi: 10.1109/LGRS.2010.2043920, ISSN 1545-598X, 2010.

Geyer, F., Fer, I., Smedsrud, L H.: Structure and forcing of the overflow at the Storfjorden sill and its connection to the Arctic coastal polynya in Storfjorden, Ocean Science, Copernicus Publications on behalf of the European Geosciences Union, Vol. 6, 2010.

Hessen, D.O., Carroll, J., Kjelstad, B., **Korosov, A.A., Pettersson, L.H., Pozdnyakov, D.**, Sørensen, K.: Input of organic carbon as determinant of nutrient fluxes, light climate and productivity in the Ob and Yenisey estuaries, Estuarine, Coastal and Shelf Science, Elsevier, Vol. 88, pp.10, doi: 10.1016/j.ecss.2010.03.006, 2010.

Johannessen, O.M., Miles, M.: Critical vulnerabilities of marine and sea ice–based ecosystems in the high Arctic, Regional Environmental Change, Springer, Vol. 11, No. 1, doi: 10.1007/s10113-010-0186-5, 2010.

Kosnik, M V., Dulov, V., **Kudryavtsev, V.N.**: Generation Mechanisms for Capillary–Gravity Wind Wave Spectrum, Izvestiya, Atmospheric and Oceanic Physics, Pleiades Publishing, Ltd., Vol. 46, No. 3, doi: 10.1134/S0001433810030102, ISSN 00014338, 2010.

Morozov, E., **Korosov, A.A., Pozdnyakov, D., Pettersson, L.H.**, Sychev, V.: A new area-specific bio-optical algorithm for the Bay of Biscay and assessment of its potential for SeaWiFS and MODIS/Aqua data merging, International Journal of Remote Sensing, Taylor & Francis, Vol. 31, No. 24, doi: 10.1080/01431161.2010.508802, ISBN 1366-5901, 2010.

Rouault, M J., Mouche, A., Collard, F., **Johannessen, J.A.**, Chapron, B.: Mapping the Agulhas Current from space: an assessment of ASAR surface current velocities, Journal of Geophysical Research, American Geophysical Union, Vol. 115, pp.14, No. C10026, doi: 10.1029/2009JC006050, 2010.

Smedsrud, L.H., Ingvaldsen, R., **Nilsen, J.E.**, Skagseth, Ø.: Heat in the Barents Sea: Transport, storage, and surface fluxes, Ocean Science, Copernicus Publications, Vol. 6, pp.219-234, 2010.

Soloviev, Y.P., **Kudryavtsev, V.N.**: Wind-Speed Undulations Over Swell: Field Experiment and Interpretation, Boundary-layer Meteorology, Springer, doi: 10.1007/s10546-010-9506-z, ISSN 0006-8314, ISBN 1573-1472, 2010.

Modelling and Data assimilation

Dumont, D., Kohout, A., **Bertino, L.**: A wave-based model for the marginal ice zone including a floe breaking parameterization, Journal of Geophysical Research, doi: 10.1029/, 2010.

George, M.S., Bertino, L., Johannessen, O.M., Samuelsen, A.: Validation of a hybrid coordinate ocean model for the Indian Ocean, Journal of Operational Oceanography, Institute of Marine Engineering, Science and Technology (Imarest), Vol. 3, 2010.

Hansen, C., Kvaleberg, E., **Samuelsen, A.**: Anticyclonic eddies in the Norwegian Sea; their generation, evolution and impact on primary production, Deep Sea Research Part I: Oceanographic Research Papers, Elsevier Ltd., Vol. 57, doi: 10.1016/j.dsr.2010.05.013, 2010.

Keghouche, I., Counillon, F., Bertino, L.: Modeling dynamics and thermodynamics of icebergs in the Barents Sea from 1987 to 2005, Journal of Geophysical Research, American Geophysical Union, Vol. 115, pp.14, No. C12062, doi: doi:10.1029/2010JC006165, 2010.

Sakov, P., Bertino, L.: Relation between two common localisation methods for the EnKF, Computational Geosciences, Springer Netherlands, doi: 10.1007/s10596-010-9202-6, ISSN 1420-0597, ISBN 1573-1499, 2010.

Sakov, P., Evensen, G., Bertino, L.: Asynchronous data assimilation with the EnKF, Tellus A, Blackwell Munksgaard, Vol. 62A, No. 1, doi: 10.1111/j.1600-0870.2009.00417.x, ISSN 0280-6495, ISBN 13405, 2010.

Seiler, A., Aanonsen, S I., **Evensen, G.**, Rivenæs, J C.: Structural Surface Uncertainty Modeling and Updating Using the Ensemble Kalman Filter, SPE Journal, Society of Petroleum Engineers, Vol. 15, No. 4, doi: 10.2118/125352-PA, ISSN 1086-055X, ISBN 1930-0220, 2010.

Simon, E., Debreu, L., Blayo, E.: 4D Variational Data Assimilation for Locally Nested Models: complementary theoretical aspects and application to a 2D shallow water model, International Journal for Numerical Methods in Fluids, Wiley-Blackwell, doi: 10.1002/fld.2244, ISSN 0271-2091, 2010.

Wan, L., **Bertino, L.**, Zhu, J.: Assimilating altimetry data into a HYCOM model of the Pacific: Ensemble Optimal Interpolation versus Ensemble Kalman Filter, Journal of Atmospheric and Oceanic Technology, American Meteorological Society, Vol. 27, pp.753-765, doi: 10.1175/2009JTECHO626.1, ISBN 1520-0426, 2010.

Boundary Layer Research

Esau, I., Zilitinkevich, S.: On the role of the planetary boundary layer depth in the climate system, Advances in Science and Research, Copernicus Publications, Vol. 4, doi: 10.5194/asr-4-63-2010, ISSN 1992-0628, 2010.

Esau, I.: On Application of Artificial Neural Network Methods in Large-eddy Simulations with Unresolved Urban Surfaces, Modern Applied Science, Canadian Center of Science and Education, Vol. 4, ISSN 1913-1844, 2010.

Kouznetsov, R D., **Zilitinkevich, S.**: On the velocity gradient in the stably stratified sheared flows. Part 2: Observations and models, Boundary-Layer Meteorology, Springer, Vol. 135, No. 3, doi: 10.1007/s10546-010-9487-y, ISBN 1573-1472, 2010.

Zilitinkevich, S., Esau, I., Kleeorin, N., Rogachevskii, I., Kouznetsov, R D.: On the velocity gradient in the stably stratified sheared flows. Part 1: Asymptotic analysis and applications, Boundary-Layer Meteorology, Springer Netherlands, Vol. 135, doi: 10.1007/s10546-010-9488-x, ISBN 1573-1472, 2010.

Zilitinkevich, S.: Principal comments on numerical simulation of homogeneous stably stratified turbulence, Boundary-Layer Meteorology, doi: 10.1007/s10546-010-9484-1, ISBN 1573-1472, 2010.

Books & Book Contributions

Johannessen, O.M., Volkov, V.A., **Pettersson, L.H.**, Maderich, V.S., Zheleznyak, M., Gao, Y., **Bobylev, L.**, Stepanov, A V., Neelov, I A., Tishkov, V P., Nielsen, S.P.: Radioactivity and pollution in the Nordic Seas and Arctic region: Observations, Modelling and Simulations, Nansen Center´s Polar Series, Springer Praxis Books, Vol. 5, pp.408, ISBN 978-3-540-24232-1, 2010.

Esau, I., Sorokina, S.: Climatology of the Arctic planetary boundary layer, Atmospheric Turbulence: Prediction, Measurement, and Effects, Nova Science Publishers, Inc., pp.3-58, 2010.

Romeiser, R., **Johannessen, J.A.**, Chapron, B., Collard, F., Kudryavtsev, V.N., Runge, H., Suchandt, S.: Direct surface current field imaging from space by along-track InSAR and conventional SAR, Oceanography From Space, Revisited, Springer Science+Business Media, pp.73-91, 2010.

Other Referee Papers

Bahurel, P, Adragna F, Bell MJ, Jacq F, **Johannessen JA**, Traon P-YL, Pinardi N, She J. 2010. Ocean monitoring and forecasting core services, the European MyOcean example. White paper in the proceedings of OceanObs09: Sustained Ocean Observations and Information for Society. ESA Publication WPP-306.

Breivik, L-A., T. Carrieres, S. Eastwood, A. Fleming, F. Girard-Ardhuin, J. Karvonen, R. Kwok, W. N. Meier, M. Mäkynen, L. Toudal Pedersen, **S. Sandven**, M. Similaand R. Tonboe. Remote sensing of sea ice. Peer review Community White Paper In OceanObs09, Edited by J. Hall, D. E. Harrison and D. Stammer. Vol. 2. Proceedings of OceanObs'09: Sustained Ocean Observations and Information for Society. ESA Publication WPP-306 2. Venice Italy, 21-25 Sept. 2009: European Space Agency, 2010.

Chapron, B, Bingham A, Collard F, Donion C, **Johannessen JA**, Piollé J-F, Reul N. 2010. Ocean Remote Sensing Data Integration - Examples and Outlook, White paper in the proceedings of OceanObs09: Sustained Ocean Observations and Information for Society. ESA Publication WPP-306.

Dushaw B., Whitlow Au, A. Beszczynska-Möller, R. Brainard, B.D. Cornuelle, T. Duda, M. Dzieciuch, A. Forbes, L. Freitag, J-C. Gascard, A. Gavrilov, J. Gould, B. Howe, S.R. Jayne, **O.M. Johannessen**, J.F. Lynch, D. Martin, D. Menemenlis, P. Mikhalevsky, J.H. Miller, S.E. Moore, W.H. Munk, J. Nystuen, T.I. Odom, J. Orcutt, T. Rossby, **H. Sagen, S. Sandven,** et al. A Global Ocean Acoustic Observing Network. White paper in the proceedings of OceanObs09: Sustained Ocean Observations and Information for Society. ESA Publication WPP-306.

Shum, CK, Plag H-P, Schröter J, Zlotnicki V, Bender P, Braun A, Cazenave A, Chamber D, Duan J, Emery W, **Johannessen JA** et al. 2010. Geodetic observations of the ocean surface topography, geoid, currents and changes in ocean mass and volume. White paper in the proceedings of OceanObs09: Sustained Ocean Observations and Information for Society. ESA Publication WPP-306.

Popular Science Articles & Broadcast

Johannessen, O.M.: Norge er en sinke innen forskning, Bergens Tidende and bt.no, 2010.

Johannessen, J.A.: Vi tar pulsen på planeten, Bergens Tidende, 2010.

Johannessen, O.M.: Hvor er satsing på norsk forskning?, Bergens Tidende, Bergens Tidende, 2010.

Johannessen, O.M.: The Arctic ice - Future perspectives, Forskning.no, 2010.

Johannessen, O.M.: Forskning og grunnbevilgninger, Forskning.no, 2010.

Johannessen, O.M.: Petermanns flytende is-shelf brekker opp, Forskning.no, 2010.

Johannessen, O.M.: Isen i Arktis - fremtidige perspektiver, Forskning.no, 2010.

Conference Proceedings

Alexandrov, V, Sandven S, Johannessen OM, Bobylev L, Yarygina A, Volkov VA, Zakhvatkina NY. 2010. Methodology of Complex Analysis of Sea Ice SAR Images. ESA Living Planet Symposium, 28. June - 2. July, 2010, Bergen, Norway, ESA Proceedings SP-686.

Alexandrov, V, Sandven S. 2010. Analysis of Arctic ice thickness, freeboard and snow cover from the data of Russian Sever expeditions. ESA Living Planet Symposium, 28. June - 2. July, 2010, Bergen, Norway, ESA Proceedings SP-686.

Alpers, W, Ivanov YA, **Dagestad K-F.** 2010. Investigation of coastal wind fields over the Black Sea using Envisat Synthetic Aperture Radar images. ESA Living Planet Symposium, 28. June - 2. July, 2010, Bergen, Norway, ESA Proceedings SP-686.

Backeberg, B, **Johannessen JA**, Rouault M, Veitch J. 2010. Preliminary inter-model comparison of the Agulhas Current with direct range Doppler velocity estimates from Envisat's Advanced Synthetic Aperture Radar. ESA Living Planet Symposium, 28. June - 2. July, 2010, Bergen, Norway, ESA Proceedings SP-686.

Bahurel, P, Bell MJ, Jacq F, **Johannessen JA**, Le Traon PY, Pinardi N, She J, Adragna F. 2010. The MyOcean GMES Marine Core Service for Ocean monitoring and forecasting. ESA Living Planet Symposium, 28. June - 2. July, 2010, Bergen, Norway, ESA Proceedings SP-686.

Breivik, L-A, Ardhuin F, Dinessen F, Dybkjær G, Eastwood S, Fleming A, **Hamre T**, Karvonen J, Lavergne T, Pedersen LT et al. 2010. MyOcean SIW TAC, Sea Ice products and service. ESA Living Planet Symposium, 28. June - 2. July, 2010, Bergen, Norway, ESA Proceedings SP-686.

Dagestad, K-F, Johannessen JA, Hansen MW. 2010. Wind Retrieval over the Ocean from Combined Use of Synthetic Aperture Radar and Weather Forecast Models. ESA Living Planet Symposium, 28. June - 2. July, 2010, Bergen, Norway, ESA Proceedings SP-686.

Dagestad, K-F, Kudryavtsev VN, Johannessen JA, Hansen MW. 2010. A Radar Modulation Transfer Function for Oceanic Internal Waves. ESA Living Planet Symposium, 28. June - 2. July, 2010, Bergen, Norway, ESA Proceedings SP-686.

Dagestad, K-F, Mouche A, Collard F, **Hansen MW, Johannessen JA**. 2010. On The Use Of Doppler Shift For SAR Wind Retrieval. 3rd International Workshop SEASAR 2010. ESA-SR-679 Proceedings.

Djolov, G, **Esau I.** 2010. International conference on planetary boundary layer and climate change. International conference on planetary boundary layer and climate change, IOP conference series: Earth and environmental science, Vol. 13.

Dransfeld, S, Fernandez D, Doron M, Martinez E, Shutler J, Papandrea E, Biggs J, **Dagestad K-F**, Palazzi E, Garcia-Comas M et al. 2010. The Changing Earth Science Network - Projects and Results from the First Call. ESA Living Planet Symposium, 28. June - 2. July, 2010, Bergen, Norway, ESA Proceedings SP-686.

Esau, I, Zilitinkevich S, Djolov G, deW. Rautenbach CJ. 2010. A Micro-Meteorological Experiment in the Atmospheric Boundary Layer in Highveld Region. International Conference on Planetary Boundary Layer and Climate Change. IOP conference series: Earth and environmental science, Vol. 13.

Esau, I. 2010. Large-eddy simulation of the urban boundary layer in the MEGAPOLI Paris Plume experiment. EGU General Assembly 2010. 12 (EGU2010-13050)

Esau, I. 2010. Large-scale urban boundary layer turbulence: An example of large-eddy simulations for a megacity. ENVIROMIS-2010.

Hamre, T, Groom S, **Sandven S.** 2010. Interoperable GMES services for environmental risk management in marine and coastal areas. Proceedings of the 5th EuroGOOS Conference, Coastal to Global Operational Oceanography: Achievements and Challenges.

Hansen, MW, Dagestad K-F, Johannessen JA, Mouche A, Collard F. 2010. ASAR surface velocity retrievals in the Northeast Atlantic. ESA Living Planet Symposium, 28. June - 2. July, 2010, Bergen, Norway, ESA Proceedings SP-686.

Hansen, MW, Kloster K, Dagestad K-F, Sandven S, Johannessen JA. 2010. Retrieval of sea ice drift from SAR doppler shift. ESA Living Planet Symposium, 28. June - 2. July, 2010, Bergen, Norway, ESA Proceedings SP-686.

Huang, W, **Johannessen JA**, Alpers W. 2010. Progress toward Demonstrating SAR Monitoring of Chinese Seas. ESA Living Planet Symposium, 28. June - 2. July, 2010, Bergen, Norway, ESA Proceedings SP-686.

Johannessen, JA, Chapron B, Collard F, Mouche A, Rouault M, Tounadre J. 2010. ENVISAT ASAR: A speed-gun in space. 3rd International Workshop SEASAR 2010. ESA-SR-679 Proceedings.

Johannessen, OM, Ivanova N. 2010. Sea Ice Passive Microwave Algorithms and SAR Validation. ESA Living Planet Symposium, 28. June - 2. July, 2010, Bergen, Norway, ESA Proceedings SP-686.

Johannessen, OM, Khvorostovsky K, Chen L. 2010. Recent Ice-Sheet Decay in the Interior of Greenland. ESA Living Planet Symposium, 28. June - 2. July, 2010, Bergen, Norway, ESA Proceedings SP-686.

Johannessen, OM, Miles V, Korablev A. 2010. Variability of the Helheim Outlet Glaciers in the Sermilik Fjord on the East Coast of Greenland. ESA Living Planet Symposium, 28. June - 2. July, 2010, Bergen, Norway, ESA Proceedings SP-686.

Kloster, K, Sandven S, Wåhlin J. 2010. Ice Motion and Ice Area Flux in the Fram Strait. ESA Living Planet Symposium, 28. June - 2. July, 2010, Bergen, Norway, ESA Proceedings SP-686.

Korosov, A, Pettersson LH. 2010. Detection of Decadal Cimate Change Based on Consistent Satellite Observation of the Nordic Seas Aquatic Ecosystem. ESA Living Planet Symposium, 28. June - 2. July, 2010, Bergen, Norway, ESA Proceedings SP-686.

Kudryavtsev, VN, Myasoedov AG, Chapron B, **Johannessen JA**, Collard F. 2010. Synergy of SAR and optical imagery in studies of mesoscale ocean dynamics. 3rd International Workshop SEASAR 2010. ESA-SR-679 Proceedings.

Melentyev, VV, Chernook VI, Melentyev KV, **Bobylev L, Pettersson LH, Sandven S.** 2010. ASAR Catalogue Ice Parameters Valid for Sustainable Development Harp Seals White Sea, Newfoundland, Jan-Mayen Population. ESA Living Planet Symposium, 28. June - 2. July, 2010, Bergen, Norway, ESA Proceedings SP-686.

Melentyev, VV, Chernook VI, Melentyev KV, **Bobylev L, Pettersson LH.** 2010. ENVISAT ASAR Technology for Monitor of Habitat of Ice-Accociated Marine Mammals as Measure Stability of Living Atric. ESA Living Planet Symposium, 28. June - 2. July, 2010, Bergen, Norway, ESA Proceedings SP-686.

Myasoedov, AG, **Kudryavtsev VN**, Chapron B, **Johannessen JA.** 2010. Sunglitter imagery of ocean surface phenomena. 3rd International Workshop SEASAR 2010. ESA-SR-679 Proceedings.

Nickola, MM, **Esau I**, Djolov G. 2010. Determining astronomical seeing conditions at Matjiesfontein by optical and turbulence methods. International Conference on Planetary Boundary Layer and Climate Change. 13, no. 012010

Pettersson, LH, Korosov A, Hamre T, Samuelsen A. 2010. Integrated Monitoring and Forecasting of Harmful Algae Bloom Events in Coastal Waters. ESA Living Planet Symposium, 28. June - 2. July, 2010, Bergen, Norway, ESA Proceedings SP-686.

Pozdnyakov, D, Morozov E, **Korosov A, Pettersson LH.** 2010. Observation of Multi-Year Spatial Dynamics of Biogeochemical Variables in the Bay of Biscay from Space. ESA Living Planet Symposium, 28. June - 2. July, 2010, Bergen, Norway, ESA Proceedings SP-686.

Sagen, H, Sandven S, Beszczynska-Möller A, Boebel O, Duda TF, Freitag L, Gascard JC, Gavrilov AN, Lee CM, Mellinger DK et al. 2010. Acoustic technologies for observing the interior of the Arctic Ocean. Ocean Obs´09: Sustained Ocean Observations and Information for Society. ESA Publication WPP-306.

Sagen, H, Sandven S, Skarsoulis E, Worcester PF,

Beszczynska-Möller A, **Bertino L, Haugen SA**, Dzieciuch MA, Piperakis G, Kalogerakis M et al. 2010. The Fram Strait tomography system for ocean model validation, assimilation, and inversion. International Polar Year Science Conference, 8-12 June 2010, Oslo, Norway.

Sandven, S, Kloster K, Geyer F, Dumont D, Babiker M. 2010. Sea ice drift and area flux in the Fram Strait from SAR data. International Polar Year Science Conference, 8-12 June 2010, Oslo, Norway.

Simon, E, Bertino L. 2010. Joint state-parameter estimation in a 3-D coupled physical-ecosystem model of the North Atlantic: assimilation of SeaWiFS data with a non-Gaussian extension of an ESRF. ESA Living Planet Symposium, 28. June - 2. July, 2010, Bergen, Norway, ESA Proceedings SP-686.

Smirnov, AA, **Korablev A**, Alekseev GV, **Esau I.** 2010. Temporal and spatial changes in mixed layer properties and atmospheric net heat flux in the Nordic Seas. Extended Abstract. International Conference on Planetary Boundary Layers and Climate Change. 13, no. 012006

Technical & Special Reports

Sandven, S., Kahrs, H.R., Eknes, E., Kvingedal, B., Bruserud, K., Nilsen, F., Wåhlin, J., **Sagen, H., Kloster, K.**: ICESONAR Monitoring of sea ice thickness from a subsea 4D sonar, NERSC Tech. Rep. 294, 2010.

Hamre, T., Sandven, S.: D7-7 InterRisk Final Scientific Report, NERSC Technical report no. 309, NERSC, No. 309, 2010.

Sandven, S., Hamre, T., Babiker, M., Kloster, K., Hansen, M.W., Wåhlin, J., **Kudryavtsev, V.**, Myasoedov, A.G., **Alexandrov, V.**, Melentyev, V V., Zakhvatkina, N.Y., Yarygina, A O., Feoktistov, A A., Novikova, N N., Denisov, P V., Malinovsky, V., Spivak, L.: MONRUK SAR data analysis report: Monitoring the marine environment in Russia, Ukraine and Kazakhstan using Synthetic Aperture Radar, NERSC Technical report no. 310, NERSC, No. 310, 2010.

Dumont, D., Lisæter, K.A., Bertino, L.: Sea Ice Modelling of the Marginal Ice Zone July 2007 - June 2010, NERSC technical report no. 311, NERSC, No. 311, 2010.

Samuelsen, A., Bertino, L.: Lofoten and Vesterålen currents - LOVECUR, NERSC Technical report no. 312, NERSC, No. 312, 2010

Vionnet, V.: Sea ice model evolution: influence of the snow cover, NERSC Technical report no. 313, NERSC, No. 313, 2010.

Samuelsen, A., Bertino, L.: Lofoten and Vesterålen currents (LOVECUR) mid-term report, NERSC Technical report no. 314, NERSC, No. 314, 2010

Dumont, D., Bertino, L.: Validation of ice drift in a HYCOM model of the Fram Strait August - December 2010, NERSC Technical report no. 315, NERSC, pp.23, No. 315, 2010.

Counillon, F., Bentsen, M., Bertino, L.: Implementing the EnKF into NorESM, NERSC Technical report no. 316, 2010.

Ness, B., Counillon, F., Dumont, D.: Sensitivity of the Arctic and North Atlantic Oceans to the Bering Strait inflow: A modeling study, NERSC Technical report no. 317, NERSC, No. 317, 2010

Bertino, L., Sakova, I., Samuelsen, A.: Ocean weather and ecosystem, progress report, NERSC Technical report no. 319, No. 319, 2010.

Dagestad, K.F.: INverting consistent surface CUrrent fields from SAR (INCUSAR), NERSC, No. -, 2010

Others Reports

Esau, I.: Urbanized Turbulence-Resolving Model and Evaluation for Paris, pp.20,, ISBN 978-87-992924-9-3, 2010.

Esau, I.: Analysis of the planetary boundary layer with a database of large-eddy simulation experiments, Arxiv.1011.1815, Cornell University, 2010.

Esau, I.: Numerical Experiments for Central Paris with Urbanized Large-Eddy Simulation Model PALM (MEGAPOLI Del 2.4), MEGAPOLI Newsletters, No. 7, 2010.

Esau, I.: Numerical experiments with assimilation of the mean and unresolved meteorological conditions into large eddy simulation model, preprint from MEGAPOLI "Emissions, urban, regional and Global Atmospheric POLlution and climate effects, and Integrated tools for assessment and mitigation" project, 2010.

Haugen, S.A., Sagen, H., Sandven, S., Dzieciuch, M.A., Worcester, P.F., Skarsoulis, E., Piperakis, G., Kalogerakis, M.: Results from the Fram Strait acoustic tomography experiment and system evaluation, DAMOCLES deliverable D8.2-06, No. D8.2-06, 2010.

Sagen, H., Sandven, S., Worcester, P.F.., Kemp, J.: Report on Tomography Array ready for deployment, ACOBAR Deliverable D3.2, No. D3.2, 2010

Sagen, H., Dumont, D., Beszczynska-Möller, A., **Haugen, S.A., Sandven, S.**: DAMOCLES deliverable D4.1-06 - Report describing the validation experiment of FRAM strait model, DAMOCLES deliverable D4.1-06, No. D4.1 -06, 2010

Sagen, H., Haugen, S.A., Sandven, S.: Results of assimilation of acoustic measurements into TOPAZ-3, DAMOCLES deliverable D4.2-05, No. D4.2-05, 2010

Doctoral Dissertations

Backeberg, B.: Modelling the mesoscale variability in the greater Agulhas Current System using a Hybrid Coordinate Ocean Model, Doctoral Thesis No. 83, Department of Oceanography, University of Cape Town, South Africa, 2010.

Chen, L.: Greenland Ice Sheet Surface Elevation Change and Influence of Atmospheric Teleconnections in the Northern Hemisphere, Doctoral Thesis No. 90, 2010.

Geyer, F.: Overflow and topographically induced mixing on the Svalbard shelf, Doctoral Thesis No. 82, University of Bergen, 2010.

Keghouche, I.: Modeling the dynamics and drift of icebergs in the Barents Sea, Doctoral Thesis No. 85, University of Bergen, Geophysical institute, pp.73, ISBN 9788230816158, 2010.

Nondal, G.: A study of the high and mid latitude biogeochemistry in the Atlantic Ocean: The influence of surface processes, Doctoral Thesis No. 88, NERSC, 2010.

Sakova, I.: Low-ferquency modes of variability of the Indian Ocean and the Connection with the Indian Ocean dipole, Doctoral Thesis # 89, NERSC/ University of Tasmania, Australia, 2010.

Seiler, A.: Reservoir structural model updating using the Ensemble Kalman Filter, Doctoral Thesis No. 87, University of Bergen, Department of Mathematics, 2010.

Master Thesis

Duarte, K.B.: An unpleasant truth about Norwegian newspapers coverage of the climate science?, Master Thesis No. 84, Institutt for informasjons- og medievitenskap, Universitetet i Bergen, pp.113, 2010

Haugen, S.A.: Acoustic Tomography in the Fram Strait: - Predicted and measured travel times, Master Thesis No. 86, 2010.

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Atlantic and Arctic occean modelling and forecasting:
http://TOPAZ.nersc.no and
http://myocean.eu.org
Monitoring of Arctic sea ice parameters:
http://arctic-roos.org
Monitoring of harmful algae blooms:
http://HAB.nersc.no

From the foundation seremony of the Nansen-Tutu Centre for Marine Environmental Research in Cape Town in May 2010. First row from the left: Prof. Berit Rokne, Archbishop Desmund Mpilo Tutu and Prof. George Philander. Second row from the left: Ambassador Tor Chr. Hildan, Prof. Johnny A. Johannessen, Prof. Frank Shilingtopn, Dr. Neville Sweijd, Mr Hans Erstad, Prof. John Field and Mr Lasse H. Pettersson. Photo: Katherine Traut, UCT.

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